United States Patent

[11] **3,579,025**

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[54] **NUMERICAL INDICATOR TUBE WITH BUILT-IN TRANSLATING CIRCUIT**
3 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **315/84.6,** 313/109.5, 315/52, 315/71
[51] **Int. Cl.** **H01j 17/34,** H03k 23/38
[50] **Field of Search** 313/109.5, 210; 315/84.6, 169, 51, 52, 58, 71, 73; 340/324

[56] **References Cited**

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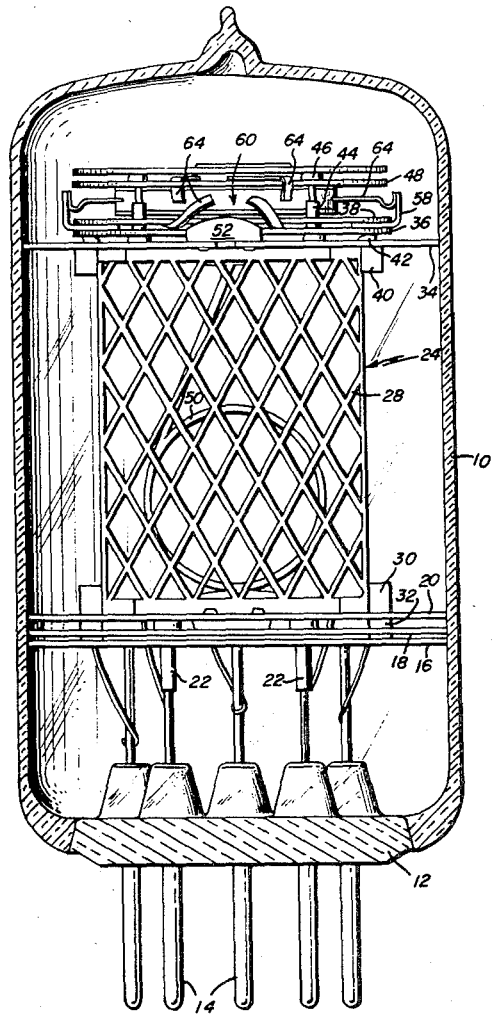
ABSTRACT: A numerical indicator tube which includes means for translating coded electrical information such as binary data into decimal readout.



