June 24, 1958 C. T. GODDARD 2,840,749

ELECTRON DISCHARGE DEVICES

Filed Oct. 17, 1952

FIG. 1

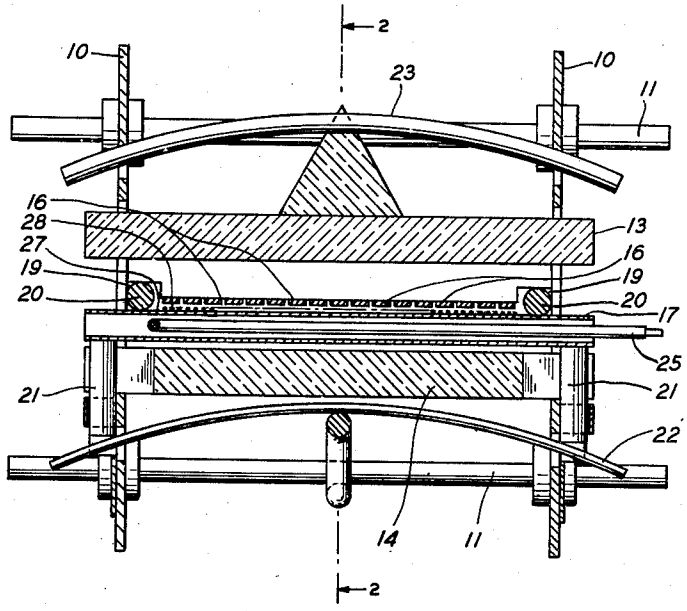


FIG. 2

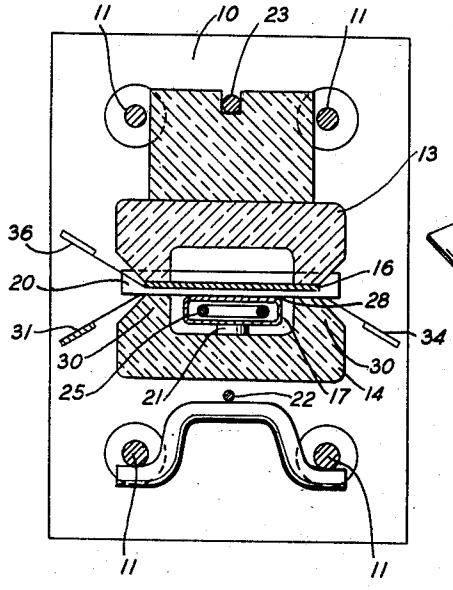
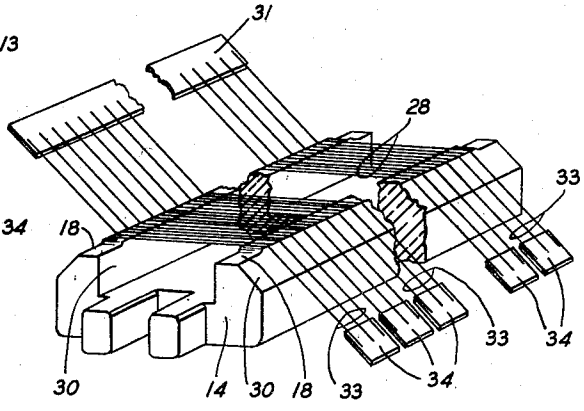


FIG. 3



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United States Patent Office 2,840,749
Patented June 24, 1958

2,840,749

ELECTRON DISCHARGE DEVICES

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Application October 17, 1952, Serial No. 315,284

6 Claims. (Cl. 313—296)

This invention relates to electron discharge devices and more particularly to such devices with coplanar electrodes.

In order to increase the power output of devices having both control and screen electrodes without an increase in the voltage of the anode, it has priorly been suggested that the control and screen electrodes be coplanar. This has been accomplished by making them each of flattened cylindrical section with separate support side rods and interleaving the wires of the two electrodes. In order to optimize the transconductance of a device for a given cathode to coplanar electrode spacing, it is desirable that the wires of the control electrode be very closely spaced from the wires of the screen electrode. Further, it is desirable that this spacing be accurately maintained between each adjacent pair of wires. In prior coplanar electrode devices this has not been attainable as relatively large tolerances and spacings must be provided to allow the two electrodes to be interleaved without the possibility of their individual wires touching at any point.

It is a general object of this invention to provide an improved electron discharge device having coplanar electrodes. More specific objects of this invention include the provision of a coplanar electrode discharge device in which the coplanar wires are very closely spaced together, very accurately spaced, and facilely assembled.

Further it is an object of this invention to increase the transconductance attainable in coplanar electrode electron discharge devices.

A further object of this invention is to enable use of coplanar electrodes of considerably smaller size than could priorly have been either fabricated or handled. Thus it is an object of this invention to facilitate the assembling and fabrication of coplanar electrode electron discharge devices. Further, it is an object of this invention to provide very minute coplanar electrode discharge units that can be utilized in a multidischarge device.

It is a further object of one specific illustrative embodiment of this invention, wherein the coplanar electrodes comprise a control electrode and an anode, to reduce the voltage of the anode.

