March 24, 1942. H. W. WEINHART 2,277,423

ELECTRON DISCHARGE DEVICE

Filed May 17, 1941

FIG. 1

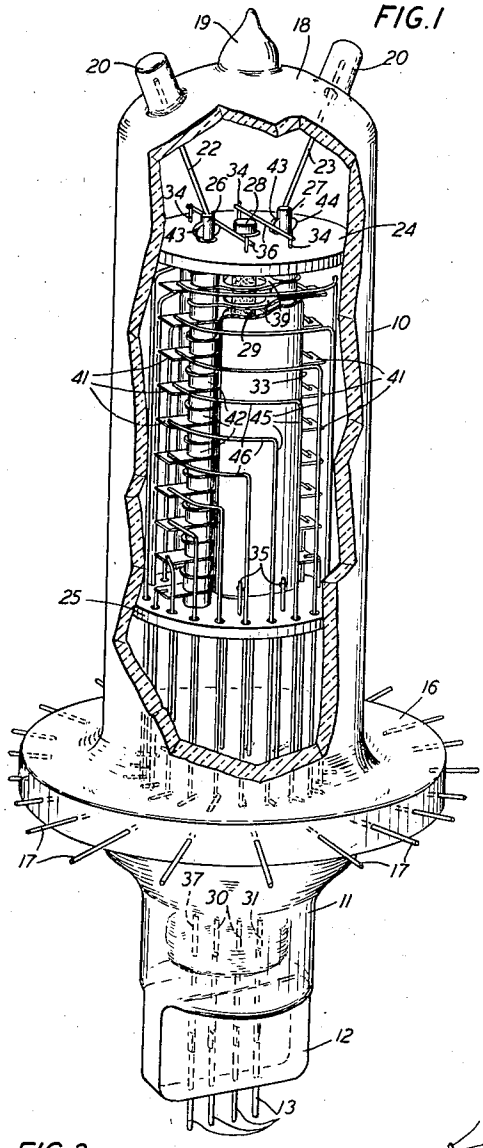


FIG. 2

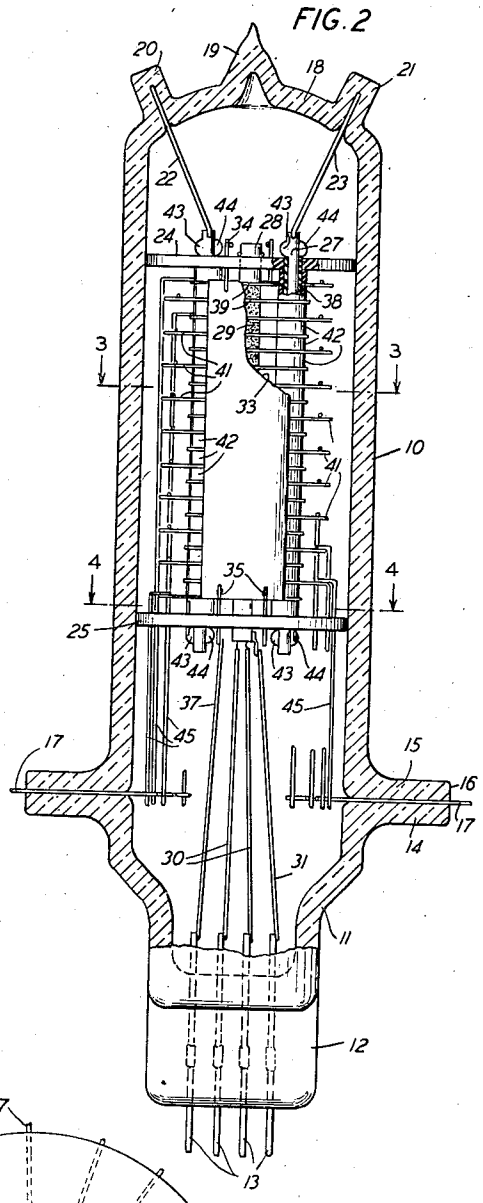
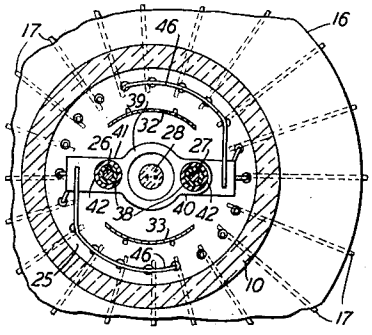


FIG. 3



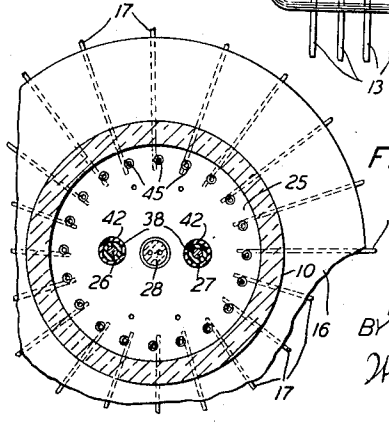


FIG. 4

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ELECTRON DISCHARGE DEVICE

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Application May 17, 1941, Serial No. 393,922

10 Claims. (Cl. 250—27.5)

This invention relates to electronic discharge devices and more particularly to devices having multicontrol elements for electronic switching application in the electric and communication arts.

