Feb. 3, 1942. S. O. EKSTRAND 2,271,685

GASEOUS GLOW DISCHARGE DEVICE

Filed June 5, 1940

FIG. 4

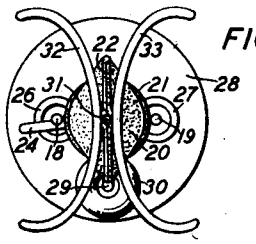


FIG. 2

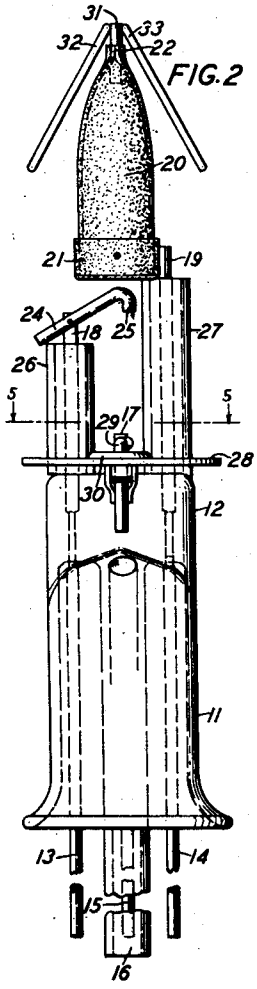


FIG. 3

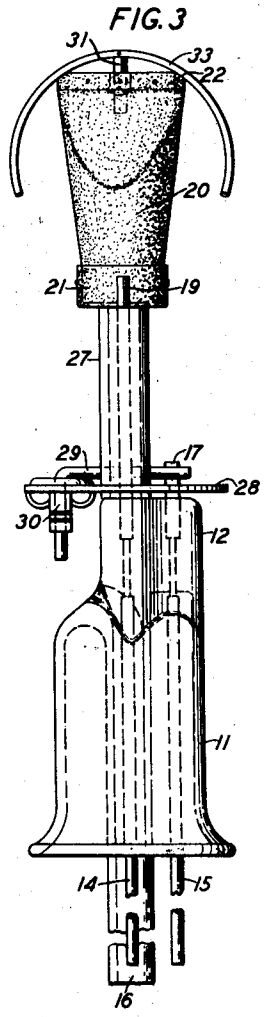


FIG. 1

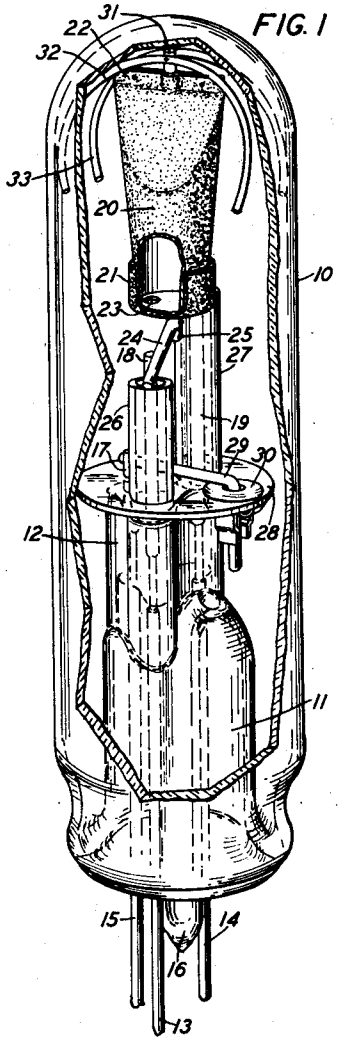
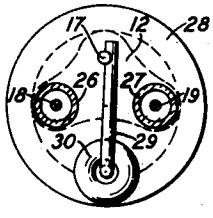


FIG. 5



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GASEOUS GLOW DISCHARGE DEVICE

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9 Claims. (Cl. 250—27.5)

This invention relates to gaseous glow discharge devices and more particularly to grid controlled or trigger devices.

