

May 13, 1958

N. D. GLYPTIS
ELECTRON TUBE

2,834,907

Filed Nov. 6, 1953

4 Sheets-Sheet 2

Fig. 2.

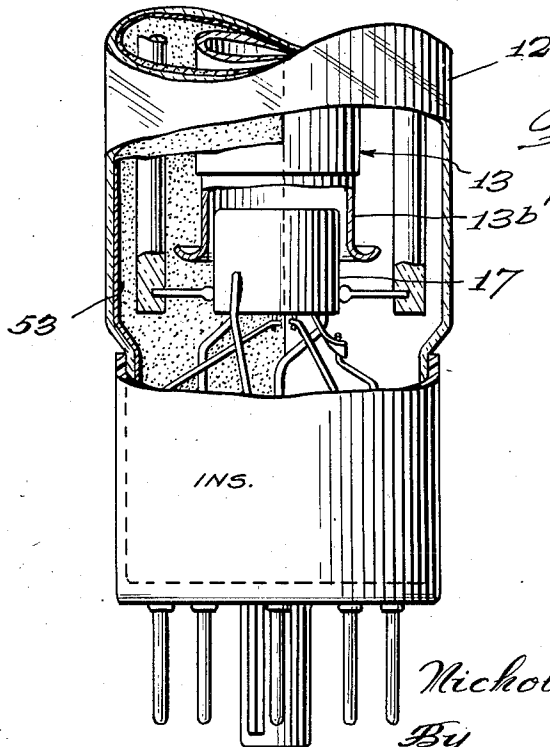
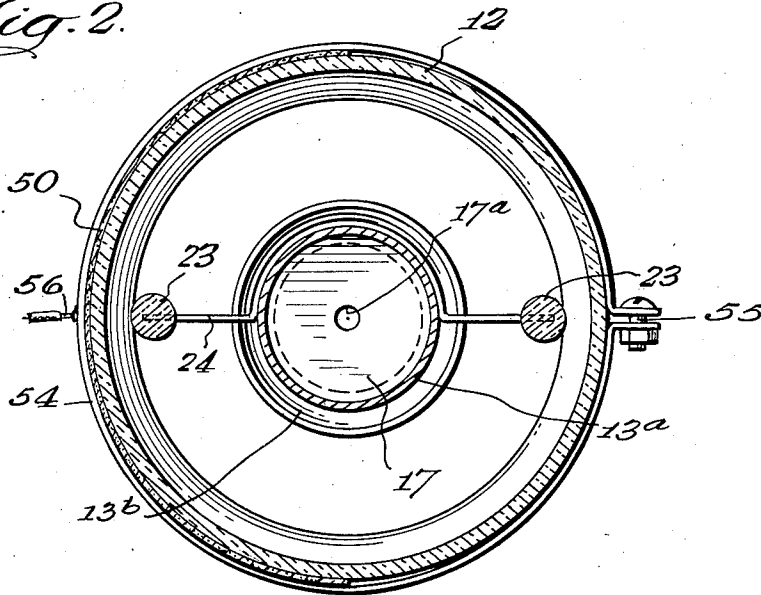


Fig. 6.

