D. McF. MOORE.

GASEOUS CONDUCTOR LAMP.

APPLICATION FILED MAY 7, 1914.

1,188,194.

Patented June 20, 1916.

Fig. 1.

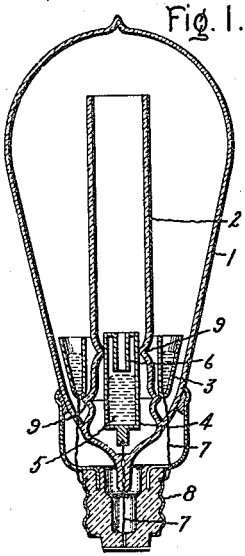


Fig. 2.

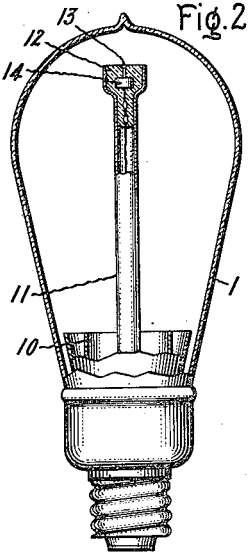


Fig. 3.

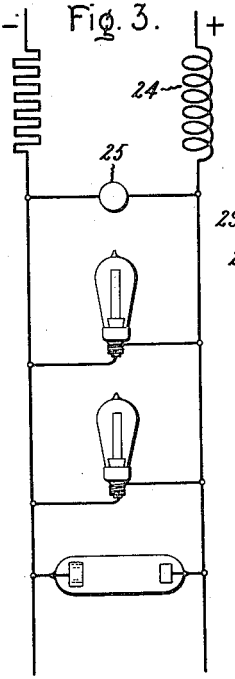


Fig. 4.

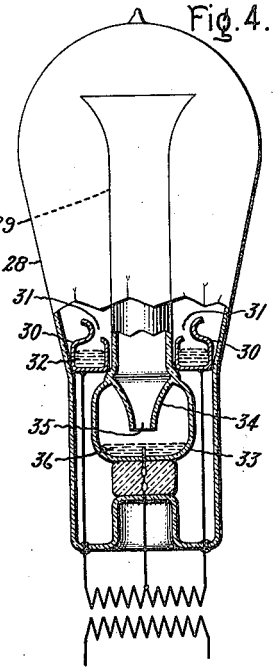


Fig. 6.

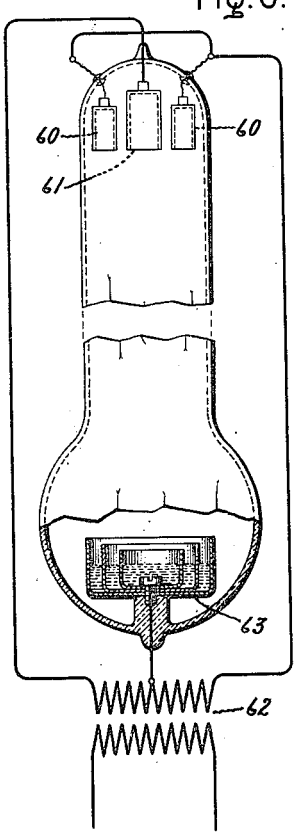
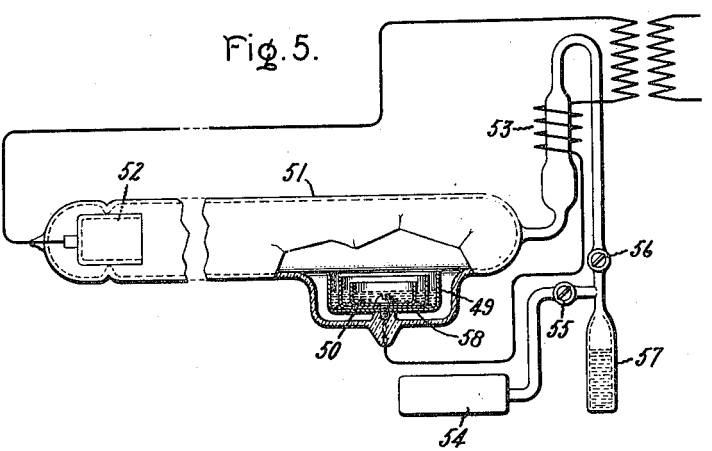


Fig. 5.



