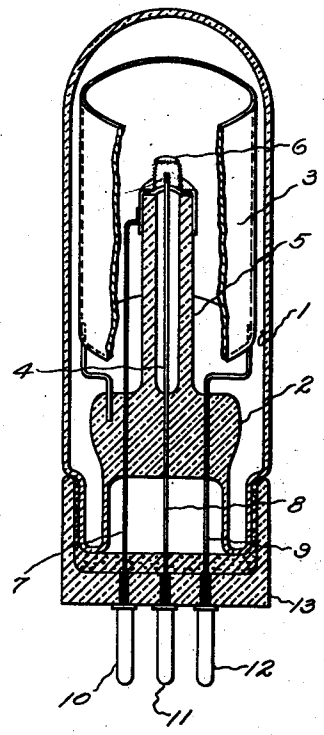
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ELECTRICAL DISCHARGE DEVICE

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ELECTRICAL DISCHARGE DEVICE

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My invention relates to electrical-discharge devices, and particularly to devices of the type known as "glow-tubes" which are normally utilized as voltage regulators.

One object of my invention is to provide a glow-tube of the usual type with self-contained discharge-controlling means.

Another object of my invention is to provide, in a glow tube capable of handling a comparatively large current, means, operated solely by potential changes and, consequently, drawing practically no current, for controlling the discharge.

Another object of my invention is to provide a gaseous relay that may be energized from a source of alternating current but which will give a rectified output suitable for the operation of direct-current relays.

Another object of my invention is to provide a gaseous relay having a large current output.

There is, at the present, a large field of usefulness for a potential-controlled relay capable of handling comparatively large currents. Multi-stage amplifiers, utilizing the usual three-electrode thermionic tubes have been employed in the past, but they are expensive to build and maintain in operation and are not entirely dependable. In addition, the thermionic amplifiers are not entirely satisfactory when an attempt is made to supply anode potential from a source of alternating potential.

I have accordingly designed a gaseous relay having two cold electrodes incorporated therein between which the output current passes, and a third, or control, electrode so arranged as to regulate the passage of the output current.

The novel features which I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following description and to the drawing.

If a potential is applied between an electrode having a large surface and a point electrode in the presence of an ionizable gas, a discharge will take place. Tubes have been developed for maintaining a constant voltage across the electrodes, regardless of the current flowing within certain limits and are known commercially as voltage-regulator glow-tubes.

It is generally known that the drop in voltage near the cathode of a glow-discharge tube is constant until the current is so large that the glow covers the whole cathode. The constant voltage drop at the cathode is called the cathode fall of potential and depends on the kind of gas used and the electrode material. When the gas is argon or neon and the cathode is made of, or coated with, sodium, potassium, or caesium, this cathode drop will be of the order of 90 volts.

A tube utilizing but two electrodes becomes active as soon as a critical voltage is applied. In order to adapt glow tubes of this type for use as relays, it was accordingly necessary to provide means for instantaneously stopping or starting the discharge independently of the applied voltage. In my improved relay I have utilized, for this purpose, an element somewhat analogous to the grid used in the ordinary thermionic tube.

Other objects of my invention will become evident from the following detailed description, taken in conjunction with the accompanying drawing, in which:

The figure is a view, partly in elevation and partly in section, of a preferred embodiment of my invention.

Referring specifically to the figure, my discharge device comprises a glass envelope 1 having mounted therein a press 2 from which are supported a cylindrical cathode 3 and a central anode 4. The central anode 4 is surrounded by a glass tube 5 which is either continuous with, or is welded to, the material of the press 2. A metallic screen element 6 encircles the glass tube and fits closely over the exposed upper end of the anode 4. Suitable conducting leads 7, 8 and 9 extend from the various electrodes to the exterior of the tube and are connected to a plurality of contact posts 10, 11 and 12 carried by a base element 13, into which the tube is cemented.

The cylindrical cathode 3 may be made of substantially any metal, although I have preferably employed nickel for this purpose. The grid or screen 6 and the anode are also preferably made of nickel.

It is very important that the grid be placed quite close to the exposed end of the wire, a space of $\frac{1}{16}$'' therebetween being amply sufficient.

In the manufacture of the device, the glass envelope carrying the various electrodes is first carefully exhausted while being heated at a temperature of 460° C. The preliminary exhaust should last for at least an hour in order to make sure that all occluded gas and water vapor are driven out of the electrodes.

A small amount of argon or neon is then admitted into the tube, sufficient being used to raise the pressure therein to approximately two

millimeters of mercury. I have utilized helium with fair results, though I prefer argon or neon.

Before removing the tube from the source of gas, an alternating potential of approximately 440 v. is applied between the anode and the cathode, and the gas pressure is adjusted until a glow discharge occurs between these electrodes at a predetermined potential. The tube is then sealed off and may be supplied with a base, as indicated in the drawing, if desirable.

In operation, a source of alternating potential is applied between the anode 4 and the cathode 3. If the grid element 6 is grounded, the gas in the tube will ionize and conduct current at a definite potential, in the same manner as in glow tubes of the usual type. The current is mainly from the wire anode to the cylindrical cathode, the percentage of inverse current being very small.

