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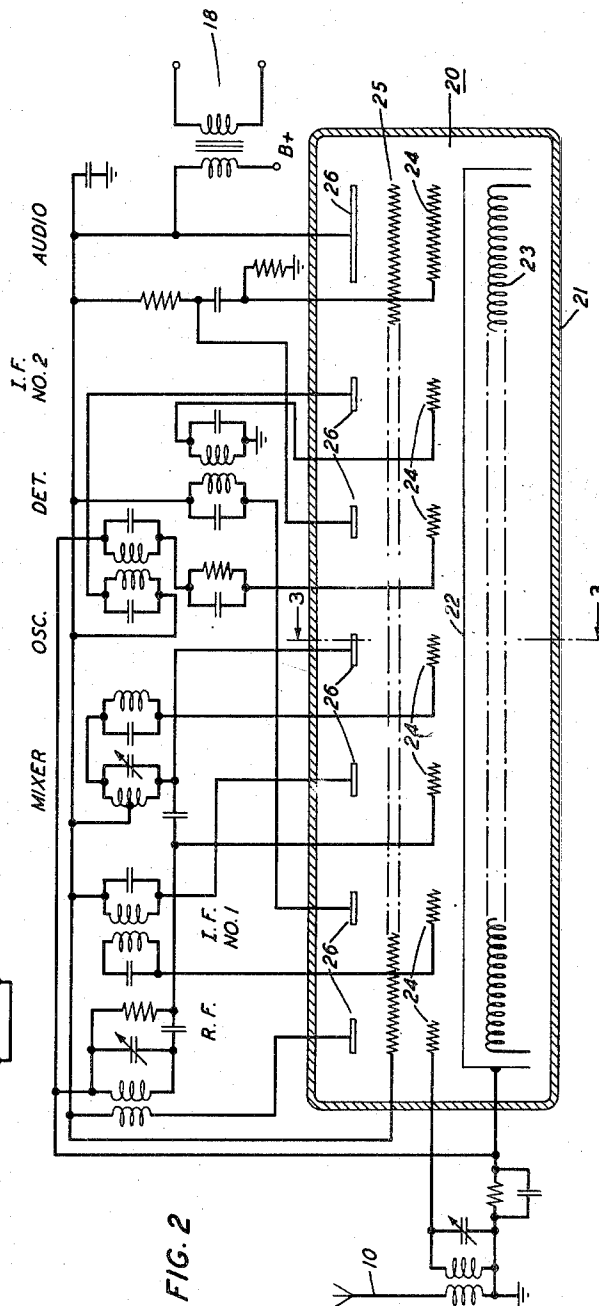
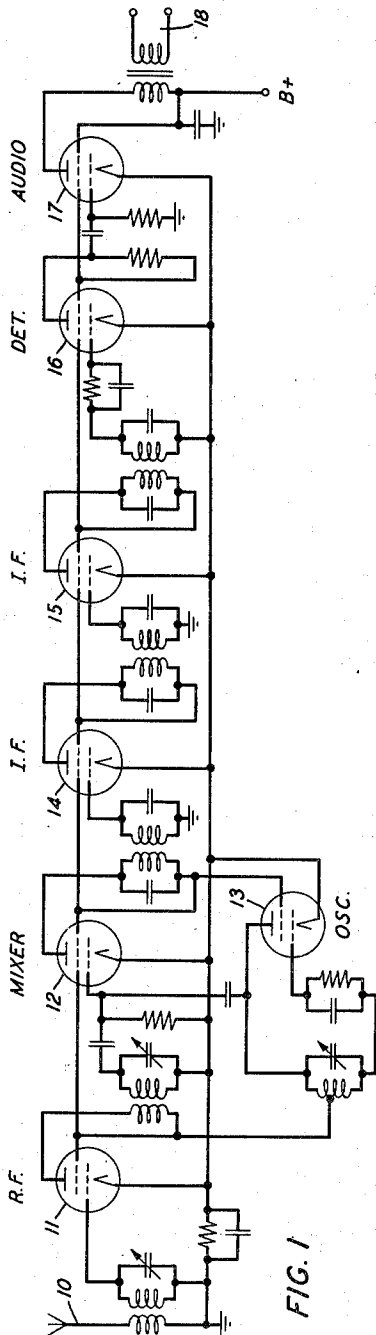
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2,784,480