Patented May 18, 1971 3,579,025

3 Sheets-Sheet 1

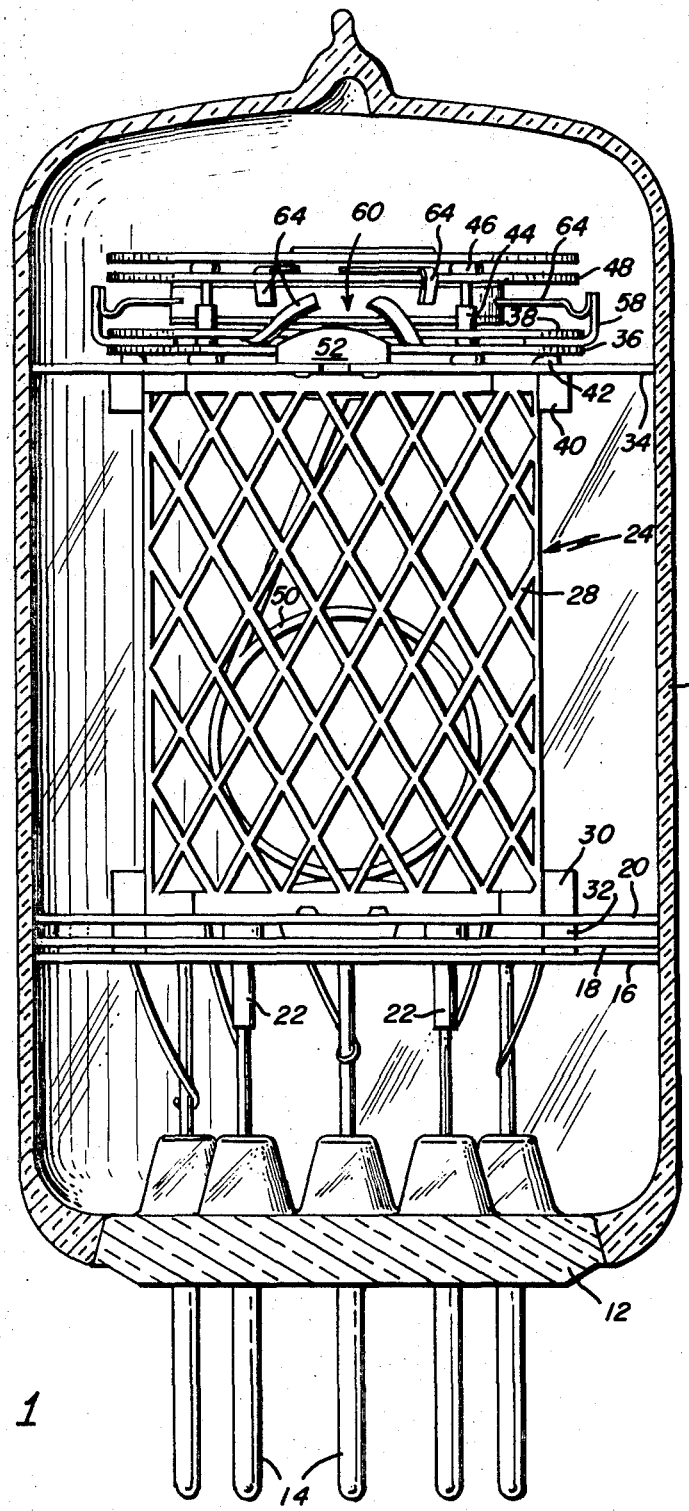


FIG. 1

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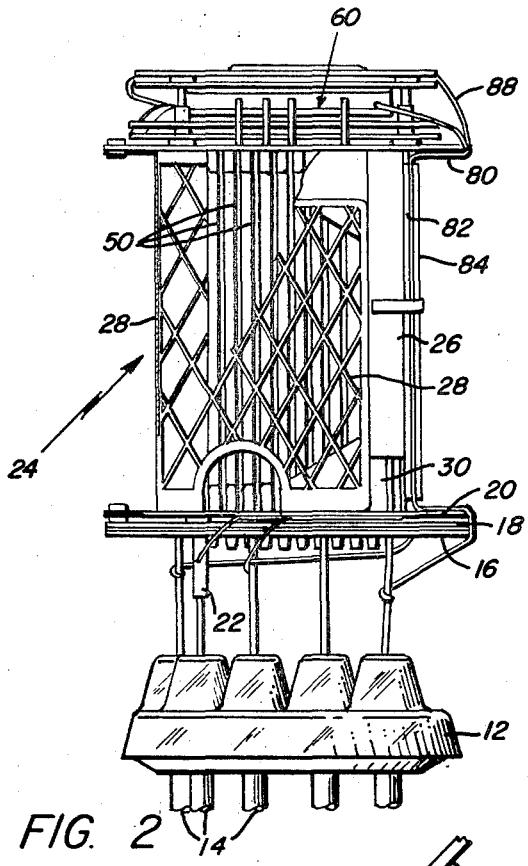

