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2,495,274

ELECTRICAL DISCHARGE DEVICE

Filed Dec. 19, 1944

2 Sheets-Sheet 1

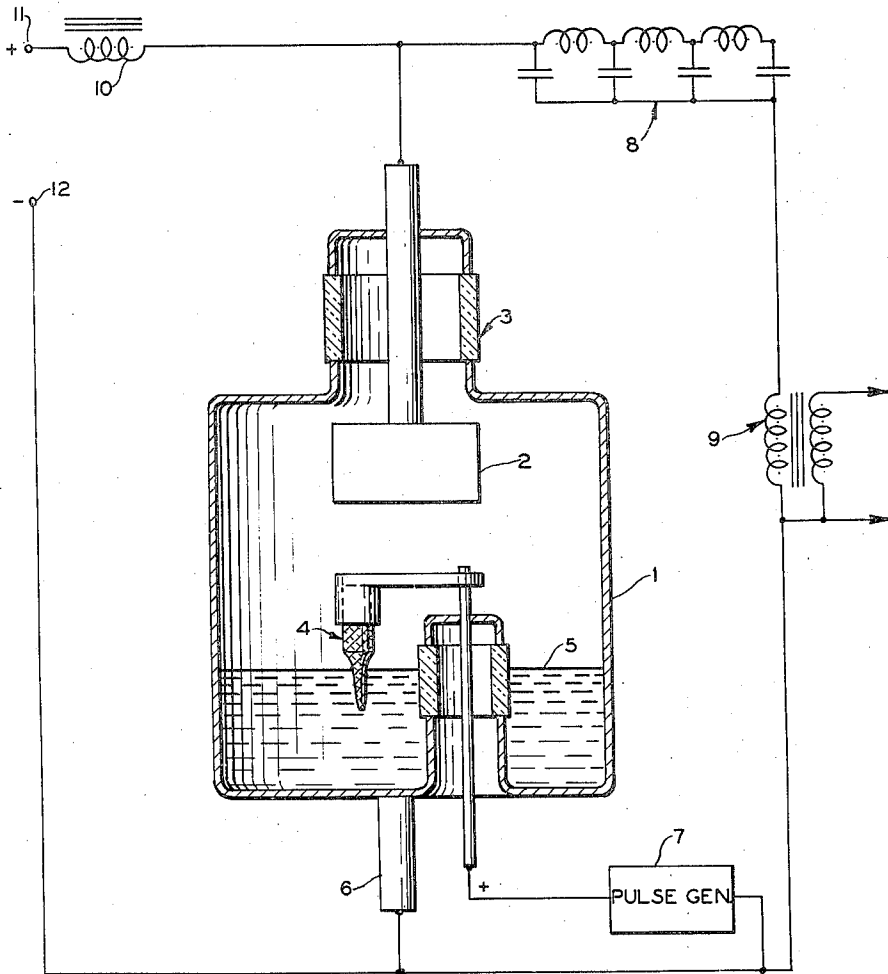


FIG. 1

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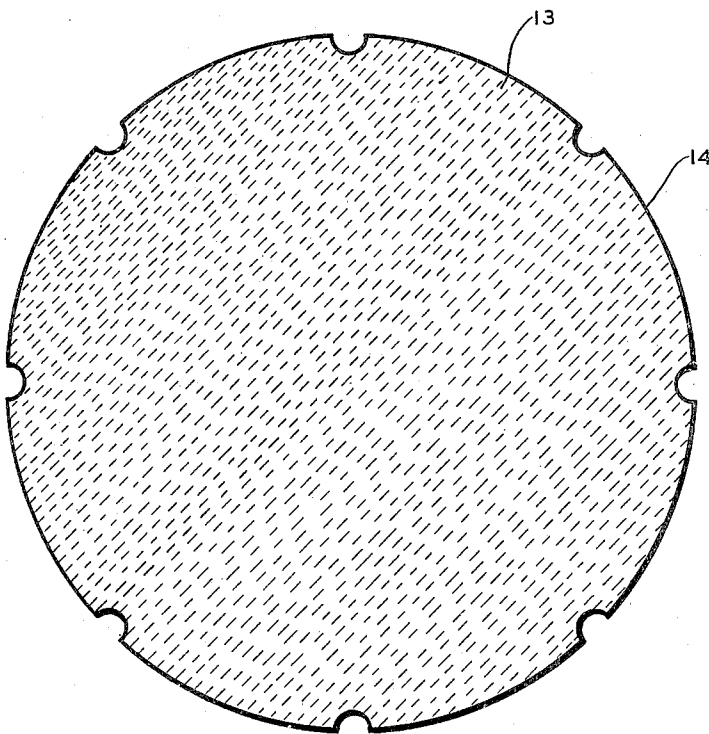


FIG. 2.

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ELECTRICAL DISCHARGE DEVICE

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to the United States of America as represented
by the Secretary of War

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4 Claims. (Cl. 250—27.5)

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amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

My invention relates to electrical discharge devices of the mercury pool type in which the discharge is initiated by an auxiliary electrode partly submerged in a pool of mercury.

Devices of this type, commonly called ignitrons, contain a control electrode, or igniter, which is partially immersed, permanently, in the pool cathode. The igniter electrode, usually a rod of high-resistance refractory material such as boron or silicon carbide, is shaped in the form of a cone-like solid of revolution. When this rod is immersed in the mercury, the surface tension of the mercury produces a very small separation between rod and mercury below the surface of the pool. Part of the voltage applied between the igniter and the mercury pool is thus caused to act across a very thin vapor-filled space, and the electric field in that space is correspondingly high. The field ionizes the vapor and the arc starts. The cathode spot, very minute at first, immediately increases in size and rises to the surface of the pool. Thereafter the anode attracts the required electron emission from the spot and the anode current flows.