These and other objects of this invention are attained in one specific illustrative embodiment in which a plurality of fine wires lie across the channel in a channeled insulator member and are secured to the sides of the member. Advantageously the wires are all wound around the insulator member at one time, secured at the same time to the opposite sides of the insulator member by a nonconducting medium, such as a glaze, and then portions of the wires not across the channel cut off. The wires are divided into two sets comprising alternate wires. The first set of alternate wires have portions extending to one side of the insulator and define the control electrode. The other set of alternate wires have portions extending to the other side of the insulator and define the screen electrode. As the wires of the two electrodes are wound at the same time in the same operation they may be spaced exceedingly close to each other with a high degree of accuracy, whereby high transconductances are attainable at specific cathode

spacings. Further because they are mounted by the same frame member, the electrodes may be considerably smaller than could be readily handled if it were necessary separately to support two frames or other support members.

As the screen and control electrodes are identically wound on the same insulator and as their spacing with respect to the anode, cathode, and each other is identical, the electron discharge device exhibits a degree of reversibility in that signals will be transmitted to the anode, and removed therefrom by appropriate circuitry, regardless of which one of the coplanar electrodes is operated at a constant positive potential and the other electrode operated with a signal applied thereto. The device is thus equally responsive to signals applicable from either of two circuit directions. Further, if no potential is applied to the anode, or if it is not present in the device, then a positive potential applied to one of the coplanar electrodes will cause it to function as the anode of the device. As the coplanar electrodes are equally spaced from the cathode, their capacitances to the cathode will be equal and small and the major interelectrode capacitance will in fact be the capacitance between the control electrode and the anode wires, which is not the case in usual triode devices.

It is therefore a feature of this invention that two electrodes comprise coplanar wires across a common insulator frame, the wires being secured to the two sides of the frame and one set of alternate wires connected together having integral extensions beyond one side of the frame to define one electrode and the other set of alternate wires having integral extensions beyond the other side of the frame and connected together to define the other electrode.

It is a further feature of this invention that the wires be wound closely together at the same time to assure accuracy of spacing and close spacings and that the number of wires comprising the electrodes be comparatively few whereby very small electrodes are attainable.

These and other desirable features of this invention may be completely understood from the follwing detailed description together with the accompanying drawing, in which:

Fig. 1 is a sectional view of an electrode mount structure in accordance with one specific illustrative embodiment of this invention wherein the electron discharge device comprises a plurality of minute discharge elements having a common cathode;

Fig. 2 is a cross-sectional view along the line 2—2 of Fig. 1; and

Fig. 3 is a perspective view of a portion of the cathode, channeled insulator, and coplanar electrodes of the embodiment of Fig. 1.

Turning now to the drawing, the specific embodiment of this invention illustrated in Fig. 1 comprises a multidischarge device wherein a plurality of small discharge units are mounted on common support members, utilize a common cathode and advantageously have their control and screen electrodes fabricated by being wound around the electrode frame in a single continuous operation, the individual electrodes of the individual discharge units being later subdivided. In this manner exceedingly small units may be fabricated, the electrodes thereof being much smaller than could be handled individually or facilely mounted from individual support members. It is to be understood, however, that while the coplanar electrode structure of this invention readily lends itself to incorporation in multiunit devices, this invention is not to be considered limited thereto but is equally applicable to devices having but a single electron discharge therein.

The specific electrode mount depicted comprises a pair of end supports **10**, such as mica plates or discs, which may be rectangular in shape and are held together

by a plurality, such as four, support posts **11**. An anode channeled support insulator **13** and a cathode channeled support insulator **14** extend between the two micas **10** and through slots therein. A plurality of small anode strips **16** extend across the channel of the anode insulator **13** and are secured to the sides thereof. A cathode **17** is positioned in the channel in the cathode insulator **14** and accurately positioned therein by means of stepped end portions **18** on the cathode insulator **14**, seen best in Fig. 3, stepped end portions **19** on the anode insulator **13**, ceramic spacer pins **20**, cathode loading pins **21**, a cathode loading spring **22**, and a mount loading spring **23**, in accordance with my application Serial No. 231,816, filed June 15, 1951, now Patent 2,663,819, granted December 22, 1953. A cathode heater element **25** is positioned within the cathode **17**.

The cathode **17**, which is advantageously a hollow rectangular sleeve, has an electron emissive surface **27** on the surface opposite the row of anode strips **16**. Directly adjacent thereto and positioned therefrom, in the manner disclosed in my application Serial No. 231,816, now Patent 2,663,819, is a plurality of fine wires **28** extending across the channel of the cathode insulator **14** and secured to the sides **30** thereof. As seen in Fig. 3, these wires **28** extend alternately beyond the sides **30**. The one group of alternate wires **28** are advantageously all secured to a common connector or tab **31** and define the screen electrode for each of the individual discharge units of the device. The other set of alternate wires **28** are subdivided into a plurality of groups **33** of wires, the number of groups **33** being equal to the number of anode strips **16** and each group being directly opposite one of the anode strips. The wires **28** of these groups **33** are connected to individual connectors or tabs **34**, the wires **28** thus defining the control electrodes for the individual discharge units of the device.

