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GASEOUS COLD CATHODE INDICATOR GLOW TUBE

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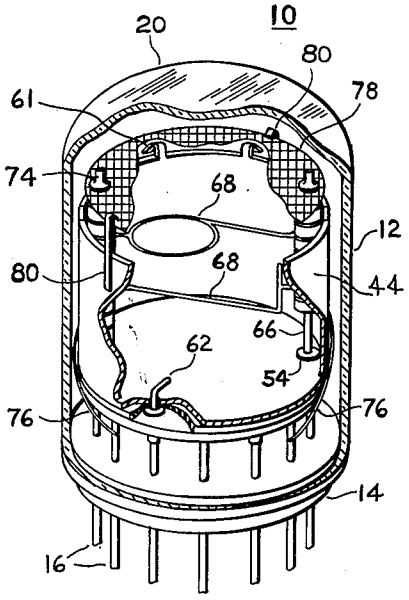

Fig. 1

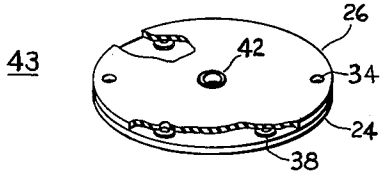

Fig. 3

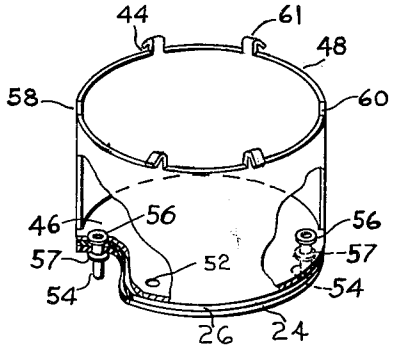

Fig. 4

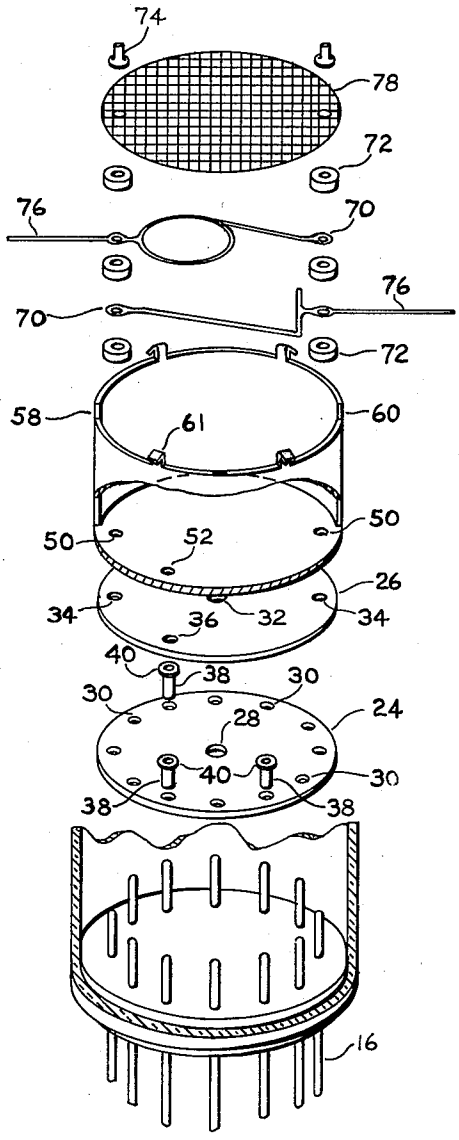

Fig. 2

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GASEOUS COLD CATHODE INDICATOR GLOW TUBE

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10 Claims. (Cl. 313—188)

This invention relates to gaseous, cold cathode glow tubes and particularlly to an improved and ruggedized mechanical construction therefor.

This application is a continuation of application Serial No. 765,147, filed October 3, 1958, now abandoned.

One type of gaseous glow tube to which the principles of the invention apply comprises a transparent envelope which contains an anode electrode and one or more cathode glow indicator electrodes which are aligned in a stack. The electrodes are mounted on support rods and are electrically connected to contact pins, the support rods and the contact pins being sealed in the stem of the envelope. Tubes of this type are made in many different sizes; and in all of these sizes, there are many small, delicate parts which are comparatively critically oriented with respect to each other. Up to the present time, a problem has existed as to how to assemble the various tube parts in the desired relationship while, at the same time, obtaining a mechanically rugged construction.

