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3,299,305

CATHODE RAY CIRCUIT CONDITION INDICATOR TUBE

Filed June 28, 1963

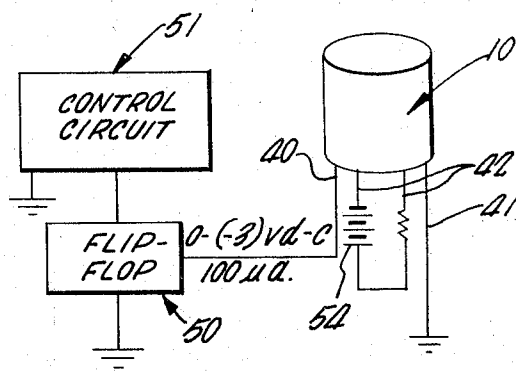
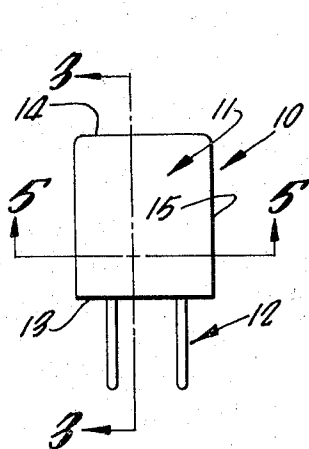
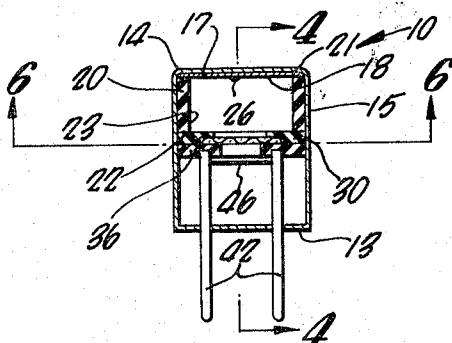


FIG 2



FILE 3

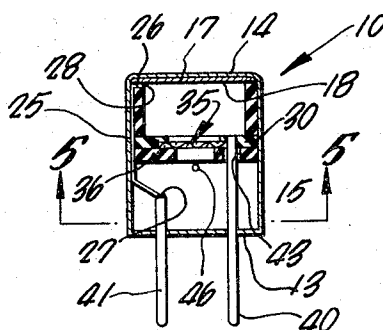


FIG. 4

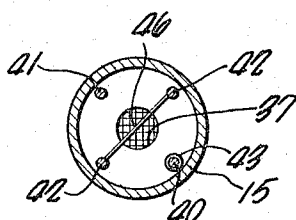


FIG 5

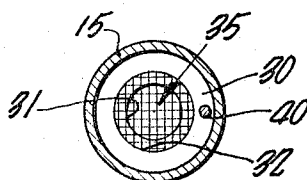


FIG. 6

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CATHODE RAY CIRCUIT CONDITION INDICATOR TUBE

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3 Claims. (Cl. 313—92)

This invention relates to circuit condition indicators. More particularly, it relates to an ON-OFF cathodoluminescent indicator which is controllable by voltages at transistor power levels.

Present indicators require such great potentials or high currents for excitation that they may not be used directly in a transistor circuit such as a flip-flop circuit in a digital data processing machine. Neon glow lamps, used in many existing indicators, require from 100 to 150 volts as a source voltage. Incandescent lamps operate at low voltages, but high current levels are required for their operation. Where such existing devices are used in transistor circuits, a transistor must be used to buffer or amplify the level of a signal which has its state monitored by the indicator.

Present indicators are not entirely suitable for end-on viewing since an observer must look through the filament to see the luminescent portion of the indicator. Additionally, existing indicators require considerable mounting space on a display panel.

The indicator of the present invention requires very low potentials and currents for its operation and may be wired directly into the logical circuitry of a data processor or other transistor or transistorized circuit. The present indicator is suitable for end-on viewing and requires a minimum mounting area in a display panel.

