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C. DEPEW ET AL

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MULTIELECTRODE GASEOUS DISCHARGE DEVICES

Filed March 5, 1948

FIG. 1

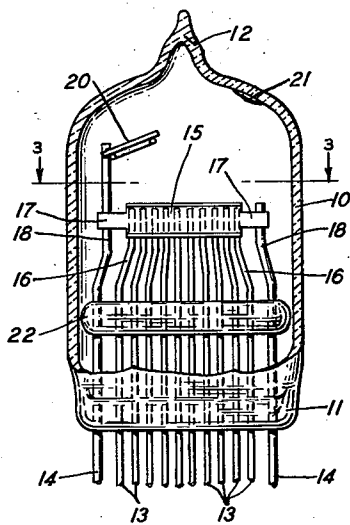


FIG. 2

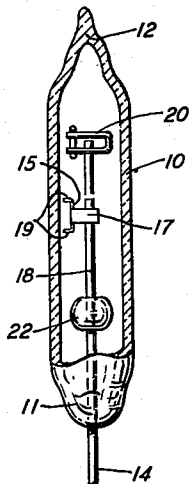


FIG. 3

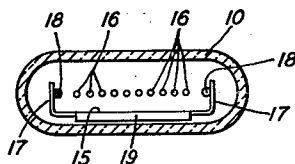


FIG. 4

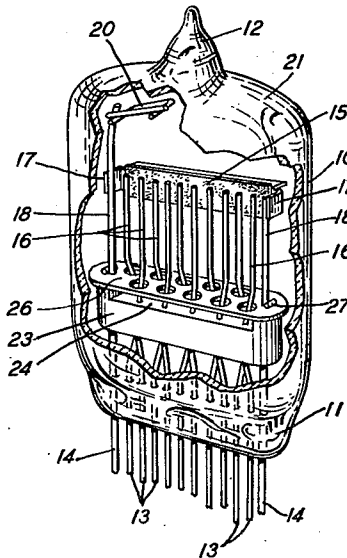


FIG. 5

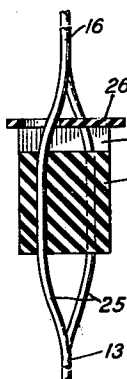
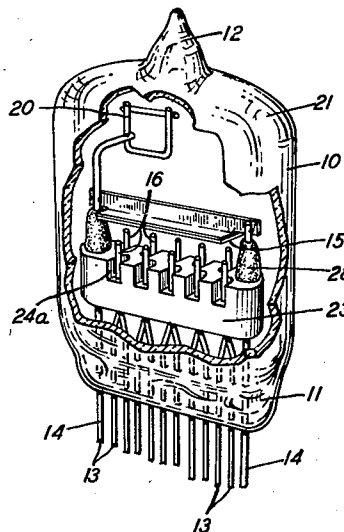


FIG. 6



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MULTIELECTRODE GASEOUS DISCHARGE DEVICES

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9 Claims. (Cl. 313-188)

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This invention relates to gaseous discharge devices and more particularly to such devices of the multiple electrode glow type for controlling coupling circuits in switching systems.

In certain cross bar switching automatic telephone systems, cross-reference circuits are provided to associate the directory numbers of a group of subscriber lines with the corresponding code designations assigned to equipment location numbers in the central office. The operation may be controlled by electronic switching devices, wherein a plurality of electrode elements are utilized to determine the selection of specified cross-reference points corresponding to switch equipment locations to effect the coupling of the directory and the line equipment numbers to translate the originating code into a desired designation determined by the code number dialed by the subscriber. For example, the electronic device is partially ionized when the originating code is transmitted and complete transfer of the discharge is performed in the device when the reference information is to be transmitted from the device to other equipment.

In accordance with a feature of this invention the electronic translating device embodies a plurality of similar control anodes disposed in uniform spaced relation to a common cathode surface in a low pressure gaseous atmosphere. Switching operations are controlled in accordance with energization of separate groups of anodes allotted to the information code and the corresponding designation number for which cross-reference is desired.