ELECTRON DISCHARGE DEVICES AND METHOD OF FABRICATING

Filed Oct. 17, 1952

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 3

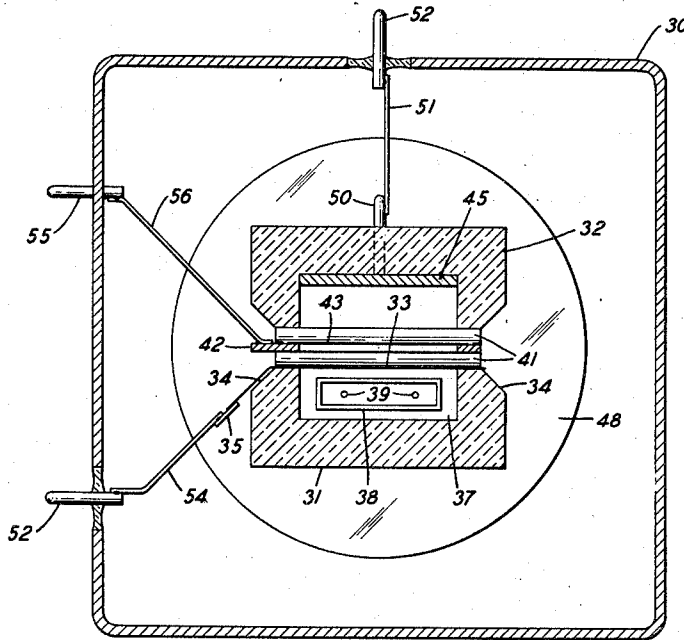
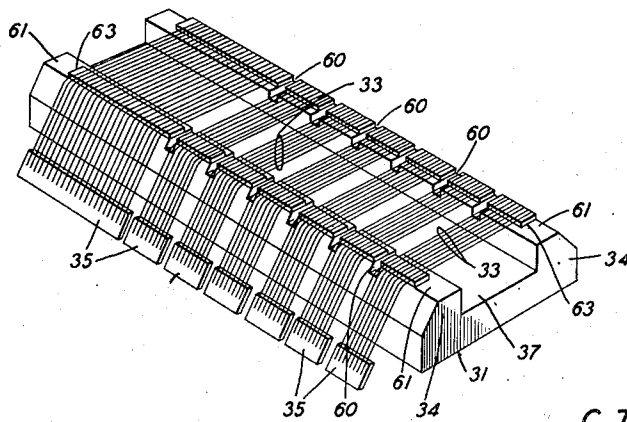


FIG. 4



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1

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ELECTRON DISCHARGE DEVICES AND METHOD OF FABRICATING

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Application October 17, 1952, Serial No. 315,282

5 Claims. (Cl. 29—25.14)

This invention relates to multiunit electron discharge devices and more particularly to control grids therefor and the fabrication of such control grids. My copending divisional application Serial No. 598,835, filed July 19, 1956, describes and claims the multiunit electron discharge device disclosed herein.

It has been suggested heretofore that the performance of various circuits might be greatly improved if those circuits could be enclosed within a single evacuated envelope. Such circuits might include intermediate frequency strips, cathode coupled stages, cascade amplifiers, a combination mixer, oscillator and one or more radio frequency amplifiers, or various combinations of these and/or other circuits. An entire superheterodyne receiver could thus advantageously be included in a single envelope. Among the advantages of including such circuits in a single envelope are reduction in power requirements, in total size, and in the effects of stray lead or socket capacitances and interstage reactances. Thus, for example, a complete hearing aid or other audio amplifier could be fabricated in a single packaged unit within a single small evacuated envelope employing printed circuit techniques for the passive elements.

Attempts to attain these advantageous results have not been successful because it has not been feasible to fabricate small enough components for the individual discharge devices of such circuits to enable their inclusion in a small compact single device. Particularly it has not been feasible either to wind small control grids for such devices or to handle such small control grids.

