

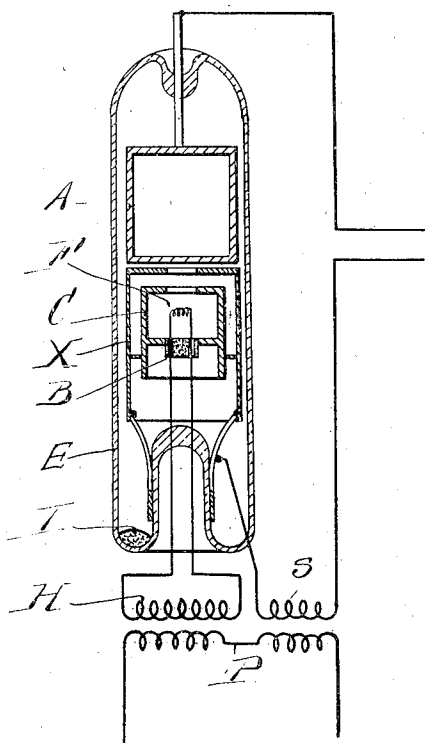
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GASEOUS CONDUCTION APPARATUS

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UNITED STATES PATENT OFFICE

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GASEOUS CONDUCTION APPARATUS

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This invention relates to gaseous discharge devices generally and particularly to glow rectifiers. Heretofore, gaseous glow tubes have required high voltages to start the gaseous discharge and this requirement has confined such devices, particularly gaseous rectifiers, to a narrow field of usefulness. The principal objects of the present invention are to enable such devices to start on lower voltages and at the same time make them rugged and durable.

According to this invention the enclosure containing the electrodes contains two gasses (or vapors). One gas, herein referred to as the first gas, is an easily ionizable gas, preferably vapor of caesium or other alkali metal or alkali earth metal such as calcium, strontium or barium. The other gas, herein referred to as the second gas is less easily ionized and preferably has one or more of the following characteristics: negligible or low electron affinity; passes electronic discharge readily; and inert with respect to the alkali gas. While various gases have certain of the requisite characteristics, the monatomic gases appear to have all these characteristics, and helium is particularly suitable. By virtue of its low ionization voltage the first gas may be readily ionized by light-radiating means or other auxiliary ionizing means to enable the discharge between electrodes to start on low voltage, after which the second gas is ionized sufficiently to maintain the discharge either independently or in conjunction with the ionization of the first gas.

The auxiliary ionizing means is preferably in the form of an incandescent solid. The incandescent solid is particularly effective when placed inside a hollow cathode.

For the purpose of illustration a rectifier embodying the invention is shown in the accompanying drawing in which E is the enclosure, preferably of glass, C the hollow cathode, A the anode, X a metal shield, F an incandescent filament, P the primary of a

transformer, S a secondary connected in series with the cathode-anode and load, and H a secondary connected to the filament F. The parts A, C, E and X are preferably cylindrical in cross-section. The cathode, anode and shield may be formed of tungsten or other suitable material. As illustrated the filament is preferably not connected to the load circuit of the rectifier so that its thermionic emission takes no part in the general flow of current, its purpose being merely to emit light and heat. The anode is mounted on a stem at the upper end of the tube and the shield X is mounted upon a stem at the lower end of the tube. As shown in the figure the cathode is supported by the shield. The spacing between the anode and shield and also between the tube E and the outer peripheries of the anode and shield is preferably so small that electrons traveling directly across either space do not substantially ionize the gas in the spaces.

While the two gases above referred to may be incorporated in the tube in various ways, when using caesium and helium the following procedure is recommended: First evacuate the enclosure E; then thoroughly free the electrodes from gas by heating during pumping; then distill a small quantity of pure caesium into the enclosure; and finally admit helium to the desired pressure, for example 1 cm. For illustration the caesium is indicated at I.

In operation the filament F is raised to the proper temperature to produce the desired degree of ionization. If the filament be heated to approximately 2200° C. for example, many of the caesium atoms will be excited by the heat to the radiation voltage level (1.45 volts) so that a large number of caesium molecules are at all times in an excited state. With the molecules (or atoms) in this excited state the relatively small amount of short-wave radiation coming from the filament readily ionizes the caesium suffi-

ciently to start on low voltage. The ionization by the filament is sufficiently intense directly to affect the voltage gradient between the cathode and anode, and causes the discharge to start at low voltage. After the start of the discharge, the filament current may be reduced, or even discontinued, but it is preferably continued to aid in production of ions near the cathode.

The discharge takes place between the anode and the interior of the cathode through the openings in the cathode and shield X. By making these openings small and passing a substantial discharge the ionized cesium vapor is pumped into the hollow cathode, as described in my application Serial No. 55,262, thereby maintaining a higher pressure of cesium vapor inside than outside the cathode. To maintain this pressure differential the lead opening through the bottom of the cathode is preferably closed with an insulation plug B.

I claim:

1. A gaseous discharge device comprising an enclosure containing electrodes including a hollow cathode having a restricted discharge opening, an easily ionizable gas, a second gas having low electron affinity, and means inside the hollow cathode for ionizing the first gas, whereby an electronic discharge may be started through said second gas on lower voltage.

2. A gaseous discharge device comprising an enclosure containing electrodes including a hollow cathode having a restricted discharge opening, an alkali vapor, a gas and heat and light radiating means inside the hollow cathode for ionizing said vapor, whereby an electronic discharge may be started through said gas on lower voltage.