In an illustrative embodiment of this invention, an electronic glow discharge device comprises a plurality of wire anode elements, for example ten, which are mounted rigidly in a glass bead connector to insure rigid space relation, and their terminating ends are sealed in the stem or press of a compact enclosing vessel containing an ionizable medium. Additional terminal wires are also combined in the bead at the ends of the anode array to support a common cold cathode having its active surface opposite the active ends of the anodes and uniformly spaced therefrom. Other embodiments of the invention provide an insulating coupling block for the anodes which are spaced in staggered relation in the block but in aligned relation on opposite sides of the block to insure accurate linearity for all the anode elements and increased insulation resistance and breakdown voltage between them. The groups of anodes may be shortened after passing through the mounting block and

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the common cathode may be arranged in overhead relation to the anodes.

The various embodiments of the invention provide a compact assembly of the multiple elements involved in the structure which can be fabricated at low cost and with uniformity to achieve a relatively long operating life with a minimum of supervision and maintenance. The constructions also facilitate the mounting of a large group of devices in a small space close to the switching equipment with which they are associated, thereby reducing the length of bus wire connections to multiple groups of devices and equipment in the central office.

The invention and the features thereof will be understood more clearly from the following description with reference to the accompanying drawing, in which:

Fig. 1 is a view in elevation of one illustrative embodiment of the invention, a portion of the vessel being broken away to show the unitary multiple electrode assembly therein;

Fig. 2 is a side view in elevation of the device of Fig. 1;

Fig. 3 is a cross-section view taken on the line 3-3 of Fig. 1;

Fig. 4 illustrates another embodiment of the invention in a perspective view with a portion of the vessel broken away to show the components of the unitary amount of the multiple elements involved in the device;

Fig. 5 is an enlarged partial view in section of the mounting of Fig. 4 showing the method of locating the multiple anode elements in the supporting block; and

Fig. 6 illustrates another embodiment of the invention in a perspective view in which the common cathode extends across the ends of the multiple anodes.

Referring to the drawing and particularly to Figs. 1 to 3 inclusive, the invention is disclosed in a compact glow discharge device of small size, convenient configuration and sturdy construction to facilitate the mounting thereof in multiple groups requiring minimum space in switching equipment, and functionally stable in operation and having a long service life with substantially no requirements of supervision and maintenance. The device in a particular example, includes a flat glass enclosing vessel 10 having an external collapsed stem 11 formed across the greater width thereof at one end and a sealing tip 12 at the other end. The vessel 10 has therein an inert gaseous atmosphere, preferably argon or similar gas or a mixture of such gases, at a

low pressure of about 15 millimeters of mercury. The stem forms a hermetically sealed joint for a plurality of lead-in wires or conductors 13 and 14 which are disposed in a single plane across the wide dimension of the vessel for conveying suitable energizing potentials to the electrodes within the vessel.

A unitary electrode assembly or mount is sealed within the vessel and includes a multiplicity of cooperating electrodes for performing the selective switching operations in a cross-reference telephone switching system for example, although the assembly may be utilized in other types of switching arrangements such as of the cross-reference type in other industries or adaptations. The unitary mount comprises, essentially, a main cathode 15 and a plurality of wire anode elements 16, for example ten, uniformly spaced in parallel relation close to the cathode surface to selectively control the discharge across the gap between these elements and perform the switching functions desired in a particular manner which will be set forth hereinafter.

The cathode is a metallic strip, preferably of nickel, having bent angular end extensions 17 joined to upright wires 18 which form continuations of the conductors 14 in the stem. The cathode surface is reinforced by flange portions 19 along the longitudinal edges, to eliminate buckling of the strip and to maintain constant planar relation of the strip with respect to the wire anode elements 16, which are disposed in a parallel plane opposite the face of the cathode. The cathode surface facing the anodes is provided with a coating of electron emissive material, for example barium and strontium oxides, which is activated in the final processing of the device to furnish a copious supply of electrons. One of the uprights 18 is lengthened beyond the cathode to form a support for a getter loop 20, to facilitate the flashing of the getter substance by high frequency induction heating methods, for fixing the residual deleterious gases remaining in the vessel after pumping. In addition, a spot of radium bromide 21 is applied to the interior surface of the glass, to insure the presence of free electrons in the device whereby the lag of the discharge in the gap is minimized.

