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[54] **PLANAR RAISED CATHODE ALPHA-NUMERIC GAS DISCHARGE INDICATOR**

[75] Inventors: **James B. Armstrong; Dan J. Schott; Leland C. Warne,** all of Phoenix, Ariz.

[73] Assignee: **Sperry Rand Corporation**

[*] Notice: The portion of the term of this patent subsequent to July 4, 1989, has been disclaimed.

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[21] Appl. No.: **158,536**

Related U.S. Application Data

[63] Continuation of Ser. No. 742,662, July 5, 1968, abandoned.

[52] **U.S. Cl.** **313/109.5,** 313/210, 313/217, 313/220, 313/331

[51] **Int. Cl.** **H01j 61/66**

[58] **Field of Search** 313/109.5, 210, 217, 220, 313/318, 331

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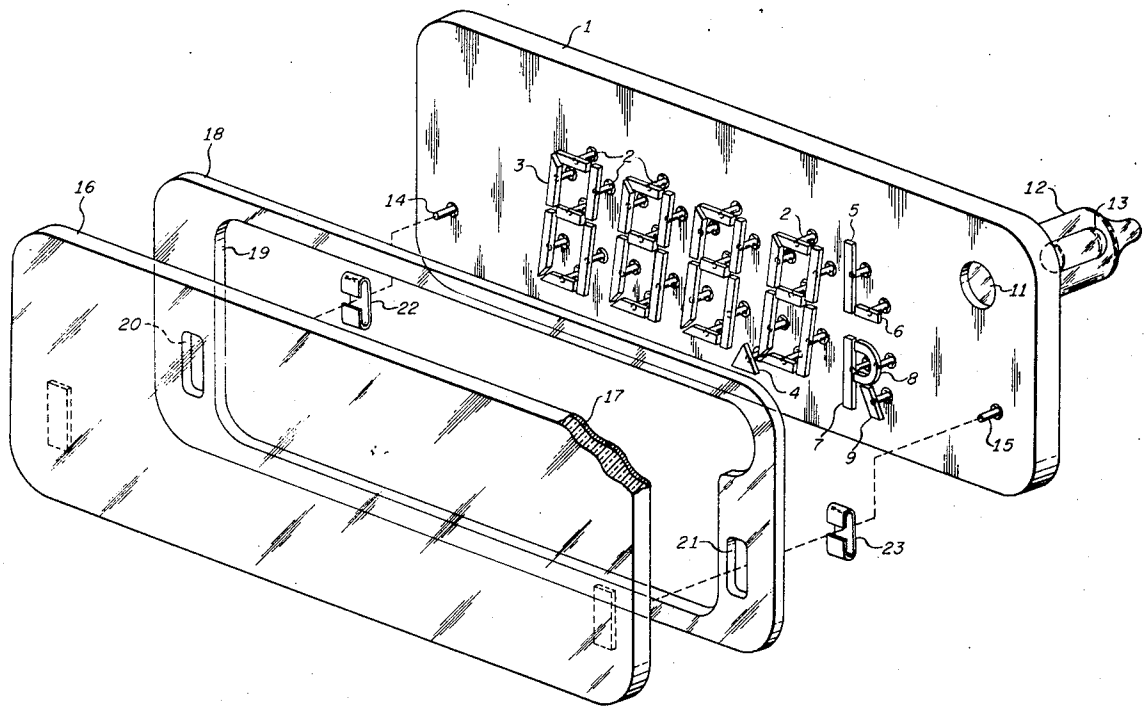
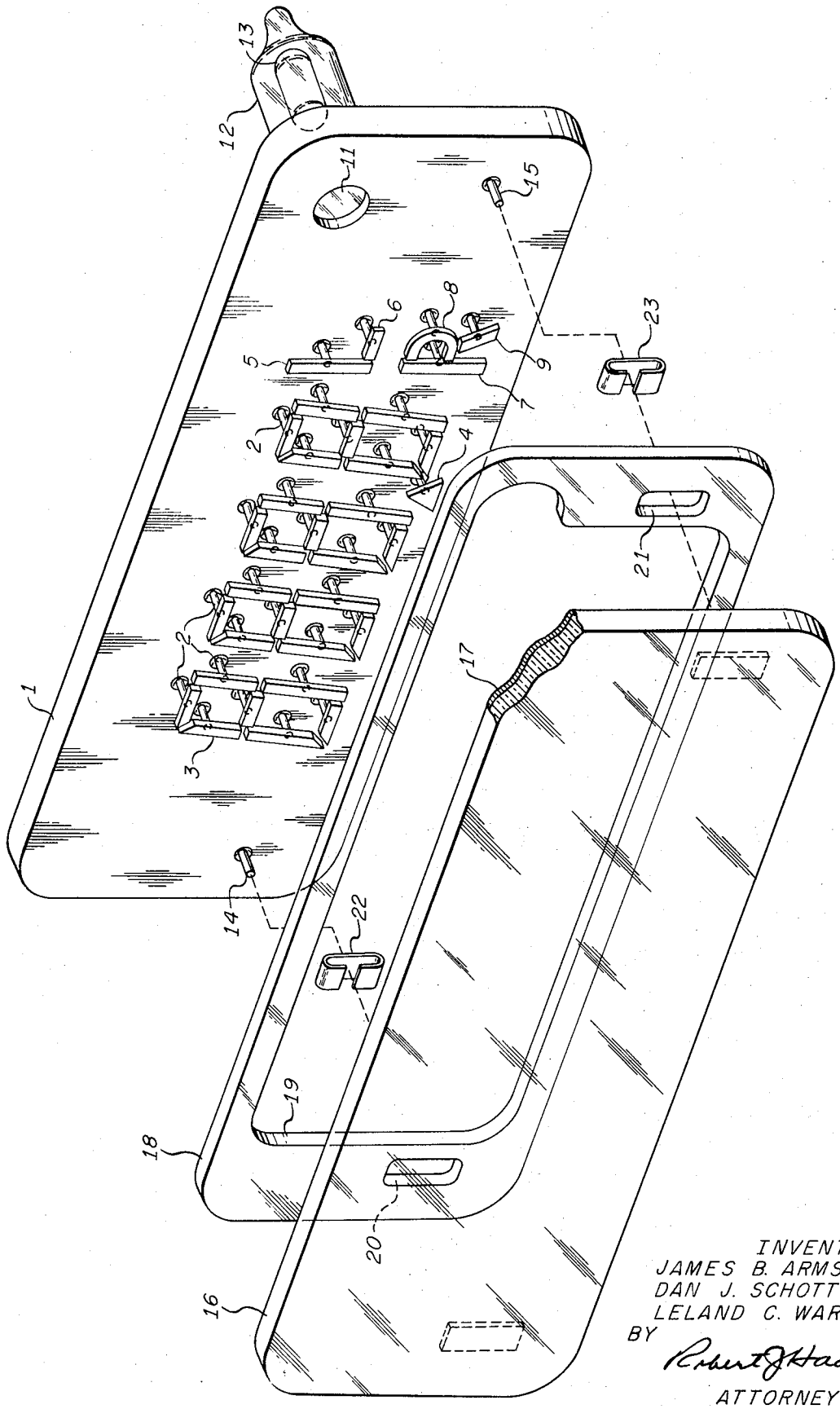
Primary Examiner—Palmer C. Demeo
Attorney, Agent, or Firm—Robert J. Steinmeyer; James M. Thomson

