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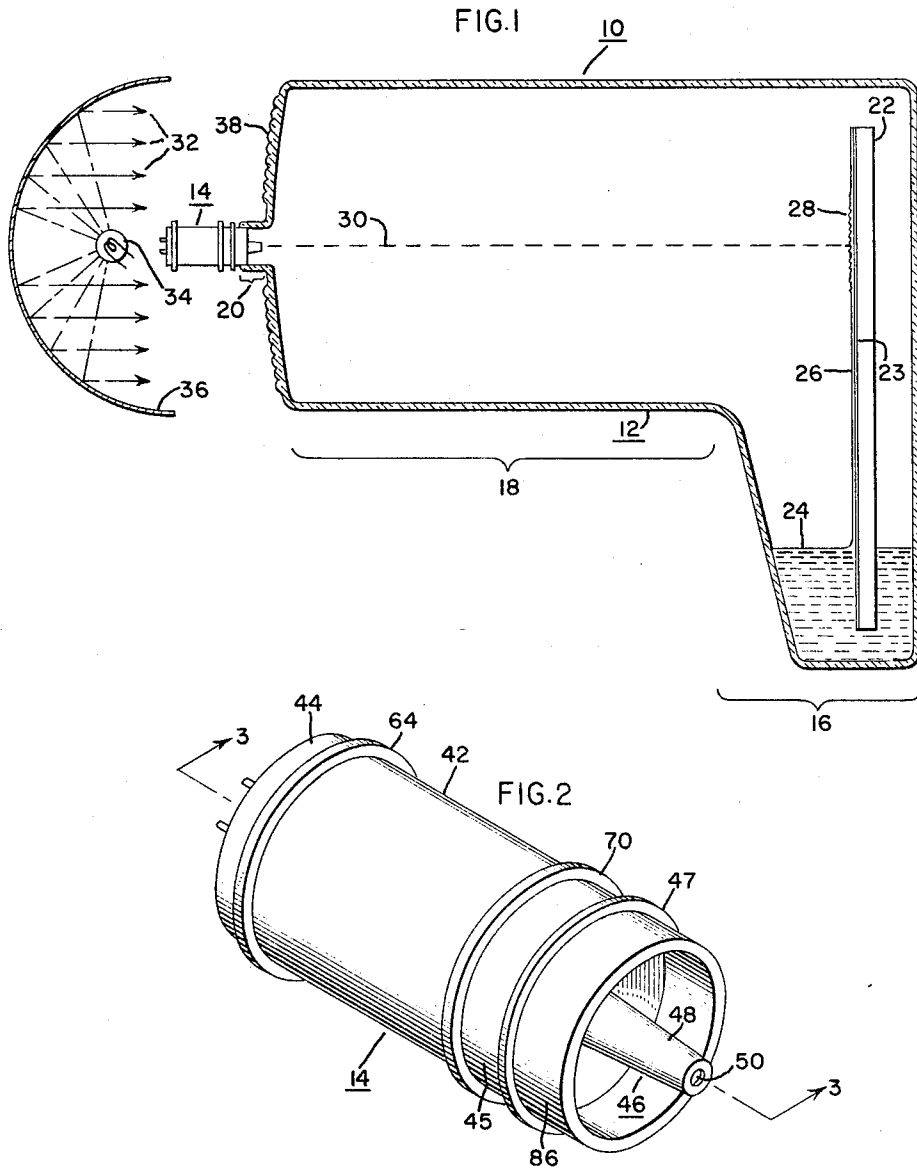
E. F. SCHILLING ET AL