If the grid is now insulated from ground, electrons will be accumulated thereby during such times as the electrode 4 is negative. When the polarity changes so that the electrode 4 is positive and the electrode 3 is negative, the previously accumulated charge on the grid remains, and each successive reversal in polarity serves to increase it. This negative charge on the grid lowers the effective gradient between the grid and the electrode 3 to a value insufficient to cause ionization and increases the gradient between the grid and the electrode 4. The distance between the grid and the electrode 4, however, is quite small as compared to the distance between molecules of the gas, so that a glow discharge does not occur between the said electrodes. The insulating property of gases between closely spaced electrodes is quite well known in the art and is styled the "short path" principle. It is based on the fact that a gas between electrodes will not ionize if the electrodes are spaced apart by a distance no greater than the mean free path of a molecule of the gas. It is thus apparent that, with the proper alternating potential impressed between the electrodes 4 and 3 and with the grid floating, only a very small current will flow when the central electrode is the cathode, and substantially no current will flow when the central electrode is the anode.

If, however, the grid is grounded in order to prevent a charge being accumulated thereon or to conduct away a previously accumulated charge, this grid-effect is lost, no charge being present to prevent a current flow when the cylindrical element becomes the cathode. The result is that a rectified alternating current flows in the same manner as in any well known point-to-plane rectifier.

When charged, the grid potential is extremely high, making it possible to remove the charge through a resistance of a megohm or more to ground. In certain instances, it is not even necessary to connect the grid to ground in order to remove the charge, contact with the body, or with any object having an appreciable capacity, being sufficient to lower the potential to the point at which the discharge starts.

The sensitivity of the device to the grid charge may be varied by varying the operating voltage on the tube. If the voltage is raised, the grid will charge to a higher potential and the tube becomes more sensitive. With lower voltage, a better contact with ground is necessary to remove the charge, in order to render the tube conductive.

The device is practically self-adjusting. If the grid is left free and unconnected to ground, or to a capacity area, it will of itself, assume a charge sufficient to block the main discharge in the tube.

The output of rectified current when the tube is energized from an alternating current source may be as high as 100 milliamperes at 100 volts. This current is amply sufficient to energize a ten-watt incandescent lamp connected directly in circuit with the discharge device.

My relay device is useful in a variety of applications. As a burglar-alarm-controlling device, an arrangement could be made in which a door knob would be insulated from ground and connected to the grid, or the grid could be connected to any other object which an intruder would be likely to handle. Upon touching the protected object, the grid charge would immediately be dissipated and the output current of the device could then be utilized to either ring a bell or actuate an indicating device of some other type.

The device would also be useful in connection with recording meters and the like, where a pointer, incapable of carrying a heavy current, could be utilized to carry off the grid charge.

It is also feasible to control the leakage of the grid charge by means of a photo-electric cell, thus giving an indication when the light reaches a certain predetermined condition. When the photo-cell is excited by a source of light, the potential of the grid 6 is increased, and the tube breaks down under the action of a voltage applied across the anode and cathode.

The photo cell could obviously be extremely small and inexpensive, inasmuch as it would merely be utilized to vary the conductivity of a leakage path for the grid charge.

Although I have illustrated and described a specific embodiment of my invention, obvious modifications will be apparent to those skilled in the art. My invention, therefore, is not to be limited except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. A gaseous rectifier device comprising a cylindrical cathode, an elongated anode supported substantially axially of said cathode, insulating means closely surrounding said anode for the major portion of its length and a screen electrode supported by the insulating means and positioned in the path normally traversed by electrons between said electrodes.

2. An electrical discharge device comprising a cathode, an anode, a cylindrical insulator surrounding said anode, said cylindrical insulator having a perforated end and a cap electrode on the perforated end of said cylindrical insulator.

3. A discharge device containing a gaseous medium and comprising a non-thermionic cathode, an anode spaced therefrom, and a control electrode spaced from and shielding said anode from said cathode and insulation means surrounding all of said anode except for a portion shielded by said control electrode and said portion being spaced from said control electrode a distance of the order of the mean free path of a molecule of said medium.

4. An electrical-discharge device comprising a container having a gas therein at reduced pressure, a non-thermionic cathode therein comprising a solid conductive surface, an anode having a surface exposed to said gas, said surface

being small compared with the surface of said cathode and a control-electrode shielding said anode at a distance therefrom of the order of the mean free path of said gas and insulation means surrounding all of said anode except for a relatively small fraction of the area of said anode, said area being the active portion of said anode.

5. A discharge tube having a gas and two non-thermionic electrodes, one having a large surface and the other a very small surface, a control-electrode shielding the smaller of said electrodes and in the path of current flow between said electrodes, the spacing between said control-electrode and said smaller electrode being of the order of the mean free path of the molecules of said gas and insulation means surrounding all of said smaller electrode except for a relatively small fraction of the area of said smaller electrode, said area being the active portion of said smaller electrode.

6. A discharge tube having a gas and two non-thermionic electrodes as anode and cathode, the cathode having a large surface and the anode a small surface, a control-electrode shielding the small surface anode and in the path of current flow between said electrodes, the spacing between said control-electrode and said anode being of the order of the mean free path of the molecules of said gas, and insulation means surrounding all of said anode except for a portion shielded by said control-electrode.

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