Generally speaking, the present invention resides in a low-voltage indicator tube which has a hollow sealed translucent enclosure. Cathodoluminescent means are deposited on a portion of the interior of the enclosure. A source of electrons is provided in the enclosure at a location spaced apart from said portion of the enclosure. Means are provided between said enclosure portion and the electron source for gating flow of electrons from the source toward the cathodoluminescent means between the conditions of flow and no-flow of the electrons.

In more specific terms, the present invention comprises an indicator for visibly indicating the condition of a selected part of an electrical circuit with which the indicator is connected. The indicator includes a housing having a translucent display portion. A film of cathodoluminescent phosphors is deposited on the display portion interiorly of the housing, an electron emitter is mounted within the housing at a location spaced apart from the display portion. A screen grid is mounted in the housing and is disposed between the display portion and the electron emitter. Housing support and conductor pins are mounted to the housing and extend from the interior of the housing to the exterior of the housing. Means are provided within the housing for conductively connecting the pins to the phosphor film and to the screen grid for application of electrical potentials thereto.

The above and other features of the invention are more fully set forth in the following detailed description of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is an enlarged elevation view of the indicator of the present invention;

FIG. 2 is a block diagram of the indicator installed directly to a flip-flop circuit of a data processing unit;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 1;

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FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 3;

FIG. 5 is a cross-section, bottom plan view taken along line 5—5 of FIG. 4; and

FIG. 6 is a cross-section bottom plan view taken along line 6—6 of FIG. 3.

Referring initially to FIGS. 1, 3, and 4, an indicator 10 according to the present invention includes a cylindrical housing or enclosure 11. A plurality of aligned enclosure support and conductor pins 12 extend from a bottom closed end 13 of the housing and are engageable in a receptacle or socket to mount the indicator. The housing has an upper closed end 14 and side walls 15. The interior of the housing is hermetically sealed from the exterior of the housing and is evacuated for improved electron flow inside the housing. If desired, a quantity of inert gas at reduced pressure may be present in the housing.

The upper end of the housing 11, as illustrated, is translucent and comprises a display portion of the housing. In a preferred form of the invention, the housing or enclosure is made of glass and is transparent. The term "translucent," as applied to the indicator display portion, also includes "transparent" within its definition. A thin film 17 of cathodoluminescent phosphors is deposited on the inner surface of the display portion transversely across the enclosure. Cathodoluminescent phosphors are phosphors which emit light upon impact by electrons and are the type of phosphors which conventionally are used in the manufacture of cathode ray tubes. Accordingly, any cathodoluminescent phosphor may be deposited as the film 17 but it is preferred that the phosphors emit green light, in the fashion of a cathode ray display, when bombarded by electrons emitted from an electron source within the tube. While the phosphors are primarily cathodoluminescent, they may also be electroluminescent and emit light on conduction of electrons through the phosphor film.

It should now be evident that the phosphor can be broadly characterized as a visible light emitting layer which layer is responsive to electrons impinging thereon or when the layer is bombarded with electrons.

In a preferred form of the invention, an electron collector or anode film 18 is provided over the phosphor film on the side of the film opposite from the display portion by sputtering an electrically conductive metal over the phosphor film. This anode film is very thin and approaches molecular thickness so that it permits electrons to impinge upon the phosphors of film 17 after passing therethrough. The anode film is provided to increase the efficiency of the indicator, although it is not necessary for the operation of this invention that when the anode film is omitted the electrons with which the phosphor film is bombarded are conducted through the phosphor film itself.

A cylindrical spacer member 20 having ends 21 and 22 and an axial longitudinal bore 23, is disposed within the enclosure and abuts the film or films deposited on the interior surface of the display portion. A length of electrically conductive wire 25, having opposite ends 26 and 27, is positioned within the enclosure along the interior surface of side wall 15 between the spacer and the enclosure, as best seen in FIG. 4. The conductor end 26 is disposed in a notch 28 formed in the end 21 of the spacer so that when the spacer is positioned within the enclosure, the conductor is forced mechanically into contact with the anode film 18, or with the phosphor end 17 when the anode film is not provided. Preferably the spacer is fabricated from ceramic glass and is electrically non-conductive.