In the copending application of A. M. Skellett, Serial No. 393,921, filed May 17, 1941, a multicontrol electronic discharge device is disclosed in which a plurality of annular flat control elements are mounted about a central cathode and an anode cooperates with these electrodes in which each control element is provided with an individual conductor sealed through the vessel to effect the selective switching operation of the device.

In certain aspects of this device it is desirable, from a production standpoint, to provide the multiple conductors for the control element in an annular rim seal near one end of the vessel and to couple these conductors to the various control elements. During operation the electrodes and their supporting parts are necessarily subjected to distortion stresses which might endanger the static and dynamic characteristics of the device. This is particularly evident in connection with the disc-like control elements which determine the transconductance characteristics of the device.

An object of the invention is to overcome distortion of the control elements of multiswitching electronic discharge devices.

Another object of the invention is to improve the mechanical and electrical efficiency of multigrid discharge devices.

A further object of the invention is to facilitate the fabrication of the multicontrol elements in a compact unit readily supported in an enclosing vessel.

These and other objects of the invention are attained in accordance with this invention in one aspect thereof in which a plurality of annular disc-like control elements are interposed between a central cathode and a cooperating anode and mounted in a unitary assembly in which the elements are insulatingly stacked in coaxial alignment about the cathode and mounted between insulating end spacer discs which are clamped together to form a rigid unit. This unit slidably fits into a cylindrical vessel and the unit is supported by a pair of hangers sealed in the top of the vessel.

A rim seal incorporating the multiconductors for the control elements is located below the unit and the thin disc-like control elements are connected to the conductors by yieldable or flexible wires which are connected to the conductors and slidably extend through the lower spacer disc.

The rigidity of the unit insures protection for the elemental parts of the assembly so that the unit as a whole contracts and expands uniformly. Since the coupling wires are flexible and slidably mounted with respect to the unit, any distortion which is present is expended in the wires which can absorb the stresses without producing any permanent set therein. Consequently, any harmful distortion to the control elements is greatly dissipated before reaching them so that the device exhibits stable characteristics throughout its operating life and the functional operation is rendered more constant.

A feature of the invention relates to the segregation of the conductors for the cathode and anode in an outwardly extending stem distinct from the annular seal involving the conductors of the control elements of the device.

Another feature of the invention relates to the mounting assembly of the unit in which the stacked control elements and the other cooperating electrodes are rigidly held in position between end spacer discs by enlarging the ends of the upright supports of the stacked unit, the enlarged heads of the supports at the top of the unit being anchored to the hangers in the vessel to relieve the weight of the unit from the flexible connector wires of the control elements.

These and other features of the invention will be more clearly understood from the following detailed description taken in connection with the accompanying drawing in which:

Fig. 1 is a perspective view of the device embodying the features of this invention with a part of the vessel broken away to show the various details of the assembly;

Fig. 2 shows the device in elevation with the vessel shown in cross section and various details broken away or shown in section to illustrate the relationship of the elemental parts of the assembly;

Fig. 3 is a cross-sectional view on the line 3—3 of Fig. 2 showing the configuration of the electrodes and the relationship of the connector wires with respect to the control elements; and

Fig. 4 is a cross-sectional view on the line 4—4 of Fig. 2 showing the distribution of the connector wires for the control elements about the periphery of the lower disc spacer of the unit.

Referring to Figs. 1 and 2, the device of this invention comprises a cylindrical enclosing vessel 10 and a cup-shaped stem 11 of glass or simi-

lar insulating material, the stem having an outwardly extending sealed press portion 12 in which four parallel wires 13 are sealed to provide external terminal connections for the input and output electrodes of the device. The stem 11 is also provided with a circular flange 14 which abuts against a similar flange 15 on the cylindrical vessel 10 to form an annular rim seal 16 for a plurality of radial conductors 17 which extend through the seal for providing multiple terminal conductors for the control elements of the device. The top of the cylindrical vessel 10 is closed by a dome portion 18 having a central sealing tip 19 and a pair of anchoring projections 20 and 21 in which metallic hangers 22 and 23 are embedded and extend diagonally within the vessel.

