Jan. 6, 1953 W. B. GREENLEE 2,624,858

GASEOUS DISCHARGE LAMP

Filed Nov. 15, 1948

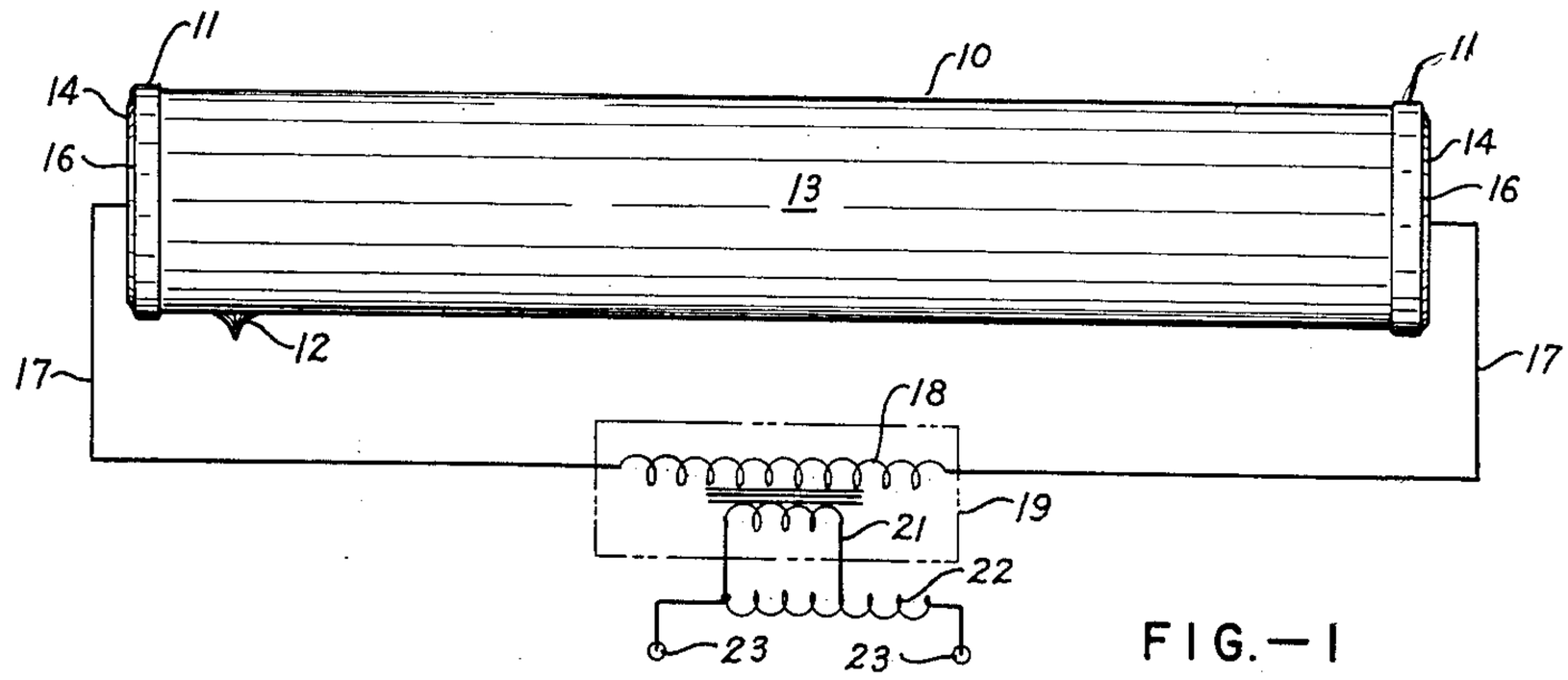