A substantially planar grid support disk 30, having an

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annular bore 31 (see FIG. 6) centrally through its thickness, is disposed transversely of the interior of the enclosure and is abutted with the lower end 22 of the spacer member. As illustrated in FIG. 6, an annular recess 32 of a diameter greater than the diameter of bore 31 is provided and arranged concentric with the bore in the under side of the grid support disk. A woven wire mesh screen 35 is disposed in recess 32 and is maintained in position relative to the support disk by a substantially planar cathode or electron emitter support disk 36 which is disposed transversely of the enclosure in abutment with the under side of the grid support disk opposite from spacer 20. Cathode support disk 36 has an annular bore 37 formed therethrough which preferably is of smaller diameter than the bore in grid support disk 30 so as to partially close recess 32 and maintain the grid in position. Bore 23, 31, and 37 preferably are disposed coaxially of one another. The grid support disk and the cathode support disk preferably are fabricated from an electrically non-conductive material such as ceramic glass.

The recess 32 of the grid support disk may be eliminated from the structure illustrated in the drawings and the grid screen may be secured to the upper surface of the grid support disk adjacent the phosphor film and concentric to bore 31 by a suitable bonding agent or cement.

The enclosure support and conductor pins 12 provide a grid pin 40, an anode pin 41, and a pair of cathode or filament pins 42. These pins are hermetically sealed within the lower end 13 of the enclosure and each has an end within the enclosure and an end exteriorly of the enclosure, as is customary. The grid pin 40 passes through an aperture 43 in the cathode support disk and is connected conductively to grid screen 35. Anode connector pin 41 is disposed diametrically opposite from the grid control pin and terminates intermediately of the cathode support disk and the closed lower end of the enclosure where it is conductively connected, as by a spot weld, to end 27 of anode conductor 20. The pair of cathode pins 42 are disposed diametrically opposite from one another on opposite sides of the axis of the cylindrical housing and intermediately of the grid and anode pins 40 and 41, respectively. A wire filament 46 is conductively connected between the cathode pins and is disposed across the lower surface of the cathode support disk transversely of bore 37. The wire filament 46 comprises the cathode electrode of the indicator.

As used herein with respect to filament 46, the term "cathode" is used generically to mean an electrode which is the primary source of electrons. Within this definition is included means which emit electrons without the application of electrical current, such as a quantity of a substance which emits beta rays.

The indicator tube of the present invention is essentially a triode which functions as an unfocused cathode ray tube. The cathode electrode 46 emits electrons which, without regulation, would normally impinge upon the phosphor screen to cause the phosphors to luminesce. By applying a potential to the grid which biases the grid negatively with respect to the cathode or electron source, the flow of electrons toward the phosphor film may be controlled or even cut off to thereby render the phosphor film dark. In this respect, the indicator tube is distinguished from a cathode ray tube where grids or screens are provided to direct and shape the electron beam without turning it off in normal usage.

The magnitude of the potential which must be applied to the grid 35 to cut off the flow of electrons from the electron emitter can be on the order of 3 volts D.C. It should be appreciated that this voltage level is consistent with the voltage level existing in transistor circuits. Thus, the indicator provided by the present invention may be connected directly to the output of a transistor circuit such as a conventional bistable element or flip-flop to visibly indicate the conductive condition or state of the circuit.

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The indicator 10 is shown in FIG. 2 connected directly to a flip-flop circuit 50 arranged with a gating circuit 51 for controlling the conductive condition of circuit 50. The flip-flop circuit 50 has an output voltage which may vary between 0 and minus three, (—3) volts D.C. and has a current level of approximately 100 micro-amperes. The output circuit of flip-flop 50 is connected directly to grid pin 40. As shown in FIG. 2, the anode electrode of the indicator is connected to ground and a supply source 54, is applied across the cathode pins to heat the filament and boil off electrons. No voltage source is required where the cathode is a beta emitter. The indicator 10 will then function as an ON-OFF indicator for visibly indicating the conductive condition or the state of the flip-flop 50.