Thus, the objects of this invention are to provide an improved cold cathode glow tube construction which is mechanically strong and rugged and provides optimum use of tube parts for fulfilling both electrical and mechanical functions.

The principles of the invention are embodied in a gaseous glow tube which includes an envelope and a stem which supports the electrode assembly within the tube. The electrode assembly includes, among other things, a plurality of cathode indicator glow electrodes mounted on, and supported by, a plurality of thin wire support rods. According to the invention, an auxiliary rugged support arrangement is provided in the area of connection between the wire support rods and the electrode assembly. The auxiliary support arrangement comprises an assembly of a plurality of insulating disks which are rigidly secured together as a unitary assembly by means of strong metallic inserts mounted in aligned apertures in the disks. Other similar inserts are provided which secure together the insulating disks and various electrodes of the electrode assembly. Some of the auxiliary inserts are also secured to the stem support rods by which the electrode assembly is secured to the stem. Thus, in this construction, the insulating disks are securely bound to each other, to the electrode assembly, and to the tube stem.

The invention is described in greater detail by reference to the drawings wherein:

FIG. 1 is a perspective view, partly in section, of a gaseous, cold cathode indicator glow tube embodying the invention;

FIG. 2 is an exploded view of the tube of FIG. 1;

FIG. 3 is a perspective view, partly in section, of a portion of the tube of FIG. 1; and

FIG. 4 is a perspective view, partly in section, of another portion of the tube of FIG. 1.

Referring to the drawings, a typical gaseous cold cathode indicator glow tube 10 embodying the invention includes an envelope 12 which has been evacuated and filled with a gas such as neon or the like at a suitable pressure to support cathode glow, e.g. about 50 to about 100 mm. of Hg. The envelope includes a base portion, or stem 14, through the periphery of which metal contact pins or lead-in wires 16 extend and by means of which electrical connection is made to suitable external electrical circuit elements. The contact pins are positioned on a common circumference on the stem 14. Within the envelope, the contact pins 16 support the tube electrode assembly. The envelope 12 also includes a transparent viewing window 20 through which glowing indicator cathode electrodes 22 are viewed. A sealed-off exhaust tubulation (not shown) is provided in the stem 14.

According to the invention, an improved supporting structure for the tube electrodes is provided. This supporting structure comprises a unitary assembly of a plurality of disks of insulating material such as mica, ceramic, or the like. The assembly shown includes two disks 24 and 26. However, more than two disks may be employed, if desired. In the two-disk assembly, the bottom mica disk 24 referring to the exploded view in FIG. 2 includes a central aperture 28 and a plurality of peripheral apertures 30 spaced apart on a common circumference near the periphery of the disk. The apertures 30 are aligned with the pins 16 in the assembled tube. The top mica disk 26 includes a central aperture 32, two diametricaly opposed peripheral apertures 34, and at least one other peripheral aperture 36. The central aperture 32 in the disk 26 is axially aligned with the central aperature 28 in the disk 24, and, similarly, the apertures 34 and 36 in disk 26 are aligned with corresponding apertures 30 in disk 24 when the disks 24 and 26 are assembled and are in contact with each other.

Means are provided for strengthening and reinforcing the assembly of mica disks. Referring to the bottom mica disk 24 (FIGS. 2 and 3), this means comprises a tubular sleeve or eyelet 38 positioned in each of a plurality of the peripheral apertures 30. The sleeves 38 serve to strengthen and rigidify the assembly and may be employed in as many of the apertures 30 as desired. It is preferable to provide at least three sleeves 38 oriented at the apices of an imaginary triangle in the plane of the disk 24. The lower end of each sleeve extends below the bottom mica disk 24, and a lip or flange 40 at the upper end of each sleeve is seated on the top surface of the disk 24. The top and bottom mica disks (FIG. 3) are secured together, with their corresponding apertures aligned, by means of a sleeve or rivet 42 which is inserted in the aligned central apertures 28 and 32 and which includes flanges at each end which bear against the mica disks. Thus, the sleeve 42 serves to hold the two mica disks securely and rigidly together as a unitary assembly 43. Since the mica disks 24 and 26 are secured together by other means, as described below, the sleeve 42, although desirable, is not required.