FIG.—1

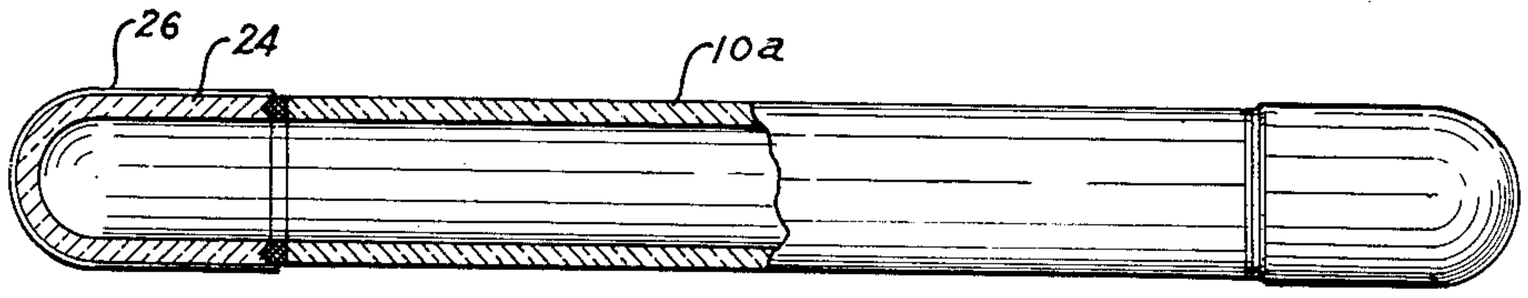
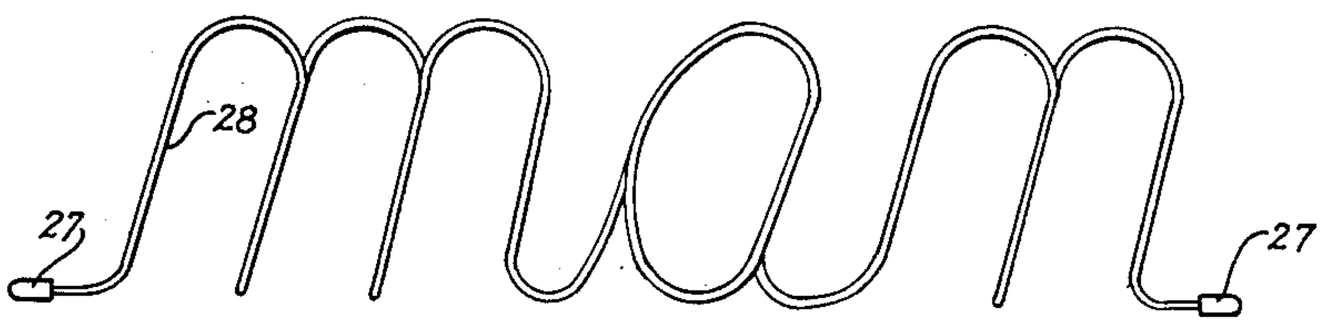