While the invention has been described above in conjunction with specific apparatus, this has been by way of example for the purpose of describing the invention and should not be considered as limiting the scope of this invention.

What is claimed is:

1. A cathode ray indicator triode for use directly with a transistor circuit as an indicator of circuit condition and controllable by a circuit signal applied directly to the grid thereof comprising a hollow cylindrical enclosure having spaced apart ends, one end being translucent, a film of cathodoluminescent phosphors deposited across the one end of the enclosure interiorly thereof, a cylindrical non-conductive spacer having spaced apart ends and an axial bore therethrough disposed concentric to the enclosure interiorly of the enclosure, one end of the spacer being abutted with the one end of the enclosure, a non-conductive grid support disk having an annular bore therethrough disposed transversely of the interior of the enclosure in abutting relation with the other end of the spacer, a screen grid secured to the grid support disk and extending across the bore thereof, a non-conductive cathode support disk having an annular bore therethrough disposed transversely of the enclosure in abutting relation to the grid support disk opposite from the spacer, a cathode filament mounted to the cathode support disk and extending across the bore thereof, a plurality of connector pins extending through the other end of the enclosure, and means for conductively connecting respective ones of the pins to the phosphor film, to the grid and to the cathode filament for conduction of electrical current through the filament.

2. A cathode ray indicator triode comprising a translucent cylindrical enclosure having spaced apart ends, a film of cathodoluminescent phosphors deposited across one end of the enclosure interiorly thereof, a spacer having spaced apart ends and an axial bore therethrough disposed concentric with the enclosure interiorly of the enclosure, one end of the spacer being abutted with the one end of the enclosure, a non-conductive grid support disk having an annular bore therethrough disposed transversely of the interior of the enclosure in abutting relation with the other end of the spacer, a grid secured to the grid support disk and extending across the bore thereof, a non-conductive cathode support disk having an annular bore therethrough disposed transversely of the enclosure in abutting relation to the grid support disk opposite from the spacer, a cathode mounted to the cathode support disk and disposed in the bore thereof, a plurality of connector pins extending through the other end of the enclosure, and means for conductively connecting the pins to the phosphor film, to the grid, and to the cathode for conduction of electrical current through the cathode.

3. An indicator tube comprising a transparent cylindrical enclosure having spaced apart, closed ends, a film of cathodoluminescent phosphors deposited across one end of the enclosure interiorly thereof, an anode film of electrically conductive metal deposited over the phosphor film and having a thickness sufficient to allow electrons incident thereon to pass through the anode film into the

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phosphor film for causing the film to emit light, a cylindrical electrically non-conductive spacer having spaced apart ends and an axial bore disposed concentric with the enclosure interiorly of the housing, one end of the spacer being abutted with the one end of the enclosure, a substantially planar non-conductive grid support disk disposed transversely of the interior of the enclosure in abutting relation with the other end of the spacer and having an annular bore therethrough of less diameter than the spacer bore, a substantially planar non-conductive heater support disk disposed transversely of the enclosure in abutting relation to the grid support disk opposite from the spacer and having an annular bore therethrough of less diameter than the bore of the grid support disk, the bores of the spacer and the disks being concentrically aligned, a heater filament mounted to the heater support

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disk and extending across the bore thereof, a mesh grid disposed between the disks transversely of the disk bores, a plurality of connector pins extending through the other end of the enclosure, and means for conductively connecting respective one of the pins to the anode film, the grid, and to the opposite ends of the heater filament.

References Cited by the Examiner

UNITED STATES PATENTS

2,195,460	4/1940	Knoll et al.	313—92	X
2,927,237	3/1960	Lieb	313—107.5	X
2,938,134	5/1960	Levin	313—250	X

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