FIG. 2

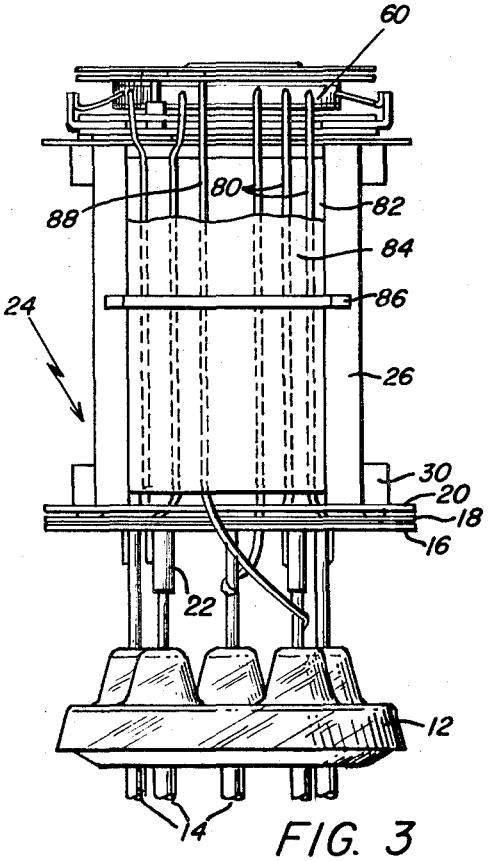

FIG. 3

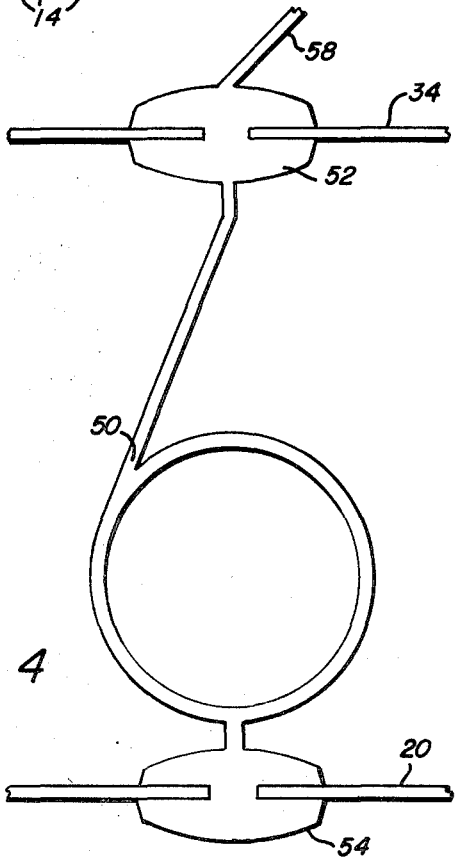

FIG. 4

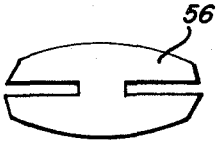

FIG. 5

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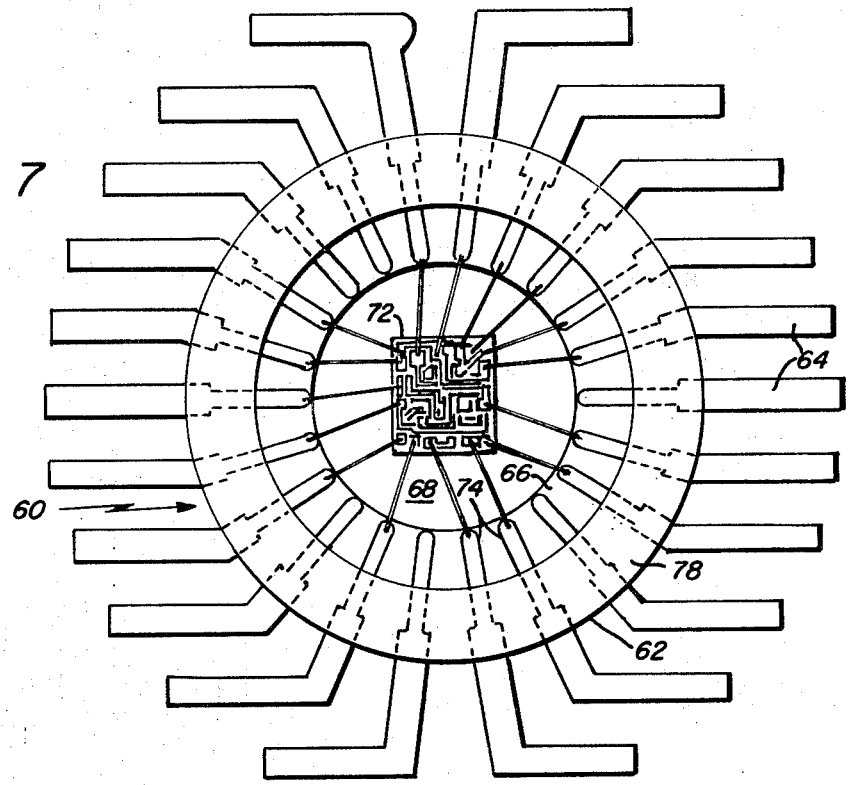
FIG. 7



