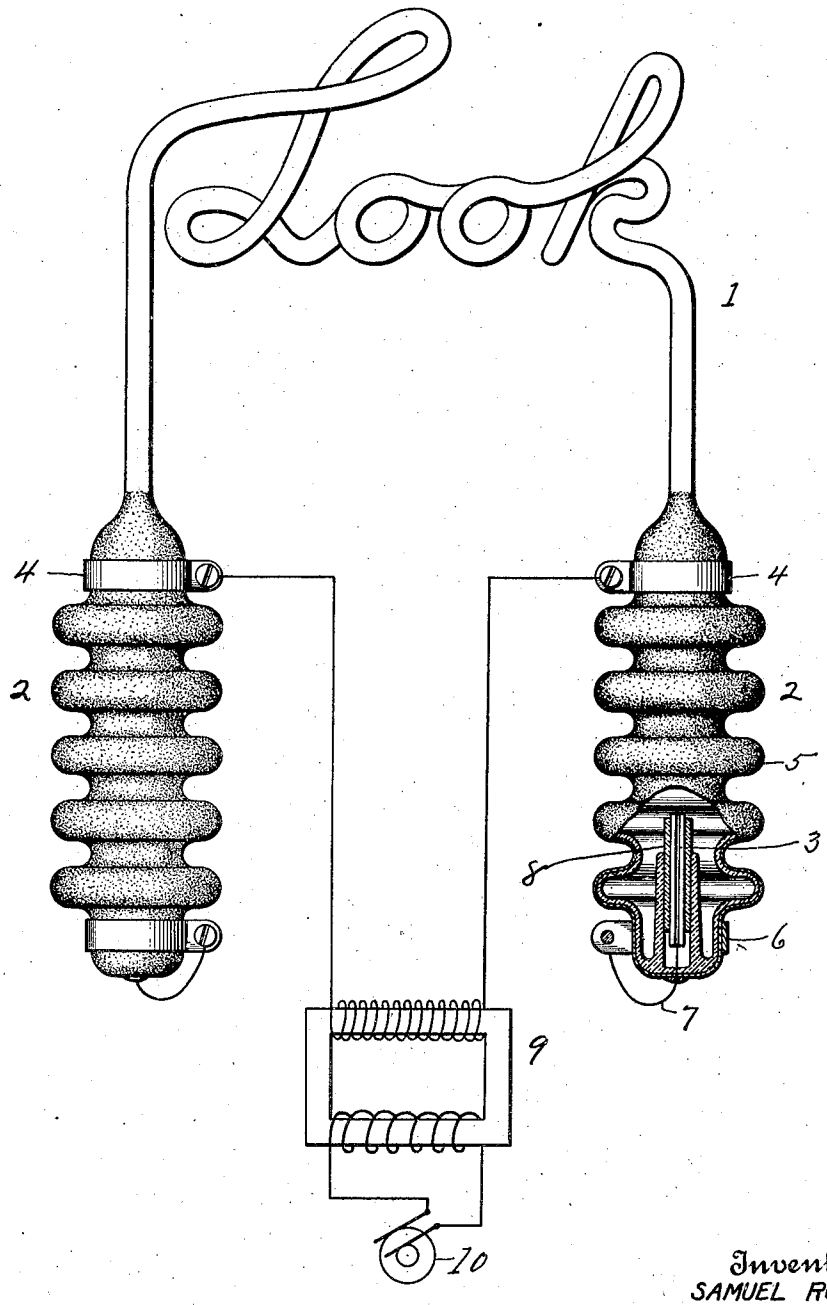
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ELECTRIC DISCHARGE DISPLAY DEVICE

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ELECTRIC DISCHARGE DISPLAY DEVICE

Application filed June 26, 1926. Serial No. 118,865.

This invention relates to improvements in electric discharge display devices and the method of filling them with gas; and more particularly, it relates to luminescent display devices employing electrical discharges through the gaseous content of transparent containers and to the means for preparing them. The object of the invention is to provide at low cost durable display devices which employ an electrical discharge through monatomic gases within a transparent container.