FIG.— 2



FIG—3

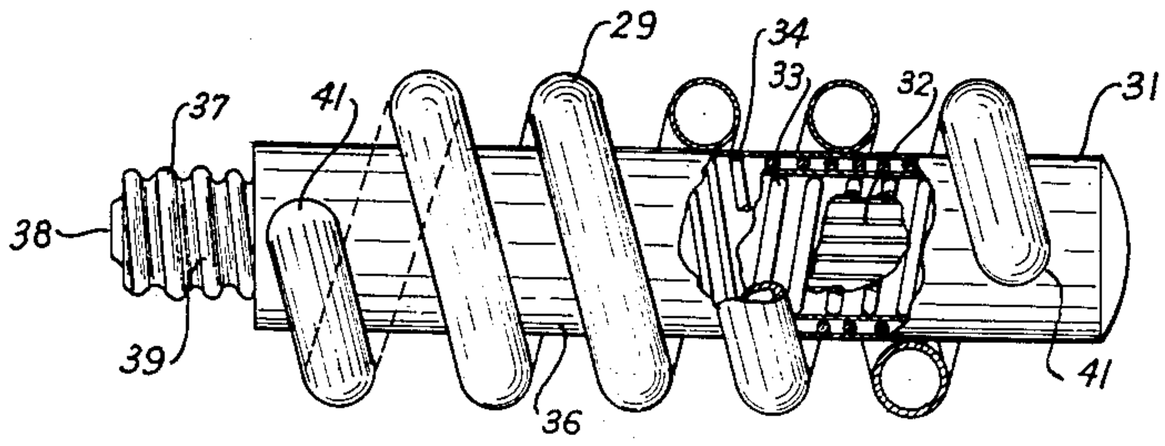


FIG.—4

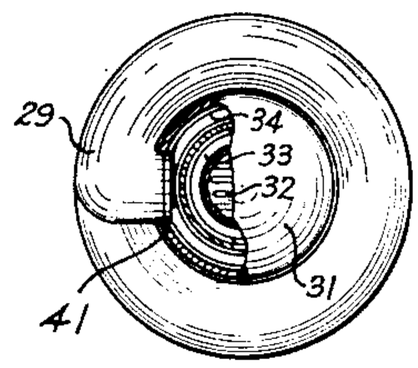


FIG.—5

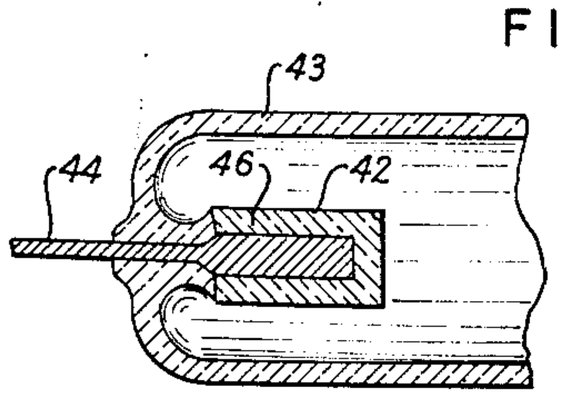


FIG.—6

INVENTOR.
William B. Greenlee
BY
H. A. McGregor
ATTORNEY

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GASEOUS DISCHARGE LAMP

William B. Greenlee, Denver, Colo.

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3 Claims. (Cl. 313—201)

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My invention relates to gaseous discharge lamps and more particularly to such lamps having electrodes external to the lamp envelope wherein said electrodes are formed on exterior surfaces of material having a high dielectric constant.

Various types of gaseous discharge lamps are known to the art. Among these are cold cathode lamps, hot cathode lamps, high frequency externally excited lamps, and lamps having external electrodes as set forth in my co-pending application, Serial No. 785,353, filed November 12, 1947.

The lamp presently to be described has advantages over all the above listed types. Among these advantages are freedom from the sputtering characteristics of the cold cathode lamps with attendant darkening of the lamp near the electrodes, and the drying up of the lamp. In addition, my lamp gives longer service and is adaptable to simple means of output control. As compared to the hot cathode lamp, my lamp has advantages similar to those set forth above and in addition, provides instant starting and an even longer life expectancy. My lamp does not require high frequency current generating equipment and is therefore not handicapped by the low efficiency and high cost of this type of equipment which is necessary for operation of high frequency gaseous discharge lamps. As compared to the external electrode lamp disclosed in the aforementioned co-pending application, my present lamp has the advantage of increased capacity thereby making increased illumination and greater efficiency of operation possible. In summary, my lamp is instant starting, has a long life, does not darken with use, is efficient and economical to operate, and requires a minimum of control equipment inasmuch as it may be operated at line frequency.

An object of my invention is to provide a gaseous discharge lamp in which a tube or other hollow body is provided with closure members formed of materials having a high dielectric constant and having electrodes formed on exterior surfaces of said high dielectric material.

A further object of my invention is to provide a gaseous discharge lamp in which a tube member and end closure members of high dielectric constant material form a sealed envelope adapted to receive and contain inert or other gases that may be excited to give off radiation by the introduction of high voltage low frequency current to metal or other electrodes formed on exterior surfaces of the dielectric material.

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Further objects of my invention are to provide a quick starting lamp of the type described which may be energized by a current of relatively low frequency, which requires no auxiliary current limiting device, which is durable, inexpensive, easy to manufacture, efficient in operation, capable of output regulation, and in which a variety of gases or mixtures thereof may be employed.

Another object of this invention is to provide a gaseous discharge lamp that will give off ultraviolet radiations when filled with a controlled quantity of mercury vapor.

A still further object of this invention is to provide an externally excited lamp that requires use of comparatively simple auxiliary control equipment, and in which the illumination or radiation output of the lamp may be controlled by such inexpensive equipment.

Another object of my invention is to provide an externally excited discharge lamp operable at frequencies below 120 cycles per second and at voltages below 5,000 volts.

A further object of this invention is to provide an externally excited gaseous discharge lamp that will operate at relatively low ambient temperatures.

A still further object of this invention is to provide a gaseous discharge lamp having long life characteristics in which the metal electrodes are not subject to deterioration under gaseous and electrical influences.

Another object of my invention is to provide a gaseous discharge lamp having external electrodes and having a transformer in a unitary structure for engagement in conventional type light sockets.