[57] **ABSTRACT**

A gas discharge indicator comprising a cathode-supporting substrate and a parallel transparent anode spaced from and hermetically sealed to said substrate to contain an ionizable gas therebetween. Individual cathode segments are mounted on the tops of feed-through pins which penetrate the substrate in hermetically sealed relationship and extend beyond the opposite surfaces of the substrate whereby the individual cathode segments are spaced relative to the substrate as well as relative to the anode. The anode-cathode and cathode-substrate spacing are such that with a predetermined gas pressure, the cathode segments glow only on the anode or viewable side of the cathode, thereby minimizing sputtering from the substrate side thereof. Additionally, a cup-shaped moat is etched into the cathode side of the substrate about each pin. The raised cathode and moat structure minimize the effects of sputtering and extend the operating life of the indicator.

2 Claims, 1 Drawing Figure





INVENTORS
JAMES B. ARMSTRONG
DAN J. SCHOTT
LELAND C. WARNE
BY
Robert J. Haase
ATTORNEY

PLANAR RAISED CATHODE ALPHA-NUMERIC GAS DISCHARGE INDICATOR

This application is a streamline continuation of application Ser. No. 742,662, filed July 5, 1968, and now abandoned.

BACKGROUND OF THE INVENTION

The invention relates to planar alpha-numeric indicators of the gas discharge type wherein the cathode substrate forms one member of a hermetically sealed package containing an ionizable gas. Cathode glows are viewed through a transparent anode member overlying and hermetically sealed to the cathode substrate. Prior devices of the aforementioned type suffered from want of adequate operational life. Cathode sputtered material was chiefly responsible for the premature failures, the sputtered material forming low resistance paths between adjacent cathode segments. Attempts have been made to lengthen operational life by the mixture of a heavy molecular weight gas such as mercury with the ionizable gas. While this technique resulted in extended life in certain gas discharge tube designs, it alone did not yield satisfactory operation in planar type indicators wherein the cathode segments are deposited, bonded or otherwise rest upon a common substrate in closely spaced relationship.