3,289,028

APPENDAGE ELECTRON GUN FOR LIGHT VALVE PROJECTION APPARATUS

Filed Oct. 3, 1963

2 Sheets-Sheet 1



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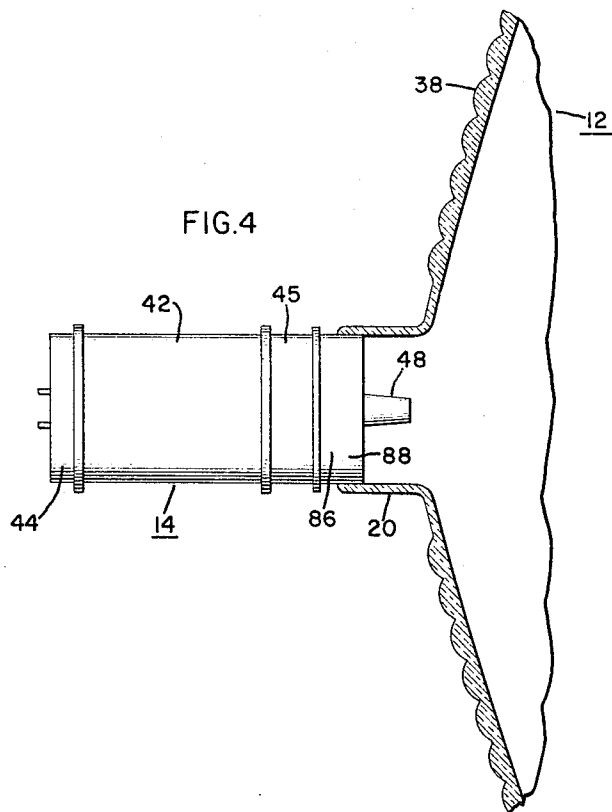
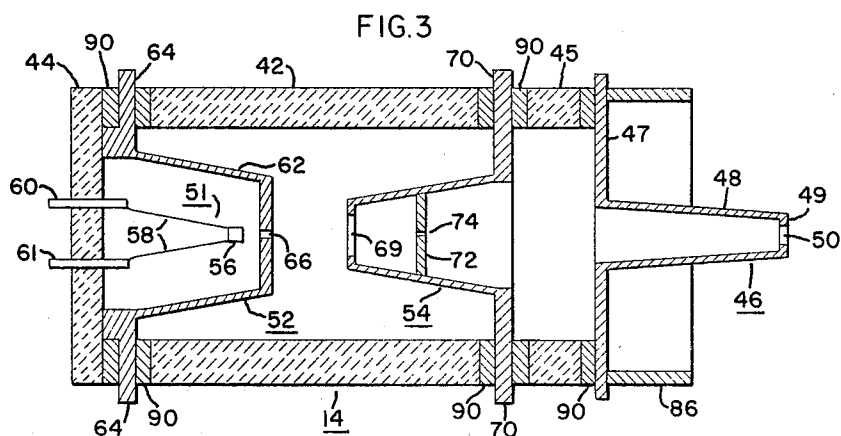
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1

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APPENDAGE ELECTRON GUN FOR LIGHT VALVE
PROJECTION APPARATUSEdmund F. Schilling, De Witt, and Von C. Campbell,
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3 Claims. (Cl. 313-318)

This invention relates to an electron discharge device for use with light valve apparatus.

One form of a light valve apparatus includes an electron discharge device having a deformable medium positioned within an envelope of the device and an electron gun exposed to the atmosphere within the envelope. An electron beam which is generated by the gun is scanned across a portion of the medium and is modulated to cause deformations in the surface of the medium. These deformations constitute gratings which, in cooperation with a light source and a Schlieren optical system, operate to reproduce images as defined by beam modulating intelligence.

The environmental conditions under which the electron gun must operate are severe. Under bombardment by the electron beam the deformable medium evolves gases including hydrocarbons which contaminate the atmosphere within the envelope. The electron emission from a cathode electrode as well as the operation of other electrodes of the gun is degraded by these gases and the operating life of the gun is rendered substantially shorter than could be expected in an operating atmosphere free of these gases.

In order to reduce the adverse effects of these gases upon the gun, it has been proposed to partition the envelope into gun and writing chambers. A wall separates the device into chambers while an aperture of desired dimension which is located in the wall allows passage of an electron beam from the gun chamber to the writing chamber while largely attenuating the flow of contaminating gases from the writing to the gun chamber.

Prior arrangements of this discharge device have been relatively complex and not readily adaptable to economical fabrication and processing in large quantities.

Accordingly, it is an object of the present invention to provide in a light valve apparatus, an electron discharge device of improved construction.

A particular object of this invention is to provide an electron discharge device of the type referred to which can be fabricated with relative facility.

Another object of this invention is to provide an electron discharge device having gun and writing chambers and in which an electron gun thereof is characterized by simplicity and relative economy both in structure and assembly.

In order to provide maximum electron beam transmission between a cathode of the gun and a target, the cathode and aperture in the chamber separating wall are required to be aligned with a high degree of care.

A further object of this invention is to provide an electron discharge device which facilitates this alignment.

It is desirable to test both the electron emission and the alignment between the cathode and the aperture in order to verify that satisfactory electron emission and transmission is provided. Testing of these characteristics has previously been accomplished subsequent to final assembly of the electron discharge device. Accurate verification has consequently been rendered difficult in view of the interposition of a writing medium between an accelerating electrode and the cathode in the evacuated envelope of the device.

It is therefore another object of this invention to provide

2

an electron discharge device which is adapted to be readily and accurately tested for electron emission and aperture alignment.