An object of the invention is to provide an efficient and economical visual light source of the cathode glow type;

Another object of the invention is to form a combined signal and relay device of compact construction;

A further object is to effect a low transfer current in the operation of the device to facilitate group operation of the devices and to realize a low voltage drop and low resistance characteristic for the functioning of the device with associated apparatus.

In accordance with this invention, these objects are attained in a gaseous discharge device having a cathode surface of large area in axial symmetry within an enclosing vessel in association with an anode of small area and a control element spaced closely in axial relation to a terminating portion of the cathode. The electrodes are supported from a stem of the vessel and the cathode is also braced at its free end by a spider spacer member engaging the inner surface of the vessel. This arrangement overcomes difficulties due to sudden mechanical shock incident to shipping and handling which would seriously affect or destroy the critical control characteristics of the device. Furthermore, the spaced member, as arranged, does not materially affect the light efficiency of the device nor interfere with manufacturing technique in the processing of the cathode.

In a more specific aspect of the invention the cathode comprises a tubular sleeve member having a cap at one end and the other end pinched flat to form a hollow elongated body. The complete outer surfaces of the sleeve and cap are coated with electron emissive material to produce a glow discharge with a wire anode projecting slightly beyond the stem of the vessel, the cathode projecting axially within the vessel and being directed toward and in close spaced relation to the closed end of the vessel. Another wire extends from the stem and supports a control grid tangentially mounted with its end closely spaced from the center of the cathode cap.

A feature of the invention relates to the supporting assembly of the elements in the device in which the grid and cathode supports are covered by insulating sleeves which extend through a mica shield and the shield is held in position by a cross-brace which is welded to the anode.

Another feature relates to the vibration elimination mounting of the cathode in the device, whereby the pinched end of the cathode supports a central stub wire and a pair of arcuate wire springs are attached thereto at the center in outwardly angular relation to form a resilient spider member so that the free portions engage the wall of the vessel to maintain the relationship of the cathode with respect to the closely spaced control electrode.

These and other features of the invention will be more clearly understood by reference to the following detailed description taken in connection with the accompanying drawing:

Fig. 1 is an enlarged perspective view of the discharge device of this invention with portions of the vessel and the cathode broken away to illustrate the details of the assembly;

Fig. 2 is a side view in elevation of the electrode mount and stem of the device shown in Fig. 1;

Fig. 3 illustrates the mount of Fig. 2, turned at an angle to show the front view of the electrode assembly;

Fig. 4 is a plan view of Fig. 2; and

Fig. 5 is a plan view in cross-section of the supporting structure taken on the lines 5—5 of Fig. 2.

Referring to the drawing, the combined signal and relay device of this invention is shown in the complete assembly of Fig. 1 and comprises an elongated tubular enclosing vessel 10 having an inwardly projecting stem 11 terminating in a press 12 having three wing portions forming a seal for leading-in wires 13, 14 and 15. A central exhaust tubulation 16 communicates with the top of the hollow stem 11 for evacuating the enclosure within the vessel. The three wires extending through the press 12 are of varying length beyond the press, the shortest wire 17 which serves as an anode being arranged in the offset wing of the press and the support wires 18 and 19 being arranged in the diverging wings of the press, the support wire 18 being shorter than the support 19. A hollow cathode body 20 in the form of a tubular metallic sleeve or thimble is provided with a cap closure 21 at the end of the cathode directed toward the stem of the vessel. The cap closure embraces the periphery of the cathode sleeve and is welded thereto at distributed points. The cathode and cap are supported by welding the support wire 19 to the outer surface of the cap so that the axis of the cathode is in alignment with the axis of the vessel and stem. The other end of the cathode is pinched flat across one diameter to effectively close the cathode body and thereby provide a

large surface area directed toward the closed end of the vessel 10. The complete outer surfaces of the cathode sleeve and cap are coated with electron emissive material, such as barium and strontium oxides, and this coating is activated in the final processing of the device. The cap 21 is provided with an aperture 23 to facilitate the removal of gases during the evacuation and occlusion treatments of the electrodes and the device.