Inventor:
Daniel McFarlan Moore,
by Albert G. Davis
His Attorney.

UNITED STATES PATENT OFFICE.

DANIEL McFARLAN MOORE, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

GASEOUS-CONDUCTOR LAMP.

1,188,194. Specification of Letters Patent. Patented June 20, 1916.

Application filed May 7, 1914. Serial No. 836,871.

To all whom it may concern:

Be it known that I, DANIEL McFARLAN MOORE, a citizen of the United States, residing at East Orange, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Gaseous-Conductor Lamps, of which the following is a specification.

My invention relates to vacuum tube devices in which an electrical discharge takes place between electrodes in a vessel containing more or less rarefied vapors or gases, and more particularly to devices of this character in which the electrical discharge is such that the gas or vapor is rendered luminous and hence the device can be used as a source of artificial light.

Any gases and vapors become luminous when subjected to an electrical discharge under suitable conditions, and in many respects my invention relates to devices of this character regardless of the particular gas or vapor used, although in other respects it especially relates to gases of high conductivity, such as neon, or similar gases which have a comparatively high conductivity and emit a light suitable for the purpose desired.

The principal object of my invention is to produce a gaseous conduction device which is particularly adapted to utilize neon as a gaseous conductor.

A further object is to provide improved electrodes by means of which the operation of gaseous conductive devices in general may be improved and their efficiency increased.

A further object is to provide gaseous conduction lighting devices which will operate either on alternating or direct current, and which are so compact as to be comparable in dimensions with the incandescent lamps commonly used.

Another object of my invention is to so combine the electrodes and the gas or vapor that the potential between the electrodes and the gaseous conductor is reduced to a minimum.

A still further object is to improve gaseous conduction devices generally and in various details of construction as hereinafter more fully described.

To this end my invention comprises various novel features and details of construction which are more fully hereinafter described and pointed out with particularity in the appended claims.

Merely for purposes of illustration I have shown in the accompanying drawings some of the many various forms in which my invention may be embodied, and in which—

Figure 1 is a longitudinal section through a lamp suitable for operation on direct current and provided with improved electrodes constructed in accordance with my invention; Fig. 2 is a longitudinal section of a similar lamp having a short gaseous column and provided with a different form of cathode; Fig. 3 is a diagram of connections, showing how a plurality of various forms of lamp embodying my invention may be connected in parallel and all may be started by an inductive discharge if necessary; Fig. 4 is a view partly in section of a lamp provided with other forms of electrodes; Fig. 5 is a view partly in section of a straight tube gaseous lamp provided with an automatic feed valve and having an improved electrode constructed in accordance with my invention; Fig. 6 shows a lamp containing neon and constructed to operate upon alternating current.

The particular form of device which I have illustrated in Fig. 1 as one embodiment of my invention is a gaseous conduction device suitable for the production of light and made of the general form and dimensions of an incandescent lamp having a filament. For convenience I designate this device a filamentless or gaseous conduction lamp to indicate that the light is produced from a gaseous conductor as distinguished from an incandescent filament. The particular form of lamp shown in Fig. 1 comprises a bulb 1 containing a suitable atmosphere which may be any gas suitable for the purpose, such as nitrogen or carbon dioxid, but which is preferably one of the rare gases of good conductivity, such as neon or helium, or a similar gas. In order that the light giving column may be of considerable length, I provide suitable means for compelling the discharge to take a more or less tortuous course inside the bulb 1. In the particular device shown in Fig. 1 this result is attained by means of a directing device or barrier 2, preferably made in the form of a tube of glass or similar material, and suitably mounted in the bulb so as to extend longitudinally of the bulb. The barrier is pref-

erably sealed to the neck of the bulb in such a manner that there is no communication between the space inside of the tube 2 and the interior of the bulb except through the open end of the tube.