For efficient transmission of light from the previously referred to light source to the writing medium and for compactness of arrangement of the apparatus, it is advantageous to position the light source of a light valve projection apparatus with respect to the electron gun in a manner for providing that a longitudinal axis of the gun is generally normal to the plane of light rays emanating from the light source and coaxial with a lamp element of the light source. It is further beneficial to minimize the length and cross sectional area of the gun housing and to space it relatively close to the light source. This size requirement creates difficulties in fabricating both the gun and its housing and in mounting and aligning the aperture with respect to the cathode.

It is thus another object of the present invention to provide an electron gun and housing for a light valve projection apparatus which reduces interference in the transmission of light from the light source to the writing medium.

A further object of the invention is to provide an electron gun and housing arrangement which may be fabricated to relatively small dimensions with facility.

The light source in a light valve projection apparatus, for example, a 500 watt xenon lamp, creates a substantial amount of heat energy. The relatively closely spaced electron gun housing which conventionally is formed of glass is therefore subjected to an intense heat. The high heat level seriously decreases the electrical insulation characteristics of the glass housing and results in relatively high leakage current, especially in view of the relatively high potentials applied to elements of the gun structure.

Accordingly, it is still another object of this invention to provide an electron gun and housing spaced relatively close to the light source in a light valve projector yet which avoids the aforementioned problems encountered at the high heat levels.

In accordance with this invention, an electron discharge device for a light valve apparatus is provided having an envelope member which forms a writing chamber for the device and an appendage member which is mounted and hermetically sealed to the envelope member and which forms an electron gun chamber for the device. The appendage member comprises an assembly of electron gun electrodes and refractory material insulating elements which are arranged to provide a hermetic seal between the atmosphere of the enclosed electron gun chamber and the ambient atmosphere to which the device is subjected.

In accordance with further features of the invention, the appendage member includes an aperture disk mounted therein for reducing the flow of contaminating gases from the writing to the gun chamber and an end element for facilitating processing of the gun. An aperture is located in the end element for passage of an electron beam from the gun chamber to a target positioned in the writing chamber.

By this arrangement an improved discharge device for a light valve apparatus is provided which may be assembled and tested in a relatively convenient and economic manner; which can be fabricated to reduce interference with light transmission; and which is substantially unaffected by the intense heat of the light source.

These and further objects, features and the attending advantages of the invention will be apparent with reference to the following specification and drawings in which:

FIGURE 1 is a view of an electron discharge device for a light valve projection apparatus illustrating an embodiment of the present invention;

FIGURE 2 is a perspective view of an appendage elec-

tron gun member of the discharge device of FIGURE 1;

FIGURE 3 is a sectional view of the gun member of FIGURE 2 taken along lines 3—3 of FIGURE 2 and illustrating in detail the various components of the appendage member; and

FIGURE 4 is an enlarged view of a portion of FIGURE 2 illustrating an arrangement for mounting and hermetically sealing the appendage member to the envelope member.

In FIGURE 1, an electron discharge device 10 for use in a light valve projection apparatus is shown. Although the present invention will be described with respect to a light valve projection apparatus, the invention may equally well be utilized with other types of light valve apparatus. Only so much of the projection apparatus is illustrated as is believed necessary for a complete understanding of the present invention.

The electron discharge device 10 comprises an envelope member which forms a writing chamber for the device and which is identified generally as 12 and an appendage electron gun member identified generally as 14. Although various other envelope configurations may be provided, the envelope member 12 may conveniently be fabricated of glass to the generally boot-shaped configuration illustrated. The writing chamber includes a reservoir and target region 16 for storing a writing medium, a deflection region 18 wherein means are provided for deflecting an electron beam, and a neck region 20 for supporting the gun member 14. A disk 22 of transparent material, such as glass, and having a conductive substrate surface 23 positioned thereon is mounted by means, not shown, in the reservoir and target region 16 of the writing chamber. The disk is mounted in a manner for providing that an outer segment of its surface area is partially immersed in a pool 24 of a writing medium such as a silicone oil. The disk is rotated by means, not shown, and a layer 26 of the writing medium forms on the surface of the disk. Through this arrangement, the writing medium is both supported in a raster area, indicated by the jagged surface 28, and continuously replenished.

An electron beam 30 is generated by the electron gun appendage member 14 and is accelerated toward the raster target area 28 by a high potential applied between a cathode of the electron gun and the conductive substrate 23. In order to simplify the drawings, the means for providing this high potential is not illustrated. The beam 30 is modulated and deflected in a scanning raster on raster area 28, by means not shown. Impingement of the electron beam on the writing medium causes deformations in its surface which constitute gratings. As indicated previously, beam impingement causes the release of gases which can contaminate a cathode and other electrodes of the electron gun.