As is readily apparent, the control electrode wires and the screen electrode wires are coplanar and each electrode comprises the wires **28** secured to the two sides **30** of the channeled insulator **14**. Advantageously the two electrodes are formed by winding a single wire continuously around the insulator **30**, securing it to the two sides **30**, and cutting off the portions of the wires **28** not across the channel but leaving extensions of successive wires **28** on alternate sides of the insulator **14** for connection to the connectors or tabs **31** and **34**. The control electrodes are separated from each other by the intervening screen electrode wire **28**, the wires being secured to the sides **30** by a nonconducting brazing material, such as a glaze. If desired, the control electrodes may be further separated from each other by grooves cut into the surface of the sides **30** between adjacent control electrode groups **33**, as disclosed in Patent 2,784,480, issued March 12, 1957.

While the cathode and coplanar electrode structure depicted in Fig. 3 comprises a portion of the specific embodiment of Fig. 1, it may in fact itself comprise another specific embodiment of this invention. Thus, if positive potential is applied to the connector **31** and no anodes or anode strips **16** are employed, the coplanar electrode wires **28** connected to the connector **31** will themselves define the anode of the device. Advantageously in such an embodiment, if utilized in a multidischarge device, the connector **31** is not common to all of the anode wires **28** but is itself divided into a plurality of distinct and separate connectors. In such an embodiment as the anode and control electrode are coplanar, the cathode capacitance to each is substantially the same, and the anode voltage necessary for satisfactory operation is considerably reduced.

In the embodiment of Fig. 1, the anode strips **16** are advantageously connected to individual tabs **36**, and each of the tabs **31**, **34** and **36**, as well as the cathode **17** and heater element **25**, are connected to terminals extending through the envelope of the device, not shown, as is well known in the art.

Thus by supporting the coplanar electrode wires all from a common support member, they may be spaced very closely together with a high degree of accuracy and they may comprise minute units, capable of incorporation in multidischarge devices or in a single discharge device, which may be readily fabricated, handled, and assembled in the device.

It is to be understood that the above described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A high transconductance electron discharge device of the type having closely spaced interchangeable grid electrode means comprising a channeled insulator member, a cathode positioned in said channel, a plurality of individual fine wires equidistantly spaced and lying in a common plane across said channel, means insulatingly securing said wires to the sides of said channeled insulator member, said plurality of five wires including a first group of alternate wires extending beyond a first side of said channeled member and a second group of alternate wires extending boyond a second side of said channeled member, connector means to said first side electrically connecting said first group of alternate wires together and connector means to said second side electrically connecting said second group of alternate wires together whereby said first group of alternate wires define control electrode means and said second group of alternate wires define screen electrode means, and an anode adjacent said wires.

2. A high transconductance electron discharge device of the type having closely spaced interchangeable control electrode and anode means comprising an elongated channeled insulator member, a cathode positioned longitudinally in said channel, a plurality of closely spaced individual fine wires lying in a common plane across said channel and secured to opposite sides thereof, said plurality of fine wires including a first group of alternate wires extending beyond said channeled member to one side thereof, tab means electrically connecting said first group of wires together, a second group of alternate wires extending beyond said channeled member to the other side thereof, and tab means electrically connecting said second group of wires together, said first group defining control electrode means and said second group defining anode means.

3. A multidischarge unit electron discharge device comprising an elongated channeled insulator, a cathode positioned longitudinally within the channel of said insulator, a plurality of individual fine wires lying in a common plane across said channel, means insulatingly securing said wires to the sides of said insulator, said plurality of fine wires including a first set of alternate wires extending beyond said channeled insulator to one side thereof, means electrically connecting all of said first set of wires together, said first set of wires defining a screen electrode, a second set of alternate wires extending beyond said channeled insulator to the other side thereof, means electrically connecting said second set of alternate wires into distinct groups, each of said groups defining a control electrode, and a plurality of anodes positioned adjacent said wires and to the other side thereof than said cathode, each of said anodes being aligned with one of said groups of wires.

4. A high transconductance electron discharge device comprising an elongated channeled insulator member, a cathode positioned longitudinally in said channel, a plurality of closely spaced individual fine wires lying in a common plane across said channel and secured to opposite sides thereof, said wires including two groups of alternate ones of said wires, means electrically connecting one group of said alternate wires together, and means electrically connecting the other group of said alternate wires together.

5. A high transconductance electron discharge device in accordance with claim 4 further comprising anode means adjacent said two groups of wires.

6. A multidischarge unit electron discharge device comprising an elongated channeled insulator, a cathode positioned longitudinally in the channel of said insulator, a plurality of closely spaced individual fine wires lying in a common plane across said channel and secured to opposite sides thereof, said plurality of individual fine wires including a first set of alternate wires and a second set of alternate wires, means electrically connecting all of said first set of wires together, means electrically connecting said second set of alternate wires into distinct groups, and

a plurality of anodes positioned adjacent said wires, each of said anodes being aligned with one of said groups of wires of said second set.

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