The time required for the ignition of the arc by the igniter electrode is very short and is usually somewhat less than 50 microseconds, although initiating pulses of the order of 0.5 to 2 microseconds are not uncommon.

The power required for the initial discharge is quite high, the starting voltage ranging approximately from 100 to 250 volts and the starting current ranging approximately from 3 to 40 amp. But since the starting power need be applied only for about 50 microseconds, the average power (in 60-cycle service) required for ignition may be only a fraction of a watt.

It is an object of this invention to reduce the power which must be supplied to the initiating electrode or igniter to start the main discharge. This is accomplished by introducing into the initiating electrode or igniter rod, a relatively small amount of a radio-active material. Polonium, one of the break-down products of radium having great activity and moderate life, may be used. The purpose of the radio-active material is to assist in the process of ionization.

The materials used in the initiating electrode, commonly called the igniter, are usually high resistance refractories such as boron carbide or silicon carbide. The introduction of radio-active

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material into the igniter electrode may be accomplished in a number of ways.

One method is to place the boron or silicon carbide of the electrode in a solution of a salt of the radio-active substance. The solution is then evaporated by any well known method, leaving the radio-active salt in the pores of the boron or silicon carbide.

Another method is to deposit the radio-active substance in the pores of the boron or silicon carbide by electrolysis.

Still another method is to crush the carbide crystals to small particles after which they are mixed with a small amount of the radio-active substance. A binder is then added to the mixture after which it is moulded to the required shape and baked at the carbonizing temperature of the binder.

When the igniter electrode is in its normal position, partly submerged in the mercury pool, the surface tension of the mercury prevents intimate contact with all the irregularities of the igniter. This leaves a small separation between the mercury and the electrode below the surface of the pool. The positive potential applied to the igniter electrode acts across this very thin vapor filled space and, because of the shortness of the distance, the electric field intensity is high and ionization occurs by the direct action of this high intensity field. Ionization by this direct unassisted action of the electric field is slow and inefficient.

However, when a radio-active material is added to the igniter electrode, there exists a continuous discharge of Alpha particles, Beta high speed electrons, and extremely short X-rays across the thin vapor sheath which separates the mercury from the electrode. The impact of these active ionizing radiations on the mercury surface and mercury vapor molecules produces ions in the vapor film and thereby reduces the field intensity required to initiate the discharge.

For a better understanding of the invention, reference is made to the following specification of a device embodying the invention, the said specification to be read in connection with the accompanying drawings, in which,

Figure 1 is a view, partly in cross section, of a device embodying the invention, external circuit elements thereto being shown schematically, and

Figure 2 is an enlarged cross-sectional view of an electrode embodying the invention.

In Figure 1 is shown a system using an ignitron device for producing power pulses of high intensity and short duration. The ignitron dis-

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charge device is shown generally by the designation 1. The anode 2 is insulated from the metal body by a glass section 3. The igniter electrode 4 dips into the mercury pool 5 which forms the cathode for the main discharge. A pulse generator 7, well known in the art, supplies positive pulses to the igniter electrode 4. The energy for the system is supplied by a high voltage D. C. source not shown, connected to terminals 11 and 12. This energy is fed through choke coil 10 to the condensers of the pulse forming network 8, which pulse forming network is well known in the art.

Each time the pulse generator 7 supplies a positive pulse to the igniter electrode 4 a main discharge is initiated between the anode 2 and the mercury pool 5. The energy for this discharge is supplied by the energy storing pulse forming network 8. The discharge ceases when this stored energy is exhausted. The pulse transformer 9 serves to transfer the pulse energy to a work circuit such as a high frequency oscillator. Thus each time a pulse is applied to the igniter electrode 4, the energy stored in the network 8 is discharged as a rectangular pulse into the work circuit.

By providing radio-active material in the igniter electrode the ionizing process is effected with less energy so that the size and cost of the pulse generator may be reduced.

Referring to Figure 2 the electrode 4 consists of a base or core 13 of high resistance refractory material, superficially interrupted by porous depressions, and a thin coating 14 of radio-active material disposed about said core and imbedded in the said porous depressions. It will be understood that the thickness of the coating 14 is exaggerated, the said coating actually being extremely thin.

Although Figure 2 shows a complete surface coating, it will be apparent that the completeness of the coating is dependent upon the amount of radio-active material that is used. In many applications it will be sufficient if the amount used is so small that only the porous depressions are filled. It will be further apparent that the radio-active material may be dispersed throughout the body of the core rather than being coated on the surface thereof.

Although I have shown but one use of and but a few methods of making a radio-active electrode, it is obvious that other uses and methods

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are possible, and the invention is to be read in the spirit of the appended claims.

I claim:

1. In a gas discharge device having an anode, a mercury cathode, and a starter electrode formed of high resistance refractory material having an irregular surface characterized by a plurality of pores partly submerged in the mercury cathode, means for reducing the energy required to initiate the discharge, said means including a deposit of radio-active material on the surface and in the pores of the refractory material of said starter electrode, said radio-active material having a radio activity at least comparable to polonium.

2. The device as defined in claim 1 in which the radio-active material is polonium.

3. In a gas discharge device for producing short pulses of electrical energy including an anode, a mercury cathode, and a starter electrode formed of high resistance refractory material having an irregular surface characterized by a plurality of pores said electrode being partly submerged in the mercury cathode, means for reducing the energy required to initiate the discharge, said means including a deposit of radio-active material on the surface and in the pores of the refractory material of said starter electrode, said radio-active material having a radio activity of the order of polonium.

4. The device as defined in claim 3 in which the radio-active material is polonium.

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