Light rays 32 which are derived from a lamp 34 and which are reflected by a surface 36 pass through a lenticular lens system 38 and are projected upon the raster area 28. In cooperation with a Schlieren optical system, not shown, an image representative of the beam modulating intelligence is projected upon a viewing surface, not shown.

Reference is now made to FIGURES 2, 3 and 4 for a more detailed description of the appendage electron gun member 14. The member comprises an assembly of a hollow annular body element 42 of refractory material, an annular base element 44 of refractory material which supports the cathode and forms a closure for one end of the gun member, a hollow annular spacer element 45 of refractory material, and an electron gun processing end element 46 of suitable material, which forms a closure at the other end of the gun member during processing. When used in conjunction with elements 42, 44, and 45 the term refractory material refers to any material having good electrical insulation characteristics and whose resistivity and structure is substantially unaffected when placed in proximity to a lamp source of relatively high

heat intensity such as a 500 watt lamp. Processing element 46 includes a generally flat support surface segment 47 which extends beyond the surface of the housing and a hollow conically shaped segment 48 having a surface 49 with an aperture 50 formed therein. The function and composition of member 46 is indicated more fully hereinafter.

The electron generating and beam forming components of the electron gun comprise a cathode electrode indicated generally as 51 in FIGURE 3, and a first electron lens having first and second electrodes indicated generally as 52 and 54 respectively. Cathode electrode 51 is of the directly heated dispenser type and comprises an emitter 56 of a dispenser type material which is supported by refractory metal legs 58 and which is heated by a voltage applied between input terminals 60 and 61. The first electrode 52 is a unitary structure fabricated of a suitable material, as indicated hereinafter, and includes an integral hollow conically shaped segment 62 and an integral annular outer support segment 64. The segment 64 may extend beyond the outer surface of the housing and conveniently provides a terminal point for coupling a suitable operating voltage to electrode 52. Electrode 52 also includes a beam shaping aperture 66 formed in a surface of the electrode. The second electrode 54 comprises a unitary structure having a conically shaped segment 68 including an aperture 69 and an integral annular support segment 70 extending beyond the surface of the housing and to which an operating voltage may conveniently be connected.

An aperture disk 72 is positioned and hermetically sealed within the hollow segment 68 and an aperture 74 located therein is aligned with respect to cathode 51 and the aperture 66 of electrode 52. The aperture disk 72 may be secured in position in a manner as is indicated hereinafter. Aperture 74 is formed to have a cross sectional area for permitting passage of an electron beam from the cathode 51 to the target 28 while largely attenuating the flow of the above referred to contaminating gases from the writing chamber to the cathode.

Means comprising a gun mounting element 86 is provided for mounting the electron gun member 14 to the envelope member 12. Element 86 is cylindrically formed and is hermetically sealed to the envelope member 12.

In addition to the above referred to elements of the electron gun member, a plurality of rings 90 are assembled in axial relation, as shown, with respect to the various other elements of the gun.

The composition and illustrated arrangement of the elements of the gun member are chosen to facilitate assembly and cohesion of the members by a brazing process. The rings 90 are brazing filler rings of a material selected to provide brazing between the refractory elements 42, 44 and 45 with elements 46, 52 and 54. The disk 72 and support element 86 are formed of a material suitable for brazing these elements to associated elements 54 and 46 respectively when brazing filler materials are provided.

In a particular illustrative embodiment of the gun member, the refractory elements 42, 44 and 45 were formed of a ceramic material such as the ceramic Fosterite having the composition by weight of magnesium oxide 49.4%, aluminum oxide 13.2%, silicon dioxide 36.4% and barium oxide 1.0% as described in U.S. Patent No. 3,060,040 which is assigned to the assignee of the present invention. Elements 46, 52, 54 and 72 were machined from titanium stock, member 86 was machined of a glass sealing alloy metal having a nominal composition of 54% iron, 29% nickel, 17% cobalt, 2% manganese and .1% carbon while rings 90 were formed of nickel.