It is an object of this invention to enable the incorporation in a single electron discharge device of a plurality of discharge units. These discharge units may be interconnected within the device to provide a complete circuit of any of a multitude of types within the single device or they may be completely distinct and have individual terminal connections extending through the envelope of the device for connection to external circuitry.

It is another object of this invention to reduce the size and power requirements of a plurality of electron discharge devices that may be utilized in a common circuit.

A further object of this invention is to attain minute individual control electrodes that can be closely positioned adjacent a common cathode in an electron discharge device and which may be the control electrodes of discrete and independent electron discharge units all mounted within a single electron discharge device. Thus it is an object of this invention to facilitate the fabrication of such control electrodes.

A still further object of this invention is the provision of a novel support structure for a common cathode and a plurality of discrete control electrodes, which support structure may provide the structural basis for the individual electron discharge device elements mounted within the single device.

These and other objects of this invention are attained by

2

a novel control electrode structure which comprises a channeled ceramic member in the channel of which the common cathode of all of the discharge units of the device is positioned. The surfaces of the side edges of the channel element are metallized, and a single wire electrode is wound around the channel element and brazed to these surfaces, the major portions of the wire not across the channel being cut-off. This single wire electrode is then divided into the desired number of individual control electrodes by cutting slots or grooves in the edges of the channel surfaces to provide an insulating slot between successive sections of the wire and of the metallized surfaces. As these slots may be spaced at any distances apart, as desired, the individual control electrodes thus fabricated can be of any desired length, and thus the individual discharge units of the device may be of various and different widths as desired by the circuitry with which they are associated.

By positioning the control electrodes of the various individual discharge units of the device closely adjacent each other on a single common support member, the overall size of the electron discharge device including these individual discharge units is greatly reduced, and the employment of a single cathode for all the discharge units is made feasible, thus considerably reducing the power consumption of the plurality of individual discharge units within the device.

The side edges of the channel insulator frame also provide a reference plane and support for the various other electrodes of the discharge elements, which may include screen grids, anodes, etc., as desired. If desired, internal shielding may be positioned within the device above the insulating slots in the control grid channel insulator frame to shield the discharge units from each other. Such shielding may take the form of metal fins projecting from the envelope of the device.

It is thus a feature of this invention that a plurality of individual discrete control electrodes be mounted on a single insulator member adjacent a common cathode, the control electrodes being electrically distinct from each other, isolated from each other by slots in the insulator member, and of prescribed length, whereby the cathode area associated with the individual control electrodes may be of any size desired.

It is a further feature of this invention that the control electrodes be fabricated by winding a single wire around an insulator frame, securing the wire to the frame, removing the undesired portions of wire not across the frame, and cutting slots into the frame between sections of the wire to divide the wire into individual electrode elements, the electrode elements being thus closely mounted together in a compact structure but being electrically independent of each other. It is thus a feature of this invention that a plurality of control electrodes comprise individual wires extending across an insulator frame, the electrodes being separated by slots cut into the frame between the electrodes. The control electrodes thus fabricated may advantageously be considerably smaller than could be handled if they were mounted individually.

A complete understanding of this invention and of these and other features thereof may be gained from consideration of the following detailed description and the accompanying drawing, in which:

Fig. 1 is a schematic representation of one type of superheterodyne circuit known in the art;

Fig. 2 is a schematic representation of a single electron discharge device comprising all the active elements of the circuit of Fig. 1;

Fig. 3 is a sectional view of one specific illustrative embodiment of the device of Fig. 2 taken along the line 3—3 thereof; and

Fig. 4 is a perspective view of the channeled insulator frame and individual control electrodes of the device of Fig. 3 in accordance with this invention.

Turning now to the drawing, Fig. 1 shows a particular superheterodyne circuit wherein each of the stages of the circuit comprises a distinct and separate tube as is usual in the art, the circuit being such that the cathodes of each of the tubes are connected together. The circuit may be considered for our purposes as comprising an antenna 10, a tube 11 comprising the radio frequency stage, a tube 12 comprising the mixer stage, a tube 13 comprising an oscillator stage, a tube 14 and tube 15 comprising two intermediate frequency stages, a tube 16 comprising a detector stage, a tube 17 comprising an audio stage, and an audio output 18. The cathode of each of these tubes requires a distinct heating supply, and there are appreciable limits in the size of each individual tube.