In accordance with my invention one of the electrodes is mounted outside the tube 2 near the neck of the bulb and the other is mounted inside the tube so that the electrodes are substantially concentric but are separated by the walls of the tube 2. In devices of this form I usually prefer to make the electrodes of a suitable metal, such as pure aluminum, which does not contain any trace of iron or other deleterious material. Any traces of foreign materials combined with the aluminum tend to cause dark deposits in the tube and to increase the difficulties of exhausting it. I have found that these difficulties are eliminated if the aluminum is really pure. One of the electrodes, preferably the anode 3, is mounted outside of the tube 2 near the neck of the bulb. The other electrode or cathode 4 is mounted inside the tube 2 and comprises a chamber of some suitable metal such as pure aluminum. This chamber contains some material 5 which will decrease the resistance to the passage of current between the gaseous conductor and the electrode, and will not appreciably attack the material of the chamber. The electrode material which I prefer to use in the aluminum chamber is metallic sodium, or an alloy or mixture containing metallic sodium. The aluminum chamber may be shaped in various ways as long as it acts as a container and holds the electrode material in such a manner that the material is in contact with the gaseous conductor of the lamp. The particular cathode shown is provided with a reëntrant tube 6 which prevents spilling of the metallic sodium 5 when the lamp is moved while the sodium is very hot, and also provides an orifice for exposing the sodium to the gas in the lamp. Usually the sodium remains in the aluminum cup because of its adhesion to the aluminum, and the reëntrant tube 6 guards only against accidental spilling of the sodium. Both electrodes are connected by leading in wires 7 to the base 8 or to other suitable means by which current is supplied to the lamp. I have found it convenient to steady the electrodes in some suitable way, as, for example, by ribs or spacers 9 engaging the electrodes and preferably formed in the tube 2.

When the lamp is in operation the discharge takes place between the anode 3 and the cathode. The discharge is compelled to traverse the length of the tube 2 and then return, hence the light giving column is long. Owing to the novel construction of the cathode the losses at the electrodes are minimized and consequently the efficiency of the lamp as a whole is increased. The sodium in the aluminum cup or chamber of the cathode not only improves the running efficiency of the lamp, but facilitates starting it, particularly when the lamp contains neon, which is the gas I prefer to use when high efficiency is desired.

In the particular form of lamp shown in Fig. 2 the bulb 1 contains some suitable gas, such as neon, and is provided with an anode 10 consisting of aluminum, iron, tungsten or similar metal. It may be, if desired, cup shaped and contain some suitable material, like metallic sodium. It is preferably so proportioned that a large surface is exposed to the neon. The cathode is mounted near the other end of the bulb in any suitable way, as for example, on the end of a pedestal 11. It may be constructed, if desired, of aluminum and metallic sodium, like the cathode 4 shown in Fig. 1. In the particular form shown in Fig. 2 the negative electrode is constructed of some refractory material 12, such as boron nitrid, pressed refractory oxids of calcium, zirconium, thorium, or similar material, and has one or more constricted passages or openings 13 which lead from the exposed end of the electrode to a piece of metal 14, preferably some refractory metal, such as tungsten, connected to the terminal of the lamp. The material 12 should be a poor conductor of heat and preferably very refractory so that the discharge through the constricted passage 13 will heat the small body of gas inclosed in the passage to a high temperature and thus in turn heat the walls of the passage. This high localized heating facilitates the transfer of current between the electrode and the gaseous conductor and in conjunction with neon makes the lamp a very efficient light producing device.