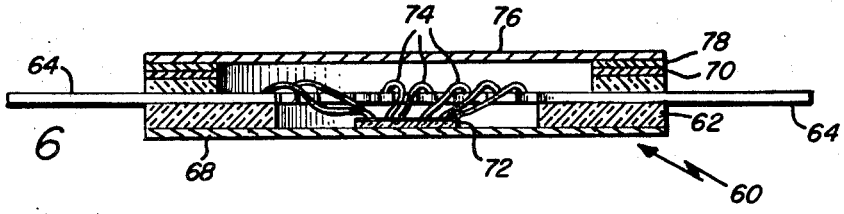
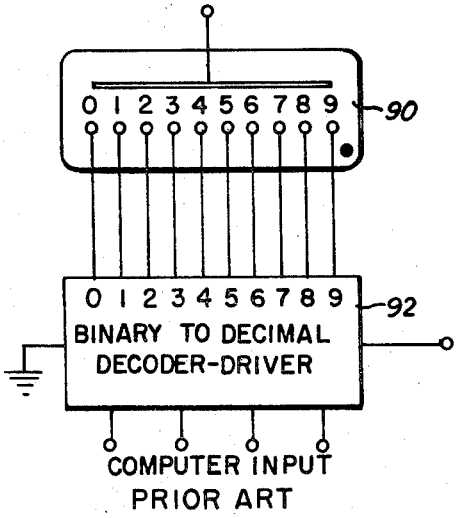


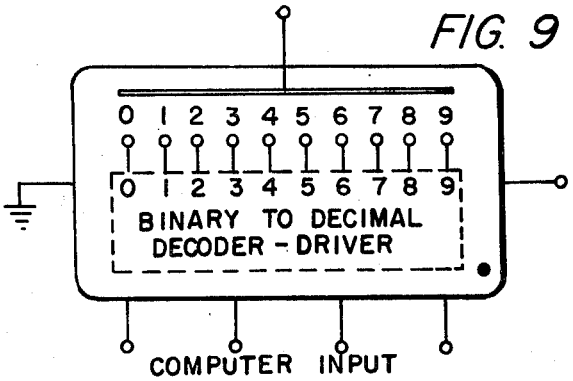
FIG. 6



PRIOR ART

FIG. 8

FIG. 9



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NUMERICAL INDICATOR TUBE WITH BUILT-IN TRANSLATING CIRCUIT

BACKGROUND OF THE INVENTION

A numerical indicator tube is a gaseous glow discharge device comprising a transparent envelope containing an anode electrode, at least one cathode glow electrode, and a gas suitable for supporting cathode glow. When a suitable electrical potential is applied between the anode and a cathode electrode, the cathode glows and space current flows through the gas between the cathode and the anode.

Usually there are provided a plurality of cathode electrodes of different shapes such as, for example, numerals, letters, and/or other selected characters to be illuminated one at a time, the cathode electrodes being connected to separate terminal pins extending through the base of the envelope.

Tubes of this type are particularly suited for use with circuits which utilize binary principles of operation. Binary counters, for example, which use a series of interconnected flip-flop circuits are one example. Such decade counters generally employ a matrix for translating a signal representing a binary number to a signal representing a decimal or other number or character equivalent of the binary number. Such equivalent number or character is displayed as a direct readout of a count made by the counting circuit. In another example, computer information is transmitted to a decoder-driver which translates the information into a decimal equivalent which is then visibly displayed by the tube.

From the foregoing, it will be apparent that associated translating circuitry is required for connection to the tube so that the tube may be operated. Such circuitry may be in the form of a number of separate electronic components wired together and connected to the tube, or in the form of a module containing miniaturized components such as an integrated circuit which accomplishes the same objective. Such circuits may be relatively complicated as in the translation of binary information from a computer, for example, into equivalent decimal signals, and often comprise bulky packages which are connected to a tube socket by a number of leads or wires.

Any thoughts of incorporating semiconductors into a gas-filled electron discharge device have been generally discarded because electron tubes generate considerable heat during their operation, and such heat has been known to be sufficient to cause degeneration or destruction of the semiconductors, and thus would render the tube useless.