The gun as shown in FIGURE 3 with the exception of element 86 is mechanically assembled in a suitable jig and the necessary alignment of the elements including the alignment of the aperture 74 with respect to the cathode 51 and aperture 66 is provided. Disk 72 is then hermetically sealed to electrode 54. At this stage in the fab-

5

rication of the gun member, the aperture 50 is not yet formed in the surface 49. This assembly is then positioned in an evacuated atmosphere. Means are provided for simultaneously heating the assembly in the evacuated atmosphere to a temperature and for a period of time for causing the assembly to be brazed and form a rigid, hermetically sealed unit. Heating to the desired temperature may be accomplished by placing the assembly within a refractory metal container positioned within an evacuated chamber and heating this container with a conventional RF inductive heating unit.

By this arrangement, an evacuated and hermetically sealed electron gun member is fabricated prior to final assembly of the discharge device. The gun member may advantageously be tested now both for cathode emission and aperture alignment. This may be accomplished by connecting suitable operating potentials to the different electrodes. As an illustrative example, a voltage of magnitude for causing approximately 4 to 5 amperes to flow between the cathode terminals 60 and 61 is applied between these terminals; a D.C. voltage variable from 0 to 300 volts is applied to electrode 52, and 10,000 volts D.C. is applied to electrode 54. In addition, 10,000 volts D.C. or greater is applied to processing element 46 to cause element 46 to operate as a collector anode. The amplitude of current which flows to elements 54 and 46 is an accurate indication of cathode emission and the ratio of the currents flowing to element 46 and to element 54 is an accurate indication of aperture alignment. Hence, a defective electron gun may be detected and in some cases repaired prior to final assembly of the device.

Subsequent to gun testing and prior to final assembly of the device, the aperture 50 is formed in the surface 49. The aperture may be formed by any conventional machine process. The pressure within the gun member 14 then rises to atmospheric level. The element 86 is hermetically sealed to processing end element 46 and the gun member 14 is now mounted and hermetically sealed to the envelope 12 as indicated in FIGURE 4. This may be accomplished by glass sealing an end portion 92 of neck region 20 to an edge of element 86.

The assembled electron discharge device is subjected to evacuation and outgassing cycling. An evacuation pump then is connected to the envelope 12 and the electron discharge device is simultaneously heated and pumped to outgas the elements therein and until a desired operating vacuum is attained within the device. The various elements of the gun member and other components of the device which are mounted in envelope 12 can be heated by RF induction. The disk 72 can be heated by electron bombardment by the electron beam generated by the cathode 51.

A relatively economical and efficient method for processing the electron discharge device and which eliminates the necessity of reoutgassing the gun elements after the discharge device has been assembled is described in co-pending application Serial No. 313,694, filed October 3, 1963 and assigned to the assignee of the present invention.

It will be appreciated that the described gun member 14 can be fabricated to relatively small dimensions with facility. For example, fabrication of a refractory material such as moulding of a ceramic material can provide a substantially smaller cross sectional area for the gun member housing and a relatively more rigid and desirable housing than could practically be accomplished if the housing comprised an elongated glass neck extending from

6

a bulbous envelope such as are known and generally used with cathode ray tubes. Further, the electrical characteristics of the refractory material remains substantially unaffected in the presence of the intense lamp heat.

Thus, we have described a novel arrangement of an electron discharge device wherein an improved electron gun member is provided which can be conveniently fabricated and tested prior to final assembly of the discharge device; which can be fabricated to relatively small dimensions; and which is adapted for operation under relatively severe environmental conditions.

While we have illustrated and described and have pointed out certain novel features of our invention, it will be understood that various omissions, substitutions, and changes in the form and details of the system illustrated may be made by those skilled in the art without departing from the spirit of the invention and the scope of the claims.

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

1. An electron discharge device for a light valve apparatus comprising: an envelope member forming a writing chamber for the device; an appendage electron gun member mounted and hermetically sealed to said envelope member; said gun member having a base, a body and a spacer element formed of an electrically insulative refractory material; said body and spacer elements having an annular hollow configuration; said base, body and spacer elements axially adapted to form an annular hollow electron gun chamber having a closure at an end thereof; a cathode electrode mounted to said base element and extending into the hollow of said body and spacer elements; an electron gun lens having first and second electrodes; said first and second electrodes having annular integral surface segments spaced between said base and body and between said body and spacer elements respectively and secured thereto by a brazing filler metal; each of said electrodes extending inwardly from a respective end of said body member and toward the axis of said body element and terminating in a disc having an aperture on said axis; an end element axially adjacent said spacer element and secured thereto by a brazing filler metal; said end element having an aperture located therein, said apertures being aligned to provide for the passage of an electron beam from the gun member to the writing chamber.
2. The discharge device of claim 1 including a chamber separating aperture disk mounted to one of said electrodes.
3. The discharge device of claim 1 including an annular element secured to said end element for mounting said electron gun member to said envelope member.

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