In the prior art there are two types of luminous display devices commonly used as signs, employing electrical discharge through confined gases in translucent vessels; namely, the electrode type and the condenser or inductive discharge type, both having limitations which the devices of my invention are designed to overcome.

The operation of the former type is restricted through the absorption of the gas content by the electrode and consequent reduction of pressure, by the sputtering of the electrode and by the high potential drop of potential at the electrodes, with a resultant relatively poor distribution of energy into the gas and high temperatures of the electrodes. The second or inductive discharge type operates only by currents of higher frequencies by electrostatic capacity discharge and leakage currents through the glass or other dielectric walls of the container. In this type the electrode usually employed is a silver coating on the outer surface of the glass container wall, forming a tubular electrode. As the discharge must pass through the dielectric walls the current discharge through the gas is necessarily limited and the glass walls soon become heated by dielectric hysteresis losses and ionic bumbardment, resulting in the puncturing of the wall or the localization of current to an area of high temperature. As glass has a high negative resistance temperature coefficient the inductive properties of the electric discharge is lost and a conductive one supersedes it, resulting in the amplification of the limitations cited.

A device constructed according to the terms of my invention consists broadly of a transparent dielectric container, preferably in tubular form, having therewithin in an atmosphere of monatomic gas alkaline electrodes, preferably supported without direct contact with the container walls, with means for restricting or confining their discharge areas, also condenser electrodes contacting with the other electrodes through a coating of conducting resistance material on the surface of the container wall.

The inner or conductive discharge electrodes are of the alkaline or second periodic group, magnesium being preferred because of its electropositive character and its low cathode drop of potential, making the temperature rise or the energy loss at the surface negligible as compared with that of the electrodes used in the devices of the prior art. Sputtering of these electrodes is avoided by the use of inductive discharge or capacity electrodes maintained at a higher potential than that of the magnesium electrodes. These magnesium electrodes, preferably in rod form, have a further important function; namely, that of gas purification by absorbing all save the monatomic gases, or the neon, helium, crypton and argon group, and therefore, any gas impurity, such as nitrogen and oxygen some of which may be due to the discharge of surface or occluded gases caused by thermal or electrical bombardment, is absorbed and becomes inoccuous.

The device walls may be of quartz or of lead, lime or borate glass, depending upon the mechanical requirements. And the device may be operated by high or low frequency alternating current or by continuous or intermittent direct current. The conductive discharge electrodes are not directly connected to the transformer, but through a coating of a conductive resistance material on the exterior wall of the container. The electrode or gas reserve chamber is preferably convoluted because of the permitted increased gas reserve maintainable therein and increased inductive electrode or capacity discharge area. By the connection between the conductive and inductive discharge electrodes through the carbon coatings surrounding the electrode chambers a difference of potential is established between the connected

electrodes. This means a reduction of the operating potential by producing a transverse field, giving a wider current distribution over the electrode discharge surfaces and a reduction of the space charge around the electrodes; and, due to the resultant low current density, the electrode sputtering is of small magnitude. One effect of the transverse field is to cause a slight discharge to the external electrode, thereby causing a liberation of physically adsorbed gases, due to the sputtering of the electrode material to the tube wall, caused by the ionic bombardment upon the electrode.

A quartz tube surrounding the magnesium rod or inner electrode restricts the discharge to a definite localized area, and as this material, even when hot will not ionize, a sodium or silicate ionic discharge from adjacent glass, is prevented. Such discharges are a familiar defect in gas discharge devices when the glass surface is too close to the electrode.