3. A gaseous discharge device comprising an enclosure containing electrodes including a hollow cathode having a restricted discharge opening, an easily ionizable gas, a second gas having low electron affinity, and energy radiating means inside the hollow cathode for ionizing the first gas, whereby an electronic discharge may be started through said second gas on lower voltage.

4. A gaseous discharge tube containing a chamber-like cathode having a restricted discharge opening, an anode in spaced relation thereto and a hollow member partially enclosing the cathode, said hollow member being within an insulatingly short distance from the anode and walls of the tube.

5. A gaseous conduction device comprising an envelope containing a vapor having a low ionization potential and a gas having a higher ionization potential, a hollow equipotential cathode, a hollow metallic member surrounding said cathode, said cathode and member having coaxial apertures and an anode spaced an insulatingly short distance from said last mentioned hollow member.

6. A gaseous discharge device comprising the combination with an envelope, of a vapor within the envelope having a low ionization potential and a gas having a higher ionization potential, a hollow cathode, a hollow anode spaced from said cathode, a filament within the cathode, a hollow metallic member surrounding the cathode, the said cathode and metallic hollow member being apertured to permit passage of the discharge between the electrodes.

7. A unidirectional gaseous discharge device comprising a hermetically sealed vessel containing a cathode having a relatively large effective electrode area, an anode having a relatively small effective electrode area, a gaseous atmosphere in said vessel at a pressure at which after starting a unidirectional glow discharge will be maintained between said cathode and anode at a predetermined voltage drop but requiring a higher voltage for starting, and a heater in said vessel adjacent said cathode arranged to be operated at incandescence to lower the starting voltage of said device, said anode being arranged relatively to said cathode to eliminate long ionizing paths along which the reverse voltage on the anode could ionize said gas and produce a reverse current.

8. A unidirectional gaseous discharge device comprising a hermetically sealed vessel containing a hollow cathode having a relatively large interior electrode area, an anode having a relatively small effective electrode area, a gaseous atmosphere in said vessel at a pressure at which after starting a unidirectional glow discharge will be maintained between said cathode and anode at a predetermined voltage drop but requiring a higher voltage for starting, and a heater in said hollow cathode arranged to be operated at incandescence for lowering the starting voltage of said device, said anode being arranged relatively to said cathode to eliminate long ionizing paths along which the reverse voltage on the anode could ionize said gas and produce a reverse current.

9. A unidirectional gaseous discharge device comprising a hermetically sealed vessel containing a cathode having a relatively large effective electrode area, an anode having a relatively small effective electrode area, a gaseous atmosphere including an easy-to-ionize gas and a difficult-to-ionize gas in said vessel at a pressure at which after starting a unidirectional glow discharge will be maintained between said cathode and anode at a predetermined voltage drop but requiring a higher voltage for starting, and a heater in said vessel adjacent said cathode surface arranged to be operated at incandescence to initially ionize said easy-to-ionize gas and lower the starting voltage of said device.

10. A unidirectional gaseous discharge device comprising a hermetically sealed vessel

containing a hollow cathode having a relatively large interior electrode area, an anode having a relatively small effective electrode area, a gaseous atmosphere including an alkali vapor and a gas in said vessel at a pressure at which after starting a unidirectional glow discharge will be maintained between said cathode and anode at a predetermined voltage drop but requiring a higher voltage for starting, and a heater in said hollow cathode arranged to be operated at incandescence to initially ionize said vapor and lower the starting voltage of said device, said anode being disposed close to said cathode and arranged in the vessel to eliminate long ionizing paths along which the reverse voltage on the anode could ionize said gas and produce a reverse current.

11. A unidirectional gaseous discharge device comprising a hermetically sealed vessel containing an anode, a cathode structure having an extended electrode surface and constituting an enclosure around the space in front of said electrode surface, said enclosure having a discharge opening, an ionizable gas in said vessel in a quantity sufficient to sustain a space discharge between said anode and said cathode electrode surface at a voltage of the order of the cathode glow fall or less, an electrical heater within said enclosure for heating and exciting the gas therein and producing a discharge between said cathode electrode surface and said anode, and an independent electric energizing circuit for said heater, said energizing circuit being insulated from the circuit of the discharge in said device.

12. A unidirectional gaseous discharge device comprising a hermetically sealed vessel containing an anode, a hollow cathode constituting an enclosure around a part of the space in said vessel and having an extended interior solid electrode surface, said enclosure having a discharge opening, an ionizable gas in said vessel in a quantity sufficient to sustain a space discharge between said anode and said cathode electrode surface at a voltage of the order of the cathode glow fall or less, an electrical heater exposed within said enclosure for heating and exciting the gas therein and producing a discharge between said cathode electrode surface and said anode, and an independent electric energizing circuit for said heater, said energizing circuit being insulated from the circuit of the discharge in said device.

13. A unidirectional gaseous discharge device comprising a gas tight envelope containing a hollow cathode having a large-area interior electrode area, an anode arranged to maintain a unidirectional discharge with the interior of said cathode, a gaseous filling at a pressure sufficient to maintain a unidirectional glow discharge between said anode and the interior of said cathode, means associated

with said electrodes for limiting the discharge surface of said anode to a small area to limit reverse current flow to a negligible value, and a heater element inside said hollow cathode arranged to be heated to incandescence to ionize the discharge between said anode and said cathode.

Signed by me at Boston, Massachusetts, this tenth day of December, 1925.

CHARLES G. SMITH. 75

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