The unitary electrode assembly, enclosed within the cylindrical vessel 10, is suspended and substantially supported by the hanger arms 22 and 23 at the top of the vessel and comprises a pair of spaced discs 24 and 25 of suitable insulating material, such as mica or lava. The discs are of such diameter as to slidably engage the inner wall of the cylindrical vessel 10, and are held on opposite ends of the electrode unit by parallel upright rods 26 and 27 which extend through apertures therein. These rods are welded to the arms 22 and 23 at the top of the vessel to rigidly support the unit therein. A central tubular cathode 28 is mounted axially between the discs and is provided with an electron emissive coating 29, such as alkaline earth oxides of barium and strontium. The cathode is also provided with an internal heater having terminations which are connected to conducting wires 30 extending to two of the lead-in conductors 13 in the stem 11, the cathode being connected to another wire 31, which is also connected to a terminal lead-in wire 13. An anode or output electrode cooperates with the cathode and is in the form of arcuate rectangular sections 32 and 33 extending longitudinally on opposite sides of the cathode between the end spacer discs. The sections are supported by short wires 34 and 35 arranged in pairs at the top and bottom thereof, and extending through the end spacer discs 24 and 25. The short wires 34, extending through the top insulating disc, being bridged by strap wires 36 and one of the short wires 35 in the lower insulating spacer 25 being connected to a conductor 37 which is coupled to the remaining leading-in terminal 13 in the stem.

The upright supports 26 and 27 extending between the end insulating spacers are surrounded by a long sleeve 38 of suitable insulating material, such as aluminum oxide, the sleeve being in abutting relation to the end disc spacers 24 and 25. A plurality of angular flat control elements or grids 39 coaxially surround the cathode 28 and are equally spaced in longitudinal alignment from the cathode and the anode sections 32 and 33, along the whole length thereof. This is accomplished by providing integral arm extensions on opposite sides of the central annular portion 39, the arm extension 40 on one side being short and provided with an aperture to slidably fit around the insulating sleeve 38 on the upright support 27 and the other arm extension 41 being relatively long and provided with an aperture whose diameter is sufficient to pass over the sleeve 38 on the upright support 26. The annular control elements are equally spaced on the upright supports by insulating collars 42 so that the control elements are accurately stacked in rigid position on the upright supports, the long arms of the control elements extending alternately on opposite sides of the assembly to provide suitable spacing between the projecting arms of the elements to increase the insulation resistance between adjacent control elements. The whole assembly including the stacked control elements, the cathode and the anode and the end spacer discs, is rigidly clamped together by pinching or crimping the sides of the upright rods 26 and 27 at opposite ends of the unit to provide wedging ears 43 and 44 which rigidly lock the end spacer discs against the electrode assembly and maintain all the electrodes in accurate spacial relation.

In order to compensate for expansion of the electrode elements and the assembly and also to prevent distortion of the flat control elements and the radial leading-in conductors 17 in the ring seal 16 of the vessel, the coupling between the control elements and the conductors is accomplished by small diameter flexible connecting wires, such as 45, which slidably pass through the lower insulating spacer disc 25 and extend from the leading-in conductors 17 to the respective control elements. As shown in the drawing, there are twenty control elements stacked around the cathode and a corresponding number of terminal conductors 17 in the rim seal. The connector wires 45 are equally distributed in a circular boundary about the electrode unit, each wire being provided with a long upright portion which slidably extends through the lower insulating disc 25 and is welded at the lower end to a corresponding radial conductor arranged at right angles thereto and provided adjacent the control element with a bent portion 46, adjacent wires having their angular bent portions arranged in successive steps and curved toward the long arms 41 of the control elements as shown in Fig. 3. This arrangement materially prevents distortion of the thin, flat control elements since any expansion and contraction of the unit is compensated by the flexibility of the connector wires 45 which are slidable in the lower spacer disc 25 and are sufficiently distributed with respect to adjacent wires so that any flexing or strain placed thereon will not be communicated to the control elements or the respective leading-in conductors.

Furthermore, the substantial support of the electrode unit in the vessel by means of the hanger arms 22 and 23 and the side support of the unit by the contact of the spacer discs with the inner wall of the vessel, relieves strain on the leading-in conductors of the various electrodes and the seals thereof and since the compensation of expansion and contraction is provided by the flexible connector wires, it is evident that the multicontrol elements and their electrical characteristics are maintained uniform regardless of the temperature conditions inherent in the operation of the device.