The supporting structure also includes the anode electrode of the tube which comprises a generally cup-shaped metallic electrode 44 having a flat base 46 and a generally cylindrical side wall 48. The anode cup electrode 44 is seated on the mica disk assembly 43, with its base in contact with the top surface of the top mica disk. The base of the cup electrode is provided with two diametrically opposed peripheral apertures 50 which are aligned with the corresponding diametrically opposed peripheral apertures in the two mica disks 24 and 26. The base of the cup is also provided with at least one other peripheral aperture 52 aligned with corresponding apertures in the disks.

A tubular sleeve 54 is provided in each of the sets of diametrically opposed peripheral apertures in the two mica disks 24 and 26 and in the base 46 of the cup electrode. These sleeves include upper flanges 56 which bear against the top surface of the base of the cup and lower flanges 57 which bear against the bottom surface

of the bottom mica **24** and thus hold the mica disks and cup electrode in a unitary, rigid and strong assembly. All of the tubular sleeves are preferably made of a metal and are of rugged and strong construction to provide the desired strength in the support assembly. The two diametrically opposed sleeves **54** are preferably stronger than the other sleeves and are made of heavier gauge material since these sleeves support more weight than the others.

The cup-shaped electrode **44** is also preferably of metal and is provided in its cylindrical wall with a pair of diametrically opposed slots **58** and **60**, positioned adjacent to the diametrically opposed sleeves **54**. These slots allow leads to be connected between the cathode electrodes and the contact pins in a manner to be described. The wall of the cup may be provided with a plurality of tabs **61** which extend outwardly therefrom and bear against the envelope. The tabs thus assist in centering and supporting the electrode assembly.

The support assembly is secured to the stem by introducing each pin **16** into the lower open end of one of the peripheral sleeves **38** (FIG. 1) with which it is aligned. The sleeves are then crimped or welded to the pins. Thus, the pins **16** rigidly support the assembly of mica disks and anode cup. Under some circumstances, the electrical requirements of the tube **10** may be such that one or more pins **16** cannot be connected to reinforcing sleeves. However, adequate strength is still maintained. The diametrically opposed sleeves **54** may also be coupled to pins **16**. However, it is more convenient to reserve them for another purpose to be described. A metal tab **62** is also connected between the cup **44** through the apertures **52**, **36**, and **30** and a sleeve **38** to one of the pins **16**. Electrical connection to the anode cup is thus provided.

The diametrically opposed sleeves **54** are used as follows. A pair of support posts **64** and **66** are inserted in the sleeves **54** and are secured thereto by crimping or welding or the like. The support posts **64** and **66** extend vertically above the base of the cup **44** adjacent to the slots **58** and **60**. The posts **64** and **66** are provided with an insulating coating or sleeve of a material such as ceramic, glass, or the like (not shown).

The electrode assembly in the tube **10** includes indicator cathode electrodes **68** which may take substantially any desired shape; for example, they may be numbers, letters, or the like, and they may be as few in number as desired, or as many as is practical for the size of the tube. Such cathodes are comparatively fragile and have small unit surface areas. In one form of the tube **10** wherein the cathode elements are numbers, ten of such elements are provided, including the numbers "0" to "9." Fewer than ten cathodes are shown in FIG. 1 for purposes of simplification of the drawing. The cathode elements **68** are made of any suitable metal, for example, stainless steel, aluminum, Nichrome, molybdenum, or the like, and they may be made in any suitable fashion, for example, by etching, stamping, or the like.

The cathode elements **68** are provided with diametrically opposed apertured end tabs **70**, by means of which they are mounted and supported on the support posts **64** and **66**. The cathode elements are stacked on the posts **64** and **66**, one above the other with their surfaces oriented parallel to each other transverse to the vertical axis of the tube and facing the viewing window **20** of the envelope **12**. The cathode elements are suitably insulated from each other, for example, by means of insulating spacers **72** threaded on the posts **64** and **66** between them, the spacers being larger than the tabs and having sufficient surface area to cover and insulate the cathode tabs to prevent the tabs from glowing. The stack of electrodes is locked on the posts **64** and **66** by any suitable means, for example sleeves **74**.