SUMMARY OF THE INVENTION

The present invention improves upon the above-described prior art by the provision of a numerical glow discharge indicator tube which contains, as a component part thereof, an integrated circuit signal translating means which is mounted internally of the tube and connected to selected terminal pins for external connection through a socket and lead wires to a computer output or the like, and which is also connected internally of the tube directly to respective cathode electrodes for operation thereof in response to binary or other information transmitted to the tube through circuitry associated with external devices.

Thus, there is achieved a novel, compact tube structure which itself embodies control circuitry such as signal translating devices which previously comprised bulky electronic components located external to the tube and which required interconnection means to a tube socket for suitable operation of the tube in a desired manner.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objectives of this invention will become apparent from the following description taken in connection with the accompanying drawings, wherein;

FIG. 1 is a vertical sectional view of a tube embodying a preferred form of the invention with the electrode structures shown in elevation;

FIG. 2 is a side elevational view of the tube shown in FIG. 1 with the envelope removed;

FIG. 3 is a rear elevational view of the tube shown in FIG. 1 with the envelope removed;

FIG. 4 is an elevational view, greatly enlarged, of a cathode electrode showing its supporting means;

FIG. 5 is an enlarged elevational view of a cathode spacer;

FIG. 6 is a vertical sectional view through the translator utilized in the tube of FIG. 1;

FIG. 7 is a plan view of the translator shown in FIG. 6 with the top plate removed;

FIG. 8 is a schematic representation of a conventional character indicating glow discharge tube and associated external decoder-driver means; and

FIG. 9 is a schematic representation of the tube of FIG. 1 illustrating the principles of this invention.

SUMMARY OF THE PREFERRED EMBODIMENTS

Referring to the drawings wherein like characters of reference designate like parts throughout the several views, the numerical indicator tube shown in FIGS. 1, 2 and 3 comprises a glass envelope or bulb 10 which has been evacuated of air and filled with an ionizable gas such as neon, argon, krypton, or the like at a suitable pressure, for example in the range of about 40—120 mm. Hg. The envelope includes a base portion or stem 12 through which metal base pins 14 extend and by means of which electrical connection is made to suitable external electrical circuit elements. The upper or inner ends of the pins 14 terminate within the envelope adjacent a group of three transversely disposed insulating discs 16, 18 and 20, preferably of mica or the like. Between the upper two discs 18 and 20 reposes the heads of two or more eyelets 22 which extend downwardly through the two lower discs 16–18 and are mounted over and welded to the adjacent ends of a corresponding number of pins 14 for support of the discs 16–18 on the pins.

Resting upon the upper surface of the upper disc 20 is the lower end of an anode 24 which comprises a solid sheet material portion 26, as seen best in FIGS. 2 and 3, which extends across a portion of the envelope, and a mesh portion 28, as seen best in FIGS. 1 and 2, which extends circumferentially of the envelope from the sides of anode portion 26. Anode portion 26 is provided at its lower and with outwardly struck angle pieces 30 to which the mesh portion 28 is attached, and tabs 32 extending down through slots in discs 20 and 18 and which are bent over to underlie disc 18. By this means, the upper disc 20 is held in place against the heads of eyelets 22 and the anode 24 is firmly supported in position of use.

Supported upon the top of anode 24 is another set of three transversely extending insulating discs 34, 36 and 38. The adjacent end of the solid portion 26 of anode 24 is also provided with angle pieces 40 to which the upper end of mesh portion 28 is attached, and tabs 42 which extend through disc 34 and are bent to overlie the upper surface of the disc 34. Eyelets 44 extend through discs 36 and 38 with their heads disposed between discs 34 and 36. Into the eyelets 44 project-headed stakes 46 which extend downwardly through another insulating disc 48, the stakes being welded into the eyelets for holding disc 48 in position in spaced relation with disc 38.

The tube, being a character indicator tube of the glow discharge type, includes a plurality of cathode electrodes 50 in the form of characters such as numerals, letters, symbols, or the like to be visibly displayed. While numerals are disclosed herein as being the form of the characters utilized in the presently described tube, other characters may be utilized as is well known in the art.