A glass bead or spacer 22 conjointly combines all the components of the electrode assembly into a unitary mount to insure accurate and stable space relation between the cathode and anode elements and to facilitate the handling of the unit prior to and during the sealing thereof in the vessel. In the fabrication of the mount, in accordance with a feature of this invention, the group of anode wires 16 and the support wires 18, after connection of each with its respective lead-in wire, are held in a suitable jig with all the anode wires spaced uniformly in a single plane and the end support wires being more widely spaced from the intermediate anode wires. A transverse bead 22, of glass, is molded or fused about all the wires so that they are embedded therein, to maintain the wires in constant space relation. The anode wires 16 are bent slightly towards the center on one side of the bead to bring the parallel ends more closely together within the boundary of the active cathode surface. The cathode is mounted on the support wires 18, to space the coated area parallel to the anode wires and laterally adjacent the ends of the anode elements. The complete unit is inserted into the vessel through the flat tubular and so that the unit extends across the major

axis and is centrally mounted therein relative to the minor axis. When the desired location is attained, the open end of the glass vessel is rendered plastic by heating and the glass collapsed against the lead-in wires to form the hermetic sealing stem 11.

The device is completed by evacuating the vessel through the tip 12, heating the electrodes to remove occluded gases, activating the cathode coating and injecting the gas filling into the vessel, after which the device is sealed by fusing the tip 12. After a short period of activation by means of a spark discharge, a flow discharge may be produced across the gap between any anode wire and the cathode surface by applying a breakdown potential of approximately 130 volts to one anode, the cathode surface being at ground potential, after which the discharge may be sustained at a lower voltage of approximately 60 to 70 volts applied to another anode whereupon the anode initiating the discharge may be disconnected. The anodes may be energized in sequence or in groups to attain any desired control of auxiliary equipment associated with the discharge device.

A particular application for which the multi-element switching device of the invention is eminently adapted is the translation of switching information obtained from different sources and supplied to different groups of anode elements, to effect the operation of associated equipment depending on the completion of the information furnished to the electronic switching device. An example is the cross-reference digital code numbers assigned in cross bar telephone switching systems, wherein the directory number of subscribers may involve a four-digit code number and the line equipment in the central office assigned to all the subscribers may involve a five-digit code number, either of natural or arbitrary relation to the previous code number. For instance, in the telephone switching field, one number may be the subscriber dial number or directory number and the associate number an arbitrary switching code or frame location number.

In another, specifically a mathematical application, one number may be a four-place number and the associate number the six-place mantissa of the corresponding logarithm. In a transportation space reservation system, one number may be a trip number and the associate number may indicate the availability of space in all or portion of the route. Many other applications for translating cross-reference information equivalent to an index card system whereby suitable equipment may be actuated and controlled by electronic switching devices of this invention may be used.

In a typical cross bar switching system, we may assume that 10,000 lines of a central office are handled by one cross-reference circuit to which all markers have access and that each line includes a multianode device such as described herein. In the device of this invention four anode wires 16 are assigned to the digits of the directory number of the subscriber's line to which it is connected and the successive anode wires, for example five, are assigned to the associate number or cross-reference designation which identifies the equipment number or party number. While the specific device disclosed includes ten anode elements, only nine are used in the specified system.

If we assume that a marker has seized the system to inquire for the equipment number cor-

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responding to the directory number 1234, the inquiry is made by a sequence firing element which very rapidly goes through the following "run-down" operation. A breakdown potential of +180 volts is applied to the No. 1 thousands bus. This causes the thousands anode of all devices connected to this bus, including 1234, to fire to their cathodes. A total of one thousand tubes will be fired with a current of about 100 microamperes through each. A transfer potential of +120 volts is applied to the No. 2 hundreds bus. This causes the hundreds anode to fire by the well-known "transfer" operation in only those devices connected to the No. 2 hundreds bus and whose thousands anodes are already fired. This will involve one hundred devices, all in the 1200 group. The hundreds anode in other devices connected to the No. 2 hundreds bus do not fire because transfer voltage is not sufficient for the breakdown necessary where a device is not already fired. The breakdown potential is removed from the thousands bus interrupting current through all thousands anodes. Nine-tenths of the devices are extinguished—all except those with the hundreds anodes fired, that is, the hundred in the 1200 group. Transfer potential is then applied to the No. 3 tens bus, firing by transfer the anodes of all tubes in the 1230 group. Potential is removed from the hundreds bus. Again, nine-tenths of the devices are extinguished, all except the ten devices in the 1230 group with the tens anode fired. Transfer potential is finally applied to the No. 4 units bus, firing by transfer only the units anode of the device with the subscriber designation No. 1234. Potential is removed from the tens bus and all devices are extinguished except the 1234 device which is held with the units anode fired.