Each cathode indicator electrode **68** is provided with a fine wire connecting lead **76** which may be of the same material as the numbers or they may be of any other suitable material. The lead of each cathode extends through one of the slots **58** or **60** in the cup **44** and is secured beneath the cup to one of the pins **16**. For convenience, only two such leads and connections are shown in FIGS. 1 and 2.

An auxiliary electrode is provided in the tube **10** to prevent sputtering of cathode material onto the viewing window. This electrode may also be used as part of the anode of the tube along with the cup electrode **44**. This auxiliary electrode comprises a comparatively fine mesh screen **78** mounted at the top of the stack of glow cathodes **68**. The screen **78** is insulated from the adjacent cathode by washers or spacers **72**, just as the cathodes are insulated from each other. When used as part of the anode assembly, the screen **78** is electrically connected to the cup by means of one or more metal tabs **80** secured between the edge of the screen **78** and the cylindrical wall of the cup. This connection also adds strength and rigidity to the entire electrode assembly. It may be desirable to coat the anode lead and pin with a layer (not shown) of a suitable insulating material, such as aluminum oxide, a glass frit, or the like, to insulate them from the other leads and pins and to prevent them from glowing during operation of the tube.

In preparing the tube **10**, several sub-assemblies may be prepared before the entire tube is assembled. One sub-assembly may comprise the stem **14** and the contact pins **16** sealed therein. A second sub-assembly may comprise the insulating disks **24** and **26** carrying the various sleeves and having the cup **44** and support posts **64** and **66** secured thereto. This second sub-assembly is strong and rugged because of the manner in which the insulating disks are secured together and because of the manner in which the cup and support posts are secured to the disks. After the second sub-assembly has been prepared, the electrode assembly is mounted thereon, and then the entire assembly is secured to the contact pins in the stem. Finally, the envelope is sealed to the stem and the tube is processed to completion.

The principles of the invention are illustrated in the foregoing description of an improved and rugged construction for a multi-cathode indicator glow tube. It will be clear to those skilled in the art that many modifications may be made in the specific features set forth above within the spirit of the invention. For example, the electrode support assembly comprising a plurality of insulating disks may include more than two of such disks, if desired. In addition, any number of strengthening sleeves may be provided so long as the necessary electrical relationships between the various portions of the tube are maintained.

What is claimed is:

1. A gaseous cold cathode indicator glow tube including an envelope filled with a gas at a pressure to sustain cathode glow, a stem at one portion of said envelope including a plurality of electrically conductive pins extending therethrough, a pair of spaced-apart support posts within said envelope, a viewing window at another portion of said envelope, a stack of cathode glow electrodes mounted on said pair of spaced-apart support posts and facing said viewing window, said cathode electrodes being in the form of indicator characters oriented substantially parallel to each other and insulated from each other in said stack, a cup-shaped anode electrode in said envelope said cup-shaped anode having an apertured side wall, a lead extending from each cathode through the apertured wall of said anode along the length of the cup and the stack of cathode electrodes to one of said conductive pins, and including a plate portion positioned at the bottom of said stack of cathode electrodes, means securing said support posts to said plate portion of said anode, and a support assembly for said electrodes, said support assembly comprising a plurality of insulating disks secured together by reinforcing members coupled to a plu-

rality of said conductive pins in said stem, said support assembly supporting said stack of cathodes.

2. The tube defined in claim 1 wherein said support assembly comprises a sandwich of a plurality of insulating disks, the disks having a plurality of aligned apertures, each group of apertures thus formed being aligned with one of said conductive pins, a plurality of reinforcing members present in some of said groups of apertures and securing said disks together in a strong and rigid unitary assembly, a plurality of said reinforcing members being secured to selected ones of said conductive pins, said spaced-apart support posts being secured to others of said reinforcing members.

3. A gaseous cold cathode indicator glow tube including an envelope filled with a gas at a pressure to sustain cathode glow, a stem at one portion of said envelope including a plurality of electrically conductive pins extending therethrough, a pair of spaced-apart support posts in said envelope, a viewing window at another portion of said envelope, a stack of cathode glow electrodes mounted on said pair of spaced-apart support posts and facing said viewing window, said cathode electrodes being in the form of indicator characters oriented substantially parallel to each other and insulated from each other, a generally cup-shaped anode electrode in said envelope, electrical leads extending from said cathodes outside said anode to said pins and a support assembly for said electrodes, said support assembly comprising a plurality of insulating disks, a plurality of reinforcing fasteners securing said disks together and coupled to a plurality of said conductive pins in said stem, said cup-shaped anode being secured to said insulating disks, said stack of cathode electrodes being mounted substantially inside said cup anode.