Briefly stated, my invention is to provide a tubular or otherwise hollow portion formed of quartz, glass or other similar materials that are transparent to illumination or the type of radiation desired which may be bonded as by glazing, cementing or other means to a different material having a high dielectric constant. The dielectric material which is bonded to the tubular portion is shaped to provide closure for said tubular portion such that the tubular portion, together with the dielectric end portions will form a closed envelope into which a gaseous mixture may be introduced at sub-atmospheric pressures.

According to my invention the external surfaces of the dielectric material are rendered electrically conductive by the application of a material such as graphite or deposited metal directly on the external surfaces, or by providing a close fitting

metal cap to surround the dielectric material. Suitable leads connect these external electrodes with a source of alternating current adapted to provide current between 500 and 10,000 volts with a frequency below 120 cycles per second. When the circuit is energized electrical charges will be induced on the external electrodes causing an electrical impulse to be transmitted through the dielectric materials due to the high specific inductive capacity characteristics of such dielectric materials. The electrical effect attained will ionize and energize the gases within the tube and cause the gases to give off illumination or other radiation as desired. In order to insure best operation of my lamp, the dielectric materials used should have a dielectric constant greater than 100 and preferably in excess of 2,000, and throughout this aplication wherever a dielectric material having a high dielectric constant is specified, materials having a constant in excess of 100 are indicated. Titanium dioxide and other titanium materials are suitable dielectric materials. Since there are no electrodes within the sealed tube, the gases used within the tube do not have to be of the conventional inert varieties. Any gas which may be energized in an electrical field to give off radiation will be suitable.

From the foregoing description it may be seen that the electrodes, being external, are not subject to rapid deterioration and will last almost indefinitely. Further, since a dielectric material having a high dielectric constant is used, a substantial current will flow through the lamp and the illumination or radiation capacity of the lamp will be increased.

Many further objects and advantages of my invention will become apparent from the following detailed description and from the appended drawings in which:

Fig. 1 is an elevation of a lamp embodying the principles of this invention and showing diagrammatical electrical circuits for the energizing of the lamp;

Fig. 2 is a cross sectional elevation of a gaseous discharge lamp according to this invention having cupped dielectric electrodes bonded to the tube of said lamp;

Fig. 3 is an elevation of a display sign made according to this invention;

Fig. 4 is an elevation in partial section showing a unitary structure combining a transformer and a dielectric electrode excited lamp;

Fig. 5 is an end view in partial section of the embodiment shown in Fig. 4; and

Fig. 6 is an elevation in cross section of a separate form for bonding the dielectric material to a glass tube.

Referring now to the drawings Fig. 1 shows an embodiment of this invention in which a tubular member 10 formed of quartz or glass or other materials transparent to illumination or the type of radiation desired is bonded to disc caps 11 formed of a material having a high dielectric constant. Caps 11 may be secured to tubular member 10 by cementing, glazing or by other means to assure a gas tight seal. A tubulation 12 is provided in tube portion 10 through which air may be evacuated and a suitable gas introduced at sub-atmospheric pressures to substantially fill the closed envelope 13 formed by tube portion 10 and end caps 11 when tubulation 12 is closed. Conductive electrodes 14 are formed on the exterior surfaces 16 of end caps 11. Electrodes 14 may be of metal bonded to cap 11, deposited graphite or sprayed metal. Electrodes

14 are connected by suitable conductors 17 to the secondary 18 of a transformer 19. The primary 21 of transformer 19 is adjustably connected with an auto transformer 22 which is in turn connected in a suitable line circuit 23. Auto transformer 22 and transformer 19 are so constructed that if auto transformer 22 is connected in a line circuit 23 having 110 volts and 60 cycles, the secondary of transformer 19 will deliver between 500 and 10,000 volts in accordance with the adjustments of auto transformer 22. As the in-put of the primary winding 21 of transformer 19 is adjusted from lower to higher values, the out-put voltage will be correspondingly increased and the excitation and ionization of the gases within the envelope 13 will be increased, thereby increasing the illumination or radiation emitted therefrom. If the envelope 13 is to be used for illumination, tubular portion 10 may be coated with a fluorescent material, and if it is desired to use the envelope 13 for ultraviolet radiation a mercury vapor may be introduced through tubulation 12. The introduction of a mercury vapor can be in a controlled amount to assure the optimum ultraviolet radiation without unnecessary use of excessive amounts of mercury. Since my lamp is not limited to the use of inert gases, other gases may be excited in my lamp to give off illumination without the use of fluorescent materials.