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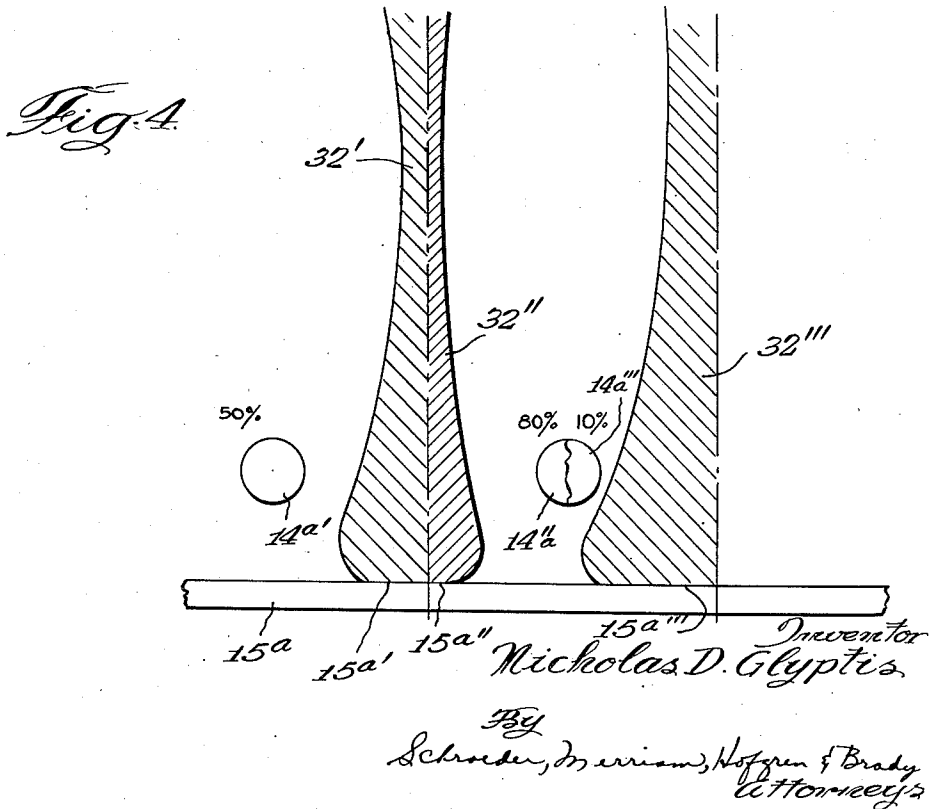
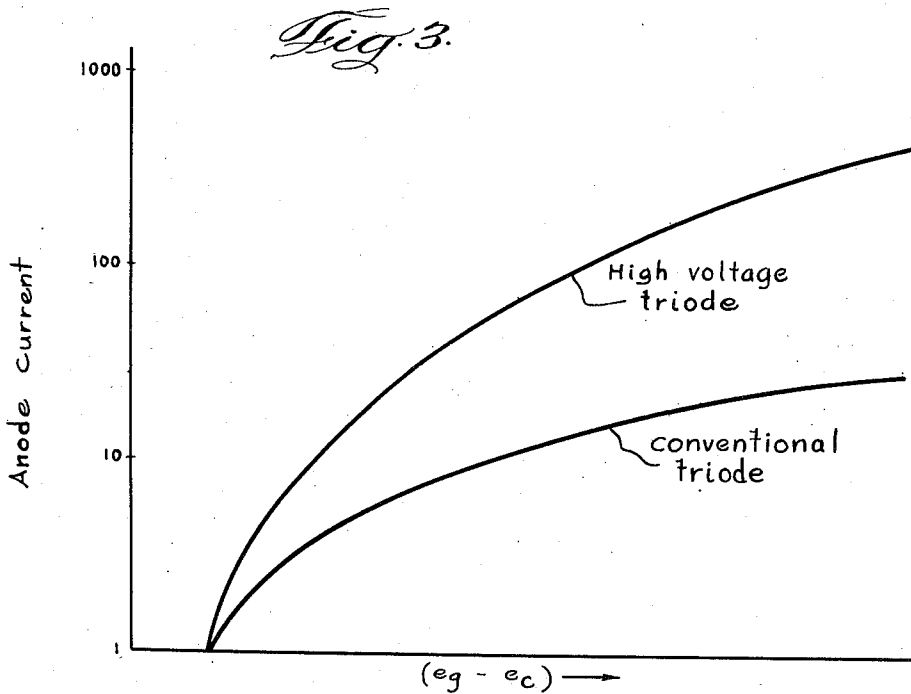
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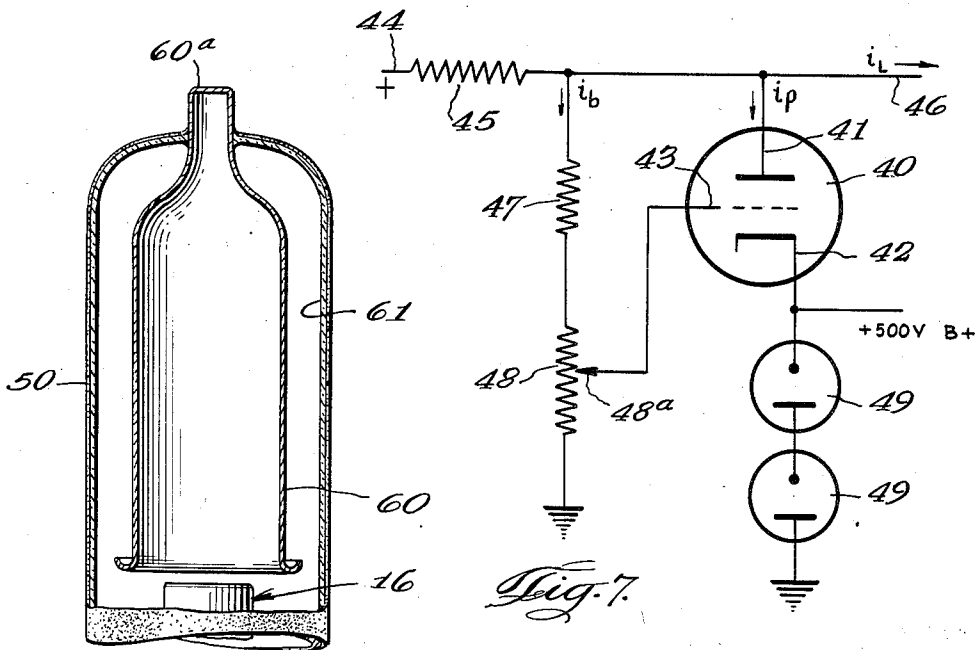
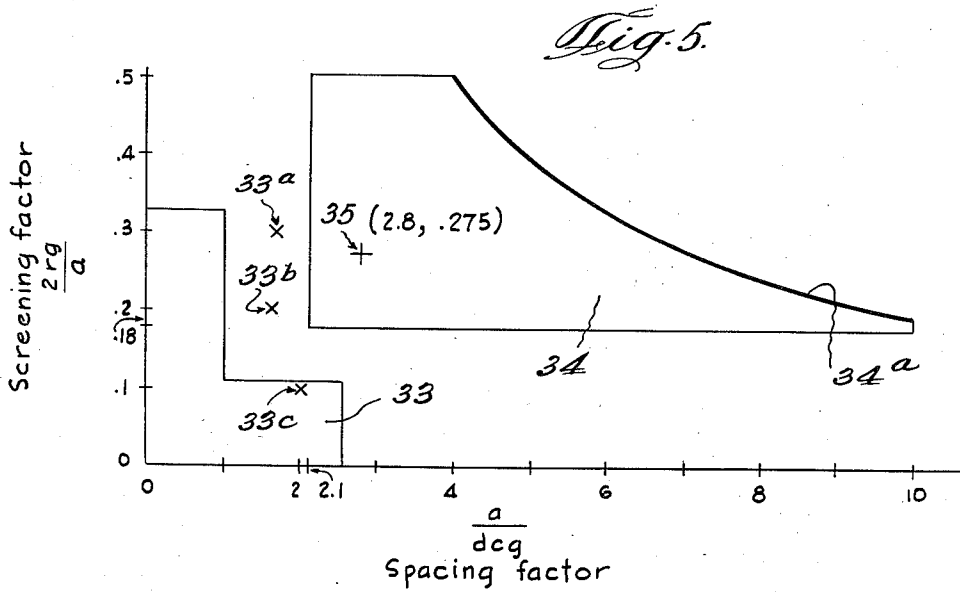
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4 Sheets-Sheet 4