SUMMARY OF THE INVENTION

In accordance with the present invention, premature failure due to sputtering in planar alpha-numeric gas discharge tube indicators is avoided by mounting each cathode segment on top of a respective feed-through pin passing through a common cathode substrate whereby each segment is raised above the substrate. Thus, each cathode segment is spaced from both the anode and the substrate, the relative spacing being such that with a predetermined gas pressure, the cathode segments glow only on the anode or viewing side thereof. For example, with a gas pressure of 50 mm Hg-neon, a 0.030 inch anode-cathode space and a 0.005 inch cathode-substrate space will produce such anode-side glow only. To further reduce the effects of sputtering a cup-shaped moat is etched into one side of the substrate around the base of each cathode support pin. An additional advantage of the anode-cathode, cathode-substrate spacing is that the power required to produce a given lumens glow is reduced by approximately 50 percent.

The cathode segment assembly is fabricated by providing a planar insulating substrate having a plurality of feed-through pins, one end of the pins lying flush with the surface of the side of the substrate with the other end of the pins extending beyond the opposite surface of the substrate. The side of the substrate having the flush pin terminations is then etched away so as to expose the desired length of each pin above the etched substrate surface. During etching, a cup-shaped indentation or moat is formed in the substrate around the base of each pin. The moats formed during the substrate etching process result from the use of a substrate-pin combination which produces compressively strained seals; these strained (glass) seal areas etching more rapidly than the unstrained portions of the substrate.

It has been determined that the raised cathode segments and the moats substantially reduce the effects of cathode sputtering and significantly increases operational life of the indicator tube. It is believed that the sputtered products do not tend to coat the steep walls of the cup-shaped moat and therefore there is provided an annular surface around the pins that is substantially free of sputtered products and hence forms an insulating barrier between the sputtered and hence slightly conductive substrate surface and the pin. In other words, the cathode segments are electrically "free" of the substrate. Other features of the invention include the provision of multiple alpha-numeric characters within a single hermetically sealed enveloped.

BRIEF DESCRIPTION OF THE DRAWING

The sole FIGURE is a simplified exploded view in perspective of a typical embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the FIGURE, glass substrate **1** is apertured to receive a number of electrical contacting pins **2** which are hermetically sealed to substrate **1.** The ends of pins **2** on the viewed (near) side of substrate **1** extend above the substrate surface a predetermined distance; in the specific embodiment illustrated, a distance of about 0.005 inches. The pins extend below the back surface of substrate **1** a convenient distance suitable to being received by a mating pin receptacle (not shown) for the application of operating potentials. Individual cathode segments **3** are mounted on the ends of respective pins **2** to form a plurality of conventional alpha-numeric configurations. In addition to the alpha-numeric cathode segments, cathode segment **4** is provided to represent a decimal point; cathode segments **5** and **6** are provided to represent the letter L and cathode segments **7, 8** and **9** are provided to represent the letter R. The disclosed segment pattern is merely illustrative of one aircraft instrument embodiment of the invention. All cathode segments lie approximately in the same plane at substantially the same distance from substrate **1** on the ends of respective pins. Substrate **1** additionally is provided with an aperture **11** to which gas fill tube **12** is hermetically sealed on the side of the substrate opposite the cathode segments. A mercury ampule **13** is inserted inside tube **12.** Finally, substrate **1** is equipped with a pair of hermetically sealed feed-through pins **14** and **15** for establishing electrical contact to the anode member of the gas discharge lamp.

Anode member **16** of the gas discharge lamp comprises a glass substrate on which is deposited a thin film **17** of a transparent conductive material completely covering the surface facing cathode substrate **1.** Cathode substrate **1** is spaced from anode member **16** by glass spacer plate **18** having a main aperture **19** defining a volume of ionizable gas for producing cathode glows when the indicator of FIG. **1** is completely assembled and energized. Spring contacts **22** and **23** pass through a pair of smaller apertures **20** and **21** to establish electrical contact from pins **14** and **15** to the conducting film surface of anode **16** in the assembled unit. In accordance with the teachings of the present invention, the thickness of the spacer plate **18** is determined by the anode-cathode, cathode-substrate space required to cause only the anode-side of the cathode segments to glow under a given gas pressure, taking into account, of course, the thickness of the cathode ele-

ments themselves. In the illustrated embodiment the spacer thickness is 0.040 inches. Alternatively, the separate anode and spacer elements may be combined into a single molded unit, the side walls of which are ground to the dimension required to result in the above-discussed element spacing. In a further alternative construction, the transparent anode may be a separate fine wire mesh of, say stainless steel, welded to pins upstanding from the substrate, such as pins **14** and **15**, to a distance required to produce the described anode-cathode, cathode-substrate spacing.