Fig. 2 shows a similar embodiment of this invention in which an elongated tube 10*a* has its open ends closed by caps 24 formed of dielectric material in a cupped shape to substantially increase the surface area of the dielectric material and to thereby increase the area of the electrode material 26 formed on the exterior surface of the dielectric cap 24. The lamp of Fig. 2 inasmuch as it has a greater electrode area will have a greater capacity and current will flow at an increased rate to correspondingly increase the illumination and radiation given off. In this and in all other embodiments of my invention, the electrode material 26 may be graphite or metal electrically deposited on the exterior surfaces of the dielectric material or may be metal sprayed on such surfaces. Likewise it is within the intent of this disclosure that a metal cap may be provided that will closely fit over the exterior surfaces of the dielectric material. For some applications it may be advisable to put such a metal cap over deposited graphite or other of the forms mentioned above.

In Fig. 3 I have shown an adaptation of my invention that is suitable for display advertising and the like. In this figure dielectric electrodes 27, coated externally with conductive material, are bonded to an elongated tube portion 28. Tube portion 28 is formed in a manner to outline various letters of the alphabet or other figures as necessary to accomplish the purposes of the display advertising intended. The conductive material coated on dielectric electrodes 27 is connected by suitable leads (not shown) to an electrical circuit having the requisite voltage and frequency characteristics to illuminate tube 28.

Figs. 4 and 5 show a separate embodiment of my invention in which an elongated tube portion 29 is formed helically about a central supporting structure 31. Supporting structure 31 encloses an iron core 32 and the primary and secondary windings 33 and 34 respectively of a transformer 36. The primary windings of transformer 36 are connected to the walls 37 and post 38 of a conventional socket 39, and the ends of secondary coil 34 are connected to conductive material

formed on external surfaces of dielectric electrode caps 41 at opposite ends of elongated tube 29. This particular embodiment of my invention will prove especially useful inasmuch as the units shown can be used in conventional present day circuits such as those now used for street lighting and other purposes. For such uses it provides a compact unitary structure of considerable brilliance that has a relatively unlimited period of usefulness.

In Fig. 6 I have shown a separate means of bonding a dielectric material to a transparent tube. In this particular form, a cupped shape dielectric material 42 is bonded to a transparent tube portion 43 in such manner that the dielectric material 42 is entirely within the tube 43. For the purpose of imposing an electrical charge on the surface of the dielectric material, a conductive lead 44 passes through the glass tube 43 and into the cupped portion of the dielectric material 42. In this form an electrical current conducted through lead 44 will be conveyed to an inner surface 46 of the cupped dielectric material 42. When a charge is imposed on inner surface 46 electrical impulse will be transmitted through the dielectric material 42 to energize any gases sealed within the transparent tube 43.

From the foregoing descriptions it will be apparent that I have provided a gaseous discharge lamp, having external electrodes, that is of comparatively high capacity and efficiency. Likewise since the electrodes are actually external of the lamp envelope, the gases used within the envelope do not have to be of the conventionally used inert type. Whatever gases are used the electrode will not tend to disintegrate under electrical and gaseous influences and consequently my lamp will be useful over a long period of time.

While separate embodiments of my invention have been shown and described it will be apparent to those skilled in the art that my invention is adaptable to certain obvious modifications and changes. Accordingly I do not wish to be limited to the form shown and described and intend therefore to be limited only within the scope of the appended claims.

What is claimed is:

1. A gaseous discharge lamp, comprising an envelope-type body of dielectric material, including a tubular glass intermediate portion and end portions of fused titanium dioxide bonded to said intermediate portion, electrodes of electrical conductive material on an external surface of the envelope at its opposite ends, an ionizable gas sealed within said envelope, and means for connecting said electrodes to an electrical current whereby the gas in said envelope will be energized to give off radiation.

2. A lamp as defined in claim 1, in which the electrodes enclose the respective ends of the tube and provide an external surface covering therefor.

3. A lamp as defined in claim 1, in which the electrodes extend into and are enclosed by end surfaces of the tube.

WILLIAM B. GREENLEE.

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