4. The tube defined in claim 3 and including an auxiliary electrode mounted at the top of said stack of electrodes and insulated therefrom, said auxiliary electrode being secured to said cup anode.

5. The tube defined in claim 3 wherein said envelope includes a side wall secured to said stem and including a plurality of spacer members positioned between said cup anode and the wall of said envelope.

6. A gaseous cold cathode indicator glow tube including an envelope filled with a gas at a pressure to sustain cathode glow, a stem at one portion of said envelope including a plurality of electrically conductive pins extending therethrough, a pair of spaced-apart support posts in said envelope, a viewing window at another portion of said envelope, a stack of cathode glow electrodes mounted on said pair of spaced-apart support posts and facing said viewing window, said cathode electrodes being in the form of indicator characters oriented substantially parallel to each other and insulated from each other, a cup-shaped anode electrode in said envelope, means securing said support posts to said anode electrode, leads extending from said cathodes outside said anode to said pins and a support assembly for said electrodes, said support assembly comprising a sandwich including bottom and top insulating disks, each of said disks having a plurality of apertures, some of the apertures in each being aligned to provide groups of apertures, the base of said cup anode being seated on the top insulating disk and having a plurality of apertures aligned with aligned apertures in said disks, a plurality of reinforcing and fastening members seated in separate apertures in said bottom disk, a plurality of reinforcing and fastening members seated in aligned apertures in both the top and bottom disks, and other reinforcing and fastening members seated in the base of said cup anode and said disks and securing said disks and anode together in a rigid unitary assembly, a plurality of said reinforcing members being secured to separate conductive pins, said support posts being secured to others of said reinforcing members.

7. A gaseous cold cathode indicator tube including an envelope having a viewing window and filled with an ionizable gas suitable for supporting cathode glow, a stem comprising a portion of said envelope and including a plurality of pins extending into said envelope, a cup-shaped anode member having a base and a slotted side wall, a pair of apertures formed in said base of said cup-shaped member and spaced apart a fixed distance, a tubular eyelet fixed in each of said apertures in said base, a support post positioned in each of said eyelets and secured thereto, said support posts extending upwardly from said base paralliel to each other and spaced apart a fixed distance, a plurality of filamentary cathode electrodes mounted in a stack on said support posts and spaced apart from each other, a cathode lead secured to each cathode and extending through the slotted side wall of said cup-shaped member and along the length of the stack of cathodes to one of said pins whereby external electrical connection may be made to each of said cathodes, and means securing said cup-shaped member and the electrodes carried thereby to said pins.

8. The tube defined in claim 7 wherein said last-named means includes at least one auxiliary eyelet secured to said base of said cup-shaped member and to one of said pins.

9. The tube defined in claim 7 wherein said last-named means includes a plurality of insulating plates secured together in a unitary consruction and secured as a unit to said cup-shaped member and fastening means securing said insulating plates to selected ones of said pins and auxiliary fastening means securing said cup-shaped member to a pin.

10. An indicator tube including an envelope having a viewing window and filled with a gas at glow discharge pressure,

a plurality of tube pins secured to said envelope,

a first insulating disk having a plurality of apertures,

generally hollow metallic inserts positioned in a plurality of said apertures,

a second insulating disk secured to said first insulating disk having a plurality of apertures aligned with the apertures in said first disk,

a pair of electrode support posts secured to two of said inserts and spaced apart a fixed distance and extending away from the surface of said second insulating disk,

a plurality of cathode glow electrodes facing said viewing window and supported on said posts insulated from and spaced apart from each other along the axis of the tube,

a generally cup-shaped anode having a base and an apertured side wall and enclosing said cathode electrodes,

said cup-shaped anode having its base seated on said second insulating disk,

and a lead extending from each cathode through the apertured wall of said cup-shaped anode and along the outside of the cup to a tube pin,

a plurality of said inserts being secured to a plurality of said tube pins whereby said cup-shaped anode and said cathodes and said disks are rigidly and securely mounted within said envelope.

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