The method of evacuating and filling the containers is important as it is only by proper evacuation and gas discharging that the purity and constancy of pressure of the gas content can be maintained. To effect the discharge of all occluded gases and vapors, while the pressure is being reduced as far as possible, the device should be raised to the highest practicable temperature and a potential applied to the inner electrodes at the same time, this assisting in electrostatically or by ionic bombardment, effecting the discharge of occluded gases, all of which must be so completely exhausted that practically no positive ionization can occur under the influence of the finally applied potential. Sometimes it is desirable to discharge sodium or potassium vapor through the container when hot, this practice being found in the prior art to materially assist in the reduction of water vapor from the inner surface of the container walls. When the device is thoroughly evacuated, so that all occluded gases and vapors are exhausted, the desired gas is admitted slowly into the container, the pumping system being then shut off. To insure the final proper gas pressure a milliammeter is placed in series with a transformer connected to the device and the gas to be employed is admitted into the device until the maximum conductivity is indicated. The gas pressure is then further increased until the conductivity or luminosity decreases by about 20%. This excess allows for the absorption of gas impurities, such as nitrogen and oxygen, and of some of the admitted gas by the container walls and contained metal parts in the process of cooling and ageing, maintaining the proper pressure. A glass sign so prepared and having a tube length of about 30 inches and an inside diameter of about $\frac{9}{16}$ inch shows an impracticable luminosity when a current of about 5 milliamperes at 3000 volts is applied to the gas.

Reference is made to the accompanying drawing of a preferred embodiment of the invention.

In the drawing, 1 represents a glass container having the display or luminous portion (Look) and its electrode or gas chamber 2, filled with neon gas in a volume as indicated electrically, about 20% beyond the point of maximum conductivity. At 3 are the magnesium conductive discharge rod electrodes, having quartz collars 8, about them and connected by metal bands 6, and conductor wires 7, with graphite coating 5, contacting with which are inductive discharge electrodes 4, connecting directly with transformer 9 and with generator 10.

By means of electrodes 4 and 6, the discharged current ionizes the contained gas which becomes highly luminous, the discharge from electrodes 3, being confined by quartz collars 8, to the exposed ends, the quartz collars at the same time serving to prevent any sodium or silicate ionic discharge from adjoining glass walls. The inductive discharge from electrodes 4, not only assists in the gas ionization but minimizes the effect of any possible sputtering of the magnesium electrodes 3. The resistance drop through graphite coating 5, gives the copper band terminal at 6 a lower potential for the discharge from electrode 3.

What I claim:

1. An electric discharge device comprising, in combination, a container having translucent dielectric walls and containing a monatomic gas and gas absorptive, conductive discharge electrodes, with inductive discharge electrodes and means for maintaining said inductive discharge electrodes at a higher potential than said other electrodes.

2. An electric discharge device comprising, a container having translucent dielectric walls and containing a monatomic gas and gas absorptive, conductive discharge electrodes, in combination with inductive discharge electrodes connected with said other electrodes by a conductive resistance material.

3. An electric discharge device comprising, a container containing a monatomic gas and therewithin conductive discharge electrodes composed of a material of the second periodic group, in combination with inductive discharge electrodes and means for maintaining said inductive discharge electrodes at a higher potential than that of said other electrodes, said inductive discharge electrodes consisting of conducting resistance material coating on an outer wall of the container adjacent the conductive electrodes.

4. An electric discharge device comprising, a container containing a monatomic gas

and therewithin conductive discharge electrodes composed of magnesium, in combination with inductive discharge electrodes and means for maintaining said inductive discharge electrodes at a higher potential than that of said other electrodes by connecting the conductive discharge electrodes with their adjacent inductive discharge electrodes by a conductive resistance material upon the outer walls of the container around the electrode chambers.

5. An electric discharge device comprising, a vessel containing a monatomic gas and therewithin magnesium electrodes, with inductive discharge electrodes connected with said other electrodes through carbon coatings upon the outer walls of said vessel.

6. An electric discharge device comprising a container having therewithin a monatomic gas and magnesium electrodes, partially shielded by a sleeve composed of quartz, in combination with inductive discharge electrodes consisting of coatings of a conducting resistance material on the outer wall of the container adjacent the other electrode.

7. An electric discharge device comprising a container having therewithin a monatomic gas and conductive discharge electrodes composed of an electropositive gas absorptive material, shielded by a sleeve composed of quartz, in combination with inductive discharge electrodes consisting of coatings of a conducting resistance material on the outer wall of the container adjacent the other electrodes.

8. In an electric discharge device, means for continuously occluding ordinary gases and continuously liberating occluded or mechanically entangled rare gases.

In testimony whereof, SAMUEL RUBEN has signed his name to this specification this 24th day of June, 1926.

SAMUEL RUBEN.