While the invention has been disclosed with respect to a particular embodiment thereof, it is, of course, understood that various modifications may be made in the detailed assembly without departing from the scope of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel, an electrode unit mounted within said vessel, said unit including a central cathode, a plurality of apertured disc control elements coaxially surrounding said cathode,

spacer discs at opposite ends of said unit, and a plurality of members for insulatingly supporting said control elements in longitudinal spaced relation along the length of said cathode between said discs, said members having means clamping said elements and spacer discs into a unitary assembly.

2. An electron discharge device comprising an enclosing vessel, an electrode unit mounted within said vessel, said unit including a central cathode, spacer discs at opposite ends of said cathode, a pair of upright supports extending parallel to said cathode and through said spacer discs, and a plurality of apertured disc control elements insulatingly stacked on said supports and surrounding said cathode, said supports being enlarged external to said spacer discs to rigidly clamp said discs and elements into a unitary assembly.

3. An electron discharge device comprising an enclosing vessel, an electrode unit mounted within said vessel, said unit including a central cathode, spacer discs at opposite ends of said cathode, a pair of upright supports extending parallel to said cathode and through said spacer discs, and a plurality of apertured disc control elements insulatingly stacked on said supports and surrounding said cathode, said supports being provided with integral ears external to said discs to perform a clamping action against said discs at opposite ends of said unit.

4. An electron discharge device comprising an enclosing vessel, an electrode mount within said vessel including a cathode and an anode, an insulating spacer disc at each end of said mount, a pair of upright supports extending between said discs parallel to said cathode and anode, a plurality of flat annular control elements insulatingly stacked on said supports and coaxially spaced between said cathode and said anode, said support having enlargements on the ends clamping said spacer discs and stacked elements into a rigid assembly, and a pair of hanger arms at one end of said vessel secured to said supports to hold said mount in suspension.

5. An electron discharge device comprising a cylindrical enclosing vessel, an electrode unit within said vessel including a cathode, an anode, and a plurality of apertured disc-like control elements surrounding said cathode and mounted in spaced relation to said anode, a spacer disc at each end of said cathode, means extending through said discs for supporting said elements, a plurality of conductors sealed in said vessel for said elements, and a pair of hanger arms sealed in the top of said vessel and secured to said means for supporting said unit.

6. An electron discharge device comprising a cylindrical enclosing vessel, an electrode unit within said vessel, including a cathode, an anode, and a plurality of apertured disc-like control elements surrounding said cathode and mounted in spaced relation to said anode, a spacer disc at each end of said cathode, means extending through said discs for supporting said elements, a plurality of conductors sealed in said vessel for said elements, and a pair of hanger arms sealed in the top of said vessel and secured to said means, said arms and said discs supporting said unit axially within said vessel and thereby relieving tension strain on said conductors.

7. An electron discharge device comprising an enclosing vessel having a cylindrical portion, an electrode unit mounted within said vessel including a central tubular cathode, a plurality of apertured disc elements surrounding said cathode having perforated side extensions, a plurality of stacked insulating collars interposed between said elements in alignment with said perforated extensions, end spacer members terminating said unit and engaging the inner wall of said vessel, supports extending through said collars, elements and spacer members and provided with clamping portions to lock the stacked parts into a rigid unit, and an individual terminal connection for each of said elements extending through a rim seal of said vessel, said connection passing slidably through an end spacer member between said element and said seal.

8. An electron discharge device comprising an enclosing vessel, an electrode mount within said vessel supported from the top thereof including a plurality of flat metallic elements arranged in stacked space relation, a plurality of lead-in conductors radially sealed in said vessel below said mount, and a flexible wire connector extending between each of said elements and a corresponding conductor, each wire being slidably movable with respect to said mount to prevent distortion in said element and said conductor.

9. An electron discharge device comprising an enclosing vessel, an electrode mount within said vessel supported from the top thereof including a plurality of flat metallic elements arranged in stacked space relation, a plurality of lead-in conductors radially sealed in said vessel below said mount, and a flexible wire connector extending between each of said elements and a corresponding conductor, each wire having a long portion intersecting its respective conductor and a curved bent portion directed toward and attached to the respective metallic element.

10. An electron discharge device comprising an enclosing vessel having a flanged rim portion and an outwardly extending stem, a plurality of conductors radially sealed in said rim portion, other conductors sealed in said stem and extending parallel to the axis of said vessel, an electrode mount within said vessel including a cathode, an anode, a plurality of annular flat control elements insulatingly stacked between said cathode and said anode, and end spacer discs in contact with said vessel, a pair of hanger members anchored in said vessel and supporting said mount, connections from said cathode and anode to said conductors in said stem, and a plurality of flexible wires coupled to said elements and said conductors radially sealed in said rim portion, said wires being distributed within the boundary of one of said spacer discs and slidably movable therein.

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