In Fig. 2 this same circuit is shown but the individual vacuum tubes 11, 12, 13, 14, 15, 16 and 17 have been replaced by a single electron discharge device 20 in accordance with this invention. As there seen, device 20 comprises an envelope 21, a single cathode 22 having a single heater element 23, a plurality of individual control grids 24, a common screen electrode 25, and a plurality of individual anodes 26. Leads are brought out of the envelope 21 for each of the control grids 24 and anodes 26. Each of the control grids 24 and anode 26, together with the portions of the cathode 22 and screen electrode 25 aligned therewith, define a discharge unit equivalent to one of the tubes 11 through 17 of the circuit of Fig. 1. Advantageously, as shown, these discharge units are positioned in the device 20 in a different order than that shown in Fig. 1 so that the stages of radio frequency, intermediate frequency, and audio frequency signals are intermixed to obtain improved shielding between the sections of the device. Further, the area of the cathode 22 for the audio power amplification discharge element of the device 20 is advantageously larger than the cathode areas for the other discharge units of the device. The other circuit elements of the superheterodyne circuit are the same for the two circuits of Figs. 1 and 2 and may advantageously, though not necessarily, all be external to the envelope 21 of the electron discharge device 20.

A section view of one specific illustrative embodiment of the electron discharge device 20 is shown in Fig. 3. The device comprises a metallic envelope 30 in which are positioned a pair of channeled insulator supports 31 and 32. A plurality of fine wires 33 extend across the frame 31 and are secured, as by brazing, to the upright side portions 34 thereof. These wires 33 are connected in small groups to tabs 35 and define the control grids 24 of the device 20, the grids and their fabrication being further discussed below in connection with Fig. 4. A flat hollow cathode 38 is positioned in the channel 37 of the support 31, and a heater element 39 extends within the cathode 38. A pair of insulator rods 41 are positioned at each end of the channels 31 and 32 and positioned between them a flat rectangular metal frame 42 having a plurality of fine wires 43 thereacross, the wires 43 defining the common screen grid 25. A plurality of flat plate members 45 are positioned in the base of channel insulator support 32 and secured thereto, the plate members 45 being of equal width to the particular control grid with which they are aligned and defining the individual anodes 26 of the device 20.

The insulator supports and cooperating members are advantageously positioned in the envelope 30 by mica insulator discs 48 at each end of the envelope, the discs 48 in turn being supported from terminals extending through the end of the envelope 30, as is known in the art. The channel members themselves and the spacing between the cathode 38 and wires 33 of the control grids are advantageously maintained by spring biasing the members together, as further described in my application Serial No.

231,816, filed June 15, 1951, now Patent No. 2,663,819, granted December 22, 1953.

Each of the anode plates 45 is connected by a pin 50 extending through the channel insulator 32 and a lead 51 to a terminal pin 52 extending through the envelope 30. Similarly each tab 35 is connected to a terminal pin 52 extending through the tube envelope by a connecting lead 54, thereby providing a distinct connection to each group of fine wires 33 and thus to each control grid element 24. A single terminal pin 55 is provided for the common screen grid, a lead 56 extending between the terminal pin 55 and the side of the screen grid frame 42.

It is apparent from the above discussion of one particular circuit and multidischarge device employed in that circuit that the positioning of a number of very minute control grids close to each other, though isolated from each other, and close to a common cathode is at the heart of such multidischarge devices. The multiple control grids 24 in accordance with one aspect of this invention are all supported by the common channel insulator 31, as best seen in Fig. 4. As there shown, the individual wires 33 extending across the channel 37 are divided into groups defining the control grids 24, extend beyond the channel insulator 31 to one side, and are connected to individual tabs 35. The control grids 24 are separated from each other by grooves or slots 60 cut into the upper surface of the side upright portions 34 of the insulator support 31.