Briefly, the cathode electrodes 50 of this disclosure are numerals, 10 of such elements being provided, including the numerals "0" to "9" For purposes of simplicity, all of the cathode electrodes are not shown in the drawings. These cathode electrodes 50 may be made of any suitable metal, for example, stainless steel, aluminum, Nichrome, molybdenum, or the like, and may be made in any suitable fashion as, for example, by etching, stamping, formed wire, or the like.

The cathode elements are shown as mounted in a transversely extending stack and are oriented substantially parallel to each other and facing one of the sidewalls of the envelope **10** for viewing therethrough and through the mesh or screen portion **28** of the anode electrode **24**. As seen in FIG. **1**, the numeral "6" is shown as being the foremost character in the stack of cathode elements, but the arrangement of the elements may be as desired.

The cathodes are made of suitably shaped and sized material and are suitably displaced laterally with respect to each other as is well known so that each one is not obstructed by the others and each is clearly visible from the front or side of the tube as viewed in FIG. **1**.

Although the tube electrodes as depicted are arranged to be viewed through a sidewall of the envelope in the embodiments described herein, it will become apparent from the following description that they may be arranged for viewing through the top of the envelope, if desired, and this invention is utilizable in connection with any selected cathode and anode arrangement or configuration.

The cathodes **50** are supported at each end by the respective discs **34** and **20** and, to accomplish this, each cathode **50** is provided with upper and lower slotted tabs **52** and **54** respectively (FIG. **4**). The tabs **52–54** are slotted and are adapted to slidingly engage with slots provided therefor in the respective discs **34–20**. The cathodes **50** may be spaced from one another by separate thin slotted dielectric spacers **56** (FIG. **5**). The tabs **52** and **54** are alternately stacked with spacers **56** so it will be apparent that the spacers also serve the function of preventing the glowing tabs from being observed during operation of the tube, while permitting the glowing numeral or character itself to be visible, as is well known.

Each cathode **50** is provided with a suitable lead wire in the form of a relatively flat lead member **58** (FIG. **4**) which extends from each upper tab **52** and which is suitably coated with magnesium oxide or the like to prevent glowing.

In accordance with this embodiment of the invention, the cathodes **50** are not connected to terminals or pins **14** as in the prior art, but are connected instead to a signal translator **60** which is preferably located between discs **38** and **48**. The translator **60** may take any of many forms but conveniently includes a cylindrical dielectric member of casing **62** (FIGS. **6** and **7**), for example glass, through which extend a multiplicity of flat, radially extending leads **64**. The inner ends of leads **64** rest upon a shelf **66** formed on the inner wall of the casing **62**, and the outer ends project outwardly from the casing to a substantial degree, as shown. Casing **62** is closed at the bottom by a plate **68** of metal, preferably gold-plated kovar or the like, which is sealed to the glass casing by suitable glass-to-metal sealing means.

Fixed on the inner surface of the bottom plate **68** is a signal-translating circuit **72** which may be a suitable integrated circuit designed to accept binary or other signal information and convert or translate it into a signal representing a decimal. Such integrated circuits may have any selected configuration and will have pads or contact areas thereon, as is well known, to which one end of gold wire leads **74** are bonded. The particular translating circuit itself does not in itself constitute the invention only insofar as a translating circuit comprises a part of the present inventive combination. Integrated circuits are old and well known and, in this invention, may be of a type which, for example, translate binary information from a computer into decimal signals, or which provide counting information to be indicated in the tube by visible numerals or other characters.

The gold heads or wires **74** are connected by conventional welds or brazes at their other ends to the adjacent ends of respective leads **64** as shown in FIGS. **6** and **7**. A top plate **76** of, for example, gold-plated kovar is bonded by means such as a gold-tin alloy ring **78** to kovar ring **70** which forms a glass-metal seal to casing **20** to close the translator unit.

It will be noted that several more leads **64** are provided than are required. This is to permit use of a device of this type with different integrated circuits having a greater or fewer number of output connections, if desired. The unused and unneeded leads **64** may be cut off at the exterior surface of casing **62**.

In accordance with this invention, the translator **60** is connected directly with the cathodes **50**. To achieve this, the leads **64** are welded, brazed or otherwise connected to respective leads **58** extending from the cathodes **50**. Leads **58** extend upwardly from the cathodes and, if desired, through disc **36**, then are bent to extend radially to a point where they may be made to contact and be sealed to the selected leads **64**. This particular method of connecting the leads **58** and **64** is exemplary only, since any other means is deemed to come within the scope of this invention.