The function of the device as an electronic relay or trigger tube is accomplished by providing a control electrode in association with the cathode so that a low transfer current may be attained. This is realized by mounting an angularly arranged stub wire 24 on the end of the support wire 18 and having the curved end thereof 25 closely adjacent the center of the cap 21, the specific spacing between the cap and the curved end of the grid control being approximately .025 inch. In order to stabilize the functioning of the device the support wires 18 and 19 are covered with insulating sleeves 26 and 27, preferably of glass, which extend from the junction of the electrodes on the respective wires to the plane of the press 12. A disc shield 28 of insulating material, such as mica, is provided with apertures to fit over the glass sleeves 26, 27 and around the short anode wire 17. This shield is spaced a short distance from the top of the press 12 and is supported in rigid position by a cross-bridge or brace member 29, which is welded to the anode 17 and secured to a metallic eyelet 30 secured to the disc at a position diametrically opposite to the anode.

This arrangement is advantageous, since it has been found that the transfer current between the cathode and grid which determines the breakdown characteristic of the device can be reduced to 2 or 3 mils, whereby group operation of the devices may be utilized without a serious drain on the voltage source. The device also exhibits a low resistance characteristic to facilitate its association with other cooperating apparatus in signaling or switching applications, such as secretarial telephone service and other allied systems. The insulating spacer assembly provides a rugged construction without reducing the cathode-anode discharge spacing or increasing the total length of the unit. Furthermore, the shield prevents active material thrown off the cathode from being deposited on the stem. Any deposition on the shield is immaterial since a conductive path cannot reach the control electrode.

In order to preserve the critical spacing between the cap portion of the cathode and the control electrode it is essential to maintain the cathode structure in rigid position and this is accomplished in accordance with this invention by a metallic spider spacer which is carried by the top of the cathode and is provided with extensions which resiliently engage the inner wall of the vessel to prevent shock or vibration displacing the normal position of the cathode. This arrangement comprises a short stub wire 31 rigidly held in the center of the flat portion 22 of the cathode and a pair of arcuate wire springs 32 and 33 welded at their centers to the stub wire 31 and lying in tangential planes on opposite sides of the flat portion of the cathode with their free curved ends spreading out to the glass wall of the vessel to resiliently center the cathode with respect to the vessel. A feature of this arrangement is the fact that the fine wire springs do not obstruct the glow discharge projected through the end of the vessel and therefore will not materially affect the light efficiency of the device. Another advantage of this arrangement is the fact that the cathode sleeve and cap may be completely coated with electron emitting material prior to the mounting of the spider assembly.

The device may be filled with a gaseous filling of a mixture of 95 per cent neon and 5 per cent argon at a pressure of 45 millimeters of mercury to form the ionizing medium for the characteristic glow discharge suitable for this device. The facility with which this device may be incorporated in associated apparatus, particularly in congested positions, may be realized from the over-all dimensions of the device which are, in one embodiment, a length of 1¾ inches and a diameter of $\frac{7}{8}$ inch. The drawing compares to these dimensions by showing the device and the elements thereof enlarged to four times normal size. The small size facilitates the grouping of a large number of glow discharge signals in a restricted space, such as an indicator panel on a secretary's desk, to constitute a visual signal or annunciator apparatus.

While the description pertains to a specific embodiment of the invention, it is, of course, understood that various modifications may be made in the detailed assembly and association of elements comprising the combination and that, therefore, the scope of the invention is to be determined by the appended claims.

What is claimed is:

1. A glow discharge device comprising a gas-filled vessel enclosing an elongated hollow cathode having a contracted end portion axially supported therein, an anode adjacent said cathode and adapted to produce a luminous glow visible through the end of said vessel, and a resilient wire member supported by said contracted end portion and engaging the wall of said vessel.