In exhausting gaseous conduction lamps, and particularly those constructed to embody my invention, all traces of foreign gases should be removed so that when completed the lamp will contain only the gaseous conductor which is to be used. This is particularly important where the lamps contain neon as the gaseous conductor. It is therefore desirable that the lamps be thoroughly heated and exhausted and that by repeated admission and exhausting of a suitable gas all impurities and occluded gases be washed out of the lamp so that when the neon is finally admitted no deleterious foreign gases will mix with it and impair its efficiency. In some cases it may be advisable to wash out the lamp once or twice with neon before finally sealing the lamp off from the pumps, even though the lamp has previously been washed out a number of times with some suitable gas such as nitrogen for the purpose of getting rid of the water vapor and occluded gases driven out of the

electrodes and the walls of the tube by heat. If the lamp is to be operated with nitrogen, for example, instead of neon, the washing will be repeated a number of times with nitrogen until only pure nitrogen remains in the lamp at the proper pressure, whereupon the lamp is sealed off from the pump.

The losses in a gaseous conduction device are the result of the necessity of the electric current changing the medium through which is passes. In general, if the current passes through a solid to a liquid, and thence to the gaseous conductor, the loss is less than if the current passes immediately from the solid conductor into the gaseous conductor. This is particularly the case if the solid conductor is cold, and the gaseous conductor is hot, as it must be while the lamp is running. In accordance with my invention a vapor may be generated near the solid conductor to cause the conditions adjacent the solid conductor to be such that flow of current into the gaseous conductor is facilitated. Where the vapor is generated from a refractory material I prefer a construction, such as that shown in Fig. 4, comprising a funnel 34 with a constricted vent or orifice 35 opening into a receptacle 33. Both the funnel and the receptacle are made of very refractory insulating material, such as fused silica. In many cases I construct the evacuated envelop of fused silica, particularly where neon is used as the gaseous conductor, and thereby secure longer life, greater intensity of current flow and higher efficiency, and in general improve the neon lamp. In the receptacle 33 I place the vaporizable electrode material 36, which may be metallic sodium, or a mixture containing sodium, as for example a mixture of approximately 65% sodium, 30% mercury, and 5% potassium, or may be a more refractory electrode material, such as carbon in such a condition that carbon vapor will be generated when the lamp is in operation at a suitable current density. The current flow is so concentrated on the electrode material in the receptacle 33 that an atmosphere containing suitable vapor is generated in the receptacle 33 and facilitates the transfer of current, thereby increasing the efficiency of the lamp. The shape of the receptacle 33 and the constricted orifice prevents the vapor in the receptacle passing out into the lamp to any great extent.

Gaseous conduction devices constructed in accordance with my invention, and especially those containing neon, will operate in parallel and will start on voltages substantially the same as or only slightly above the normal operating voltage. In some cases it may be desirable to provide means for momentarily impressing a higher voltage upon the circuit to insure the starting of all the lamps. One way of showing this is shown diagrammatically in Fig. 3, in which the circuit containing a reactance 24 is provided with a circuit interrupting device 25 connected in parallel with the lamps, which may be of the various types shown in the drawings as examples of embodiments of my invention. This circuit interrupting device 25 may be a quick break switch or any other similar device by means of which potential upon the circuit may be momentarily raised for the purpose of starting the lamps connected to the circuit in parallel.

In many cases it is desirable to operate lamps upon an alternating current system, and by my invention I provide gaseous conduction lamps which will so operate. One form of such a lamp is shown in Fig. 4, in which the bulb 28 containing neon or other gas of good conductivity is provided with a central tube 29 similar to the tube 2 of the lamp shown in Fig. 1. In addition to the electrode above described suitable electrodes 30 are mounted outside of the central tube 29. These electrodes are made in the form of aluminum chambers provided with small orifices 31 and containing a vaporizable material 32 such as metallic sodium, which facilitates the flow of current between the electrode and the gaseous column. As indicated diagrammatically, the lamp may be operated from an ordinary alternating current circuit through a transformer of the usual type.