In accordance with a feature of this invention, the control grids are advantageously fabricated by first matching the insulator frame 31, which is advantageously of a ceramic such as steatite, then metal coating, as with copper, the upper edges 61 of the side portions 34, nickel plating the prior metal coating, and winding a continuous fine wire completely around the insulator frame. After the single wire has been wound around the frame, it is brazed to the upper surfaces 61 so that each turn of the continuous wire is firmly secured to the metallic coating 63 on the surfaces 61, the coating 63 being shown greatly exaggerated in size. The wire is then cut along the outer edge of one surface 61 so that the single continuous wire is divided into the plurality of individual wires 33. One or two of these wires 33 lying across the channel 37 precisely where the slots 60 are desired, are then advantageously removed, though this step is not essential. The position along the channel 37 of the slots 60 is determined by the width desired for each of the discharge units of the device and in the superheterodyne circuit device of Fig. 2 is advantageously the same for all discharge units except the audio amplifier stage unit which is considerably wider.

The slots 60 are then cut into the face of the surfaces 61, as by a rotating cutting wheel as is known in the art. The slots 60 are cut deep enough so that the insulator below the metallic coatings 63 is penetrated whereby the groups of wires 33 between slots are electrically isolated from each other. The loose ends of the wires 33 of each grid 24 are then joined together and to a tab 35 at whatever length from the insulator 31 desired, the wires being cut at the tabs 35.

Reference is made to my applications Serial No. 315,281 and 315,284, both filed October 17, 1952, wherein related inventions are described.

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. The method of fabricating a plurality of very small electrode elements for employment with a common cathode in a multiunit electron discharge device, comprising metallizing the upper surfaces of the side portions of a channel insulator member, winding a single fine wire continuously around said insulator member, brazing each

5

turn of said wire to both of said metallized surfaces, removing the portions of said wire not secured to said insulator member or extending across the channel in said insulator member to divide said wire into individual segments, and subdividing said wire segments into groups of isolated electrode elements by cutting a plurality of grooves in said metallized surfaces.

2. The method of fabricating a plurality of very small electrode elements for employment with a common cathode in a multiunit electron discharge device, comprising winding a single fine wire continuously around an insulator member having a space therein for positioning the common cathode, securing each turn of said wire to opposite sides of said insulator member, removing the portions of said wire not secured to said insulator member or extending across said space to divide said wire into individual segments, subdividing said wire segments into groups of isolated electrode elements by cutting a plurality of grooves in said opposite sides of said insulator member, and securing each of said isolated electrode elements to electrical connecting means.

3. The method of fabricating a plurality of very small electrode elements for employment with a common cathode in a multiunit electron discharge device, comprising winding a single fine wire continuously around a channel insulator member, securing each turn of said wire to opposing side portions of said insulator member on opposite sides of the channel therein, severing said wires beyond one side of said channel insulator member, subdividing said severed wires into groups of isolated electrode elements by cutting a plurality of slots in the surfaces of said opposing side portions, and securing each of said isolated electrode elements to electrical connecting means.

4. The method of fabricating a plurality of small electrode elements for employment with a common cathode in a multiunit electron discharge device, comprising metallizing the surfaces of opposing side portions of a

6

channel insulator member, winding a single fine wire continuously around said insulator, brazing each turn of said wire to both of said metallized surfaces, removing the portions of said wire not secured to said insulator member or extending across the channel in said insulator, and subdividing said wire into a plurality of isolated electrode elements by removing certain of said turns thereof from across said channel and cutting a plurality of grooves in said metallized surfaces in the space priorly occupied by said removed turns.

5. The method of fabricating a plurality of small electrode elements for employment with a common cathode in a multiunit electron discharge device, comprising metallizing the surfaces of opposing side portions of a channel insulator member, winding a single fine wire continuously around said insulator, brazing each turn of said wire to both of said metallized surfaces, removing the portions of said wire extending outwardly from one metallized surface, subdividing said wire into a plurality of isolated electrode elements by removing certain of said portions thereof from across said channel, cutting a plurality of grooves into said metallized surfaces in the space priorly occupied by said removed turns, and joining together the group of wires of each electrode element extending beyond the remaining side of said insulator and securing each of said groups to a tab for connection to terminals in the device.

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