The indicator of FIG. **1** is assembled by bringing the elements **1**, **16** and **18** into aligned contact with each other and then hermetically sealing the entire edge surfaces of the aligned units. Conventional techniques are applied for purging the atmosphere within the sealed unit and then filling and sealing the unit with an appropriate ionizable gas and an amount of mercury in ampule **13**. The mercury is released into the sealed gas atmosphere at a suitable time during fabrication as is well known in the art. After release, the mercury provides an amount of heavy molecular weight gas which is believed to inhibit cathode sputtering by absorbing a significant amount of the kinetic energy of the ionized gas particles before they bombard the cathode segments.

Each of the cathode segments **3–9** is welded or otherwise secured to the top surface of a respective pin which protrudes from the surface of substrate **1** by an amount determined to provide the above spacing requirements; in the illustrated case, on the order of about 0.005 inches as previously mentioned. In accordance with the present invention, the tops of the pins to which the cathode segments are attached are made to lie along substantially the same plane parallel to the surface of substrate **1** by means of an etching process. In the process, the apertures in substrate **1** are filled with feed-through pins so that one end of the pins lies flush with the viewed surface of the substrate. The pins are then hermetically sealed to the substrate as by a glass-to-metal seal, which produces compressively strained areas about the pin circumferences. The viewed surface of the substrate is then chemically etched to the required 0.005 inch depth relative to the original pin surface plane whereby to expose the desired length of each pin above the etched surface.

The etching procedure simultaneously produces a cup-shaped indentation or moat about the base of each pin as the result of the fact that the etchant attacks the stressed glass-to-metal seal region around each pin at a faster rate than it attacks the glass substrate not in the vicinity of the glass-metal seal; i.e., the unstressed region of the substrate material. A solution of distilled water and hydrofluoric acid is suitable as the etchant. It has been determined that the rate with which cathode-sputtered material deposits over the surface of the substrate **1** to an amount sufficient to establish low resistance paths between cathode segments is substantially reduced in the presence of the moats as compared to the rate obtained in the absence of the moats. It is believed that the reduced rate of low resistance path build-up is attributable to the increased surface area exposed between adjacent pins by virtue of the moats about the base of each pin. It is also believed that sputtered products do not tend to coat the relatively steep walls of the moat thereby providing an annular insulative ring about the pins. Thus, for a given sputtering rate, the length of time required to deposit an objectonable conductive layer over the extended surface is substantially increased. The result is that the operational life of the gas discharge tube indicator is significantly lengthened.

While in the present embodiment the cup-shaped moats are formed as a result of the type of glass-to-metal seal used, which results in stressed areas about the pin, which in turn etch at a greater rate than the unstressed areas, it will be understood that many other techniques may be employed to form the moats without departing from the teachings of the present invention, for example, these techniques may be purely mechanical, purely chemical, or combinations of both techniques.

While the invention has been described in its preferred embodiment, it is to be understood that the words which have been used are words of description rather than limitation and that changes within the purview of the appended claims may be made without departing from the true scope and spirit of the invention in its broader aspects.

We claim:

1. A glow discharge type tube for displaying symbols or patterns comprising:

a closed hermetically sealed envelope having a substantially flat non-conductive back base and a front viewing window and containing an ionizable gas,

a plurality of electrically conductive cathode supporting pins passing in hermetically sealed relaiton through the back base into the interior of the sealed envelope to terminate in a common plane parallel to and spaced from the interior surface of the back base on the order of 0.005 inch and said pins having portions exterior of the envelope for selective energization from a source of electrical excitation,

the interior surface of the back base having a plurality of cup shaped depressions formed therein, each said cup shaped depression contiguously surrounding a respective cathode supporting pin,

a plurality of relatively spaced flat strip-like cathodes arrayed to form a pattern and each supported at the central region thereof on a respective pin end interior of the envelope so that the bottom flat surfaces of the cathodes lie in said common plane spaced from the interior surface of the back base on the order of 0.005 inch whereby sputter is substantially eliminated from the bottom surfaces of said cathodes in operation of the tube and the cathodes effectively shield a portion of the interior surface of the back base to impede deposition of cathode sputter material within said cup shaped depressions, and

anode means disposed within said envelope in spaced relation to said cathodes.

2. The apparatus of claim **1** wherein the gas pressure is on the order of 50 millimeters of mercury and the anode to cathode spacing is on the order of 0.030 inch.

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