Where it is desired that the tube have a very long life, provision must be made for automatically adding more neon as the original charge is consumed. A suitable arrangement for doing this is shown in Fig. 5, in which the tube 51 is provided with an aluminum electrode 52, and an electrode 58 of sodium or of cups 49 formed of aluminum and containing metallic sodium 50. By means of an automatic electromagnetic feed valve 53 constructed in accordance with my Patent 1,032,927, issued July 16, 1912, small amounts of neon may be automatically admitted to the tube from a reservoir or supply tank 54. In some cases it may be advantageous to so arrange the device that the valve is supplied with neon only at the will of the operator, so that the operator can take precautions to insure the purity of the neon fed to the tube, although the amount fed is controlled automatically by the valve. This result may be accomplished in many different ways, as for example by means of the valve 55 controlling the outlet of the tank 54 and the valve 56 which controls the flow of neon to the automatic feed valve 53. A purifier 57 of some suitable design is attached to the feeding system and may, for example, consist of a glass chamber con-

taining charcoal or similar absorbent material, the whole being so constructed that the chamber may at will be immersed in liquid air or similar refrigerating means, to cause the charcoal to absorb the last traces of foreign gases from the neon. When the operator sees that the lamp should be supplied with more neon he can admit a small amount of neon into the purifying chamber 57 and then after purifying it by cooling the chamber he can admit the purified neon from the purifier 57 to the automatic feed valve 53 which will thereupon feed into the tube the right amount of neon to bring the pressure in the tube back to the proper point.

In many cases it is desirable that the gaseous conduction lamp shall operate with an arcing discharge lamp upon an alternating current circuit. I have shown such a lamp in Fig. 6, in which two anodes 60 and 61 are connected respectively to the opposite terminals of the transformer winding 62, of which the middle point is connected to the cathode 63. The cathode is preferably an aluminum cup containing metallic sodium. The reactance of the circuits through the transformer windings is such that an arcing discharge is maintained through the gaseous conductor, which is thereby rendered continuously luminous.

My invention may be embodied in many other forms than those shown and described, and I therefore do not limit my invention to the precise arrangement disclosed, except in so far as it is limited by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In a gaseous conduction lamp, the combination with a sealed receptacle having a rarefied atmosphere consisting of neon, of electrodes mounted in said receptacle near one wall thereof and adjacent each other, and a barrier between said electrodes and extending away from them into the body of the receptacle to compel the discharge to pass from one electrode through the neon and around said barrier to the other electrode.

2. In a gaseous conduction lamp, the combination of a bulb containing rarefied neon, electrodes located at or near the neck of said bulb, and a tubular barrier mounted in said bulb to separate said electrodes and joined to the bulb near the neck thereof, said barrier extending to a point adjacent the tip of the bulb.

3. In a gaseous conduction device, the combination with a sealed inclosure containing rarefied neon, of an electrode comprising a body of aluminum shaped to provide cavities exposed to the neon, and metallic sodium in said cavities.

4. In a gaseous conduction lamp, an electrode consisting of an open aluminum container and metallic sodium in said container.

5. The combination with a closed receptacle containing rarefied neon, of a negative electrode having one or more discharge receiving cavities of contracted dimensions and surfaces which receive and are heated by the electric discharge.

6. In a gaseous conduction lamp, the combination with a sealed receptacle having therein a rarefied atmosphere, electrodes mounted in said receptacle, at least one of said electrodes being hollow, having a contracted opening therein and containing metallic sodium.

7. In a gaseous conduction lamp the combination with a sealed receptacle having a rarefied atmosphere consisting of neon, of electrodes mounted in said receptacle near one wall thereof and adjacent each other and a barrier between said electrodes and extending away from them into the body of the receptacle, said electrodes being composed in part at least of metallic sodium.

8. In a gaseous conduction lamp the combination with a sealed receptacle having a rarefied atmosphere consisting of neon, of electrodes mounted in said receptacle near one wall thereof and adjacent each other and a barrier between said electrodes and extending away from them into the body of the receptacle, at least one of said electrodes comprising a body of aluminum shaped to provide cavities exposed to the neon and metallic sodium in said cavities.

In witness whereof, I have hereunto set my hand this 4th day of May, 1914.

DANIEL McFARLAN MOORE.

Witnesses:
S. N. Whitehead,
J. H. Elkins.