The subscriber's device will continue to be partially conducting until the final code group designation, for example 56789, is requested to complete the cross-reference operation. The desired answer code is obtained by the marker which applies transfer potential to all the equipment number bus bars. Then, the equipment identified with the code number 56789 will fire the answer group anodes in the device by the application of transfer potential to these anodes since the 1234 device is the only one in operative condition due to the units anode maintaining the device in a discharge condition to the common cathode 15 in the device.

The electrode assembly embodies a rectangular configuration having a minor axis of small dimension so that it may be conveniently inserted in a section of flat glass tubing to provide a device of small thickness. This shape permits the mounting of many devices in close side by side relation to increase the number of devices which may be combined in a small space and thereby conserves mounting area in the equipment location in the central office.

The multianode electronic devices may be utilized for other code combinations, either in two or more groups, for any desirable cross-reference system, to interpret and discriminate between different code groups or series of code groups for energizing a particular electronic device allocated to the assigned cross-reference designation in the system.

While the glass bead spacer provides a unitary assembly of the elements in the device, it is not necessary provided the wires are held in parallel relation and suitable skill is employed in making the stem or press seal of the enclosing vessel.

These operations can be avoided by preforming a spacer member and mounting the wires therein to attain a unitary mount which will provide stable relationship in the group of anodes and the cathode surface in the mount. This is accomplished by a construction as shown in Fig. 4 in which a transverse insulating spacer element 23, of ceramic or other suitable material, is made of elongated configuration with rounded ends and having a recessed center portion 24 having small diameter apertures in staggered relation extending through the block. The block 23 is also provided with end holes to receive the uprights 18 for mounting the cathode strip 15. The anode wires 16 extend through the corresponding apertures in the block and are secured with a suitable cement. An insulating shield 26, preferably of mica, having holes therein corresponding to the number of wires extending through the block is placed across the recessed portion of the block. The enlargement of the anode wire holes in the shield and the spacing of the shield away from the block serves to eliminate the establishment of conductive paths across the top of the block due to the deposition of material from the cathode thereon. The shield 26 may be held in position with the block by stub wires 27 welded to the uprights 18 above the mica strip. The anode wires are formed, as shown at 25 in Fig. 5, so that they are in a single plane above and below the block and successive wires are alternately arranged on opposite sides of the block as they pass through the apertures in the block. This arrangement uniformly spaces the wires in a single plane adjacent the cathode 15 and in the stem 11.

In the device shown in Fig. 6, the insulating spacer 23 has individual recesses 24a on opposite sides of the top edge which coincide with the small diameter apertures extending through the block, the recesses on one side being in staggered relation to the recesses on the opposite side. The recesses around the wires increase the path between adjacent wires and thus retard the establishment of conductive paths across the top surface of the block due to the deposition of material from the cathode. In this device, the multiple anode wires 16 extending through the holes in the ceramic block 23 are cut short beyond the block and extend in parallel planes on the side of the block remote from the stem 11. This relationship is possible if the cathode surface 15 is mounted in overhead position with respect to all the anodes, so that the cathode is equally spaced from the active ends of the anodes. The short supports of the cathode may be coated with an insulating cement 28 to prevent these short sections acting as part of the cathode to eliminate variations in the constancy of the gap between the anodes and the cathode surface.