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2,834,907

ELECTRON TUBE

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Application November 6, 1953, Serial No. 390,675

15 Claims. (Cl. 313—293)

This invention relates to a novel electronic tube structure and more particularly to a high mu tube for ultra high voltage applications.

There is at the present time, no satisfactory receiving type tube for ultra high voltage work, that is for anode potentials of the order 10,000 volts and above. If a conventional tube, such as a triode having cylindrically arranged elements, were to be redesigned for ultra high voltage work several design considerations would lead to excessive physical tube size, which of course is undesirable in many applications where space considerations are of paramount importance. With a cylindrical arrangement of tube elements, the diameter of the tube must be increased in order to obtain the large spacing between the anode and the grid-cathode assembly necessary to prevent arcing. Furthermore, as the potential gradient in the grid-cathode control area increases with increased anode potential, the control of the grid over the electron stream decreases and the amplification and transconductance decrease correspondingly. In order that the tube have the desired values of amplification and transconductance it would be necessary to increase the area of the electron stream and of the grid.

Thus, in adapting a conventional tube for ultra high voltage work it would be necessary to enlarge the tube in three dimensions, both radially to maintain the necessary spacing, and axially to provide the desired amplification and transconductance and also to provide an adequate leakage path between the anode cap and the base of the tube.

Another disadvantage of conventional cylindrically arranged tube elements in ultra high voltage work is the sharp edges of the low voltage (cathode and grid) elements. Under the influence of the high potential gradient present in such tubes, the sharp edges of these low voltage elements are quite susceptible to cold emission or corona discharge, both undesirable phenomena.

I have devised and disclose and claim herein a vacuum tube which operates on a principle of multiple electron-stream flow control, permitting the design of ultra high voltage tubes of the axial element type in which only one dimension, the axial dimension, need be increased in going to higher voltages. In addition sharp edges are minimized in the grid-cathode structure, substantially eliminating cold emission or corona discharge.

The primary object of this invention is to provide an electron tube having a controlled electron source including a cathode having an electron emitting surface, grid means so designed and so placed adjacent the cathode that the grid means affects or controls the emission of electrons from the surface of the cathode, forming them into multiple discrete beams, a shield for the cathode and grid means, and an elongated anode means spaced axially from the cathode and grid, having an open end facing the electron source, a surface against which the beams impinge spaced from the open end, and means enclosing the side portions of the anode means between the

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open end and the surface, the anode means trapping the beams therein.

A further object is the provision of an electron tube having an anode, a cathode, means supporting and housing the anode and cathode and a resistive coating on at least a portion of the supporting and housing means.

Another object is the provision of such a tube with a resistive coating on at least a portion of the housing with means for applying a voltage to the resistive coating, the arrangement being such that the flow of electrons from the cathode to the anode is unaffected by the electrostatic field set up by the voltage applied to the resistive coating.

Further objects, advantages and features of the present invention will be apparent from the description of the specific embodiment thereof illustrated in the accompanying drawings, in which:

Fig. 1 is an enlarged vertical section of an electron tube of this invention;

Fig. 2 is a horizontal section taken along the line 2—2 of Fig. 1;

Fig. 3 is a graph showing the operating curve of the tube embodying this invention and compared with the operating curve of a conventional tube;

Fig. 4 is a diagrammatic illustration of the operation of the tube of this invention in controlling cathode emission;

Fig. 5 is a chart illustrating the relationship of the physical dimensions of the tube;

Fig. 6 is a fragmentary view illustrating a modified form of the tube;

Fig. 7 is a schematic diagram of a shunt