2. A glow discharge relay comprising a vessel having a stem and containing an ionizable gaseous medium, an elongated cathode supported from said stem, an anode adjacent said cathode, a control electrode adjacent said cathode and extending from said stem, and a resilient spider member joined to the center of said cathode remote from said stem and having the legs thereof in contact with the wall of said vessel.

3. A combined signal and relay device comprising a tubular vessel having a stem at one end, a gaseous mixture therein at low pressure, a tubular cathode coaxial with said vessel having a cap closure at the end adjacent said stem, a control electrode closely adjacent the center of said cap closure, parallel supports for said cathode and control electrode extending through said stem, insulating members surrounding said supports between said stem and said cathode and control electrode, an anode wire extending beyond said stem, a disc shield covering said stem and embracing said anode and said insulating members, and a resilient support at the opposite end of said cathode including a pair of arcuate springs tangentially mounted with respect to the cathode and having the ends thereof in contact with the wall of said vessel.

4. A glow discharge device comprising a gas-filled vessel enclosing a tubular cathode having a closure at one end and a diametrically flat portion at the other end, a support extending from said closure, a short wire anode parallel to said support having its end terminating in spaced relation to said cathode closure and in offset po-

sition with respect to the axis of said cathode, a disc shield transversely mounted and surrounding said anode and said cathode support, and means connecting said disc to said anode.

5. A glow discharge device comprising a gas-filled vessel, a tubular cathode having a closure at one end and a diametrically flat portion at the other end, a support extending from said closure, an anode wire parallel to said support, and a pair of arcuate wire springs supported by said cathode and mounted in outwardly angular planes with respect to the flat portion of said cathode.

6. A glow discharge relay device comprising a tubular vessel containing a gaseous filling, an elongated cathode having a cap closure at one end and a flat closed end to form a hollow body, a wire anode spaced in relation to said cathode to produce a glow discharge within said vessel, and a control electrode spaced close to the center of said cap closure to transfer the discharge from said anode at a minimum transfer current.

7. A combined signal and relay device comprising a vessel containing a gaseous filling, a tubular cathode having a closure at one end and a diametrically flat portion at the other end, a support extending from said closure, a wire anode parallel to said support having its end in spaced relation to the cathode closure, and a wire control electrode extending parallel to said anode and having an angular portion projecting toward the center of said closure.

8. A glow discharge device comprising a gas-filled vessel enclosing a tubular cathode having a closure at one end and a diametrically flat portion at the other end, a wire connected to said closure and supporting said cathode axially within said vessel, an anode in parallel relation to said wire but in offset position with respect to the axis of said cathode, a disc shield transversely mounted and surrounding said anode and said cathode wire, means connecting said disc to said anode, a wire control electrode extending parallel to said anode and having an angular portion projecting towards the center of said closure, and insulating sleeves surrounding said cathode wire and said control electrode and extending through said disc shield.

9. A combined electronic relay and visual signal comprising an enclosing vessel having a stem, three wires of varying length projecting beyond said stem in parallel relation, insulating sleeves surrounding the two longer wires, a mica disc embracing said sleeves and the shortest wire and disposed across said stem, a brace member secured to said disc and to said shortest wire and extending transversely between said sleeves, a hollow elongated cathode supported by the longest wire in axial relation to said vessel, said cathode having a cap closing the end thereof directed toward said stem and the other end being pinched flat across one diameter, a stub wire extending from the center of said pinched end, a pair of oppositely disposed arcuate springs centrally secured to said stub wire and spread outwardly to resiliently contact the wall of said vessel, an electron emissive coating on said cathode and cap, a gaseous filling at low pressure in said vessel which when ionized produces a glow discharge visible through the end of said vessel, and an angularly disposed control electrode supported by the remaining wire with the free end of said electrode spaced approximately .025 inch below the center of said cathode cap.

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