While various embodiments have been described, in accordance with this invention, it is, of course, understood that various modifications may be made in the detailed assembly of the elements without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A multielement electronic glow discharge device comprising an enclosing vessel having a stem and containing a gaseous filling, a unitary electrode assembly sealed therein including a single elongated cathode having a flat planar surface and a series of wire anodes having active portions uniformly spaced in a plane adjacent said cathode surface, a wire support extending at each end of said series of anodes and con-

nected to said cathode surface, and an insulating spacer member extending intermediate the ends of said anodes and supports.

2. A multielement electronic glow discharge device comprising an enclosing vessel having a stem and containing a gaseous filling, a unitary electrode assembly sealed therein including an elongated cathode surface and a series of wire anodes having parallel active portions uniformly spaced in relation to said cathode surface, a wire support at each end of said series of anodes and connected to said cathode surface, and an elongated insulating block having multiple staggered apertures therein for the reception of said anodes and supports, said block being positioned between said cathode and the stem seal of said vessel.

3. A multielement electronic glow discharge device comprising an enclosing vessel having a stem and containing a gaseous filling, a unitary electrode assembly sealed therein including an elongated cathode surface and a series of parallel wire anodes having active portions uniformly spaced in relation to said cathode surface, a wire support extending parallel to and at each end of said series anodes and connected to said cathode surface, a recessed insulating block extending transversely intermediate the ends of said anodes and supports, and a shielding insulating plate disposed about said anodes and supports and covering the slots in said block.

4. A multielement electronic discharge device comprising a unitary mount including a spacer block having parallel series of staggered apertures therein, a plurality of wires extending through said block, a cathode surface having bent portions connected to the terminal wires in said block, the intermediate wires being bent in a single plane and disposed laterally to said cathode surface, and a glass vessel having a collapsed stem sealing said wires therein and supporting said mount.

5. A multielement electronic glow discharge device comprising an enclosing vessel containing a gaseous filling, a unitary electrode assembly sealed therein including an elongated cathode surface and a series of parallel wire anodes, a wire support extending parallel to and at each end of said series anodes and connected to said cathode surface, and a transverse insulating spacer member mounting said wire anodes and supports in a unit within said vessel, said anodes being in alignment in one plane parallel to the plane of said cathode surface.

6. A multielement electronic glow discharge device comprising an enclosing vessel having a stem and containing a gaseous filling, a unitary electrode assembly sealed therein including an elongated cathode surface and a series of parallel wire anodes, a wire support extending parallel to and at each end of said series anodes and connected to said cathode surface, and an elongated insulating block having multiple staggered apertures therein interposed between said cathode and said stem, said wire anodes being in

alignment both in relation to said cathode surface and the stem seal in said vessel and in staggered relation adjacent said block.

7. A multielement electronic glow discharge device comprising an enclosing vessel having a stem and containing a gaseous filling, a unitary electrode assembly sealed therein including an elongated metallic cathode surface and a series of parallel wire anodes, a wire support extending parallel to and at each end of said series anodes and connected to said cathode surface, an elongated insulating block having a recessed portion therein disposed between said cathode and stem, and a shielding insulating plate threaded over said wire anodes and supports and covering the recess in said block, said wire anodes having co-operatively opposed lateral bends adjacent said block and shielding plate to hold them in position relative to said unitary assembly in said vessel.

8. A multielement electronic glow discharge device comprising an enclosing vessel having a stem and containing a gaseous filling, a unitary electrode mount sealed therein including an elongated spacer block having staggered slots therein, a group of wire anodes extending through said slots and beyond said block, and a cathode strip overlying said anodes and supported by said block in space relation to said anodes, the cathode having its active surface exposed to the ends of said anodes.

9. An electronic multiswitching device comprising a flat glass vessel of rectangular configuration having a collapsed stem at one end and containing a gas filling at low pressure, a multiplicity of wires sealed in line across said stem, an insulating spacer surrounding said wires within said vessel beyond said stem and having a plurality of staggered slots projecting from the top surface, the end wires extending in parallel relation through the ends of said spacer, and an elongated metallic cathode strip having end portions secured to said end wires, said strip being perpendicular to and laterally spaced with respect to the side surface of said spacer, the intermediate wires having oppositely bowed portions at the points passing through said staggered slots in said spacer, all of said intermediate wires forming multiple anode elements extending in position parallel to said cathode strip beyond said spacer.

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