In order to provide the translator **60** with the required input information signals, selected input pads on the integrated circuit device **72** are connected by other wires **74** to leads **64**, which leads **64** are in turn connected by wires **80** to respective terminal pins **14**. These particular pins **14** are connected to the external signal providing means such as a computer, for example.

In order to prevent shorting of wires **80** to each other or to other tube elements, two sheets **82** and **84** of mica or other suitable insulating material are disposed against the rear surface of the solid portion **26** of anode **24**, and the wires **80** extend downwardly between these sheets, the sheets and wires being held in place by one or more wires **86** which support the assembly upon the anode portion **26** as shown in FIG. **3**.

In FIG. **3**, a ground lead is indicated by still another wire **88** similar to wires **80** and which is connected to a selected terminal pin **14**.

From the foregoing, it will be apparent that, when a suitable potential is applied to the anode from its terminal pin, the translator shorts out a selected cathode to ground, causing it to glow. Anode potential is always present and is not switched. When a computer, counter, or other external source of information provides signals which are transmitted into the tube through other selected terminal pins to the translating unit **60**, the unit will, in accordance with this invention, convert the signals into decimal information signals which will switch a selected cathode electrode **50** to ground potential, causing the proper energizing voltage to appear between the selected cathode and the anode. This will cause the selected cathode to glow in the well-known manner.

While the translator **60** has been described above as being located near the top of the tube envelope between discs **38** and **48**, it may be located elsewhere except where it would interfere with the visibility of the cathode electrodes. It is necessary, however, to locate the translator in a position where it will be unaffected by heat during tube processing such as occurs, for example, when the base or stem **12** is sealed to the bottom of the envelope **10**.

Referring now to FIG. **8**, the glow discharge tube **90** is provided with an anode and ten cathode electrodes. In this diagrammatic example, a binary-to-decimal decoder-driver **92** external of the tube is connected by ten separate leads to 10 terminal pins on the tube. Thus, the tube in this illustration requires a total of 11 terminal pins, and the decoder-driver requires an additional six terminals in order to connect it into a computer. In FIG. **9**, the decoder-driver is built into the tube structure in accordance with this invention and accomplishes the same functions as the device of FIG. **8** with a total of only seven terminal pins projecting from the tube, four of which are connected directly to the computer. The advantages of this are obvious.

In U.S. Pat. No. 2,906,906, there is shown and described a tube which is adapted to provide a multiple numeral readout achieved by providing two or more stacks of numerals and wherein numerals in each stack may be energized for simultaneous viewing. The present invention is also readily adaptable for use in a tube of this type.

From the foregoing, it will be apparent that the objectives of this invention have been achieved by the novel structure shown and described. It is to be understood, however, that

various modificatons in the structure shown and described may be made by those skilled in the art without departing from the spirit of the invention as expressed in the accompanying claims.

I claim:

1. A gaseous glow discharge tube comprising a transparent dielectric envelope including a base, a stack of indicator cathodes mounted on the base and adapted to glow and to be visibly observable through the envelope, an anode mounted on the base and surrounding the cathodes and comprising a mesh portion and a solid portion, the cathodes being viewable through the mesh portion, a pair of dielectric discs between the cathode stack and the end of the envelope opposite the base, terminal means extending through said base, and semiconductor-type signal-translating means mounted between said discs for converting a first information-carrying signal into a second signal containing a numerical representation of the information contained in said first signal, first leads connecting said terminal means to said signal-translating means for transmitting a first signal thereto, and second leads connecting said signal-translating means to the cathodes for transmitting a second signal to a respective selected cathode.

2. The tube defined in claim 1 wherein said signal-translating means comprises a dielectric enclosure, a semiconductor device within said enclosure, first conductors extending through the enclosure connected to said first leads at one end and to the semiconductor device at the other end, and second conductors extending through the enclosure connected to the semiconductor device at one end and to said second leads at the other end.

3. The tube defined in claim 2 wherein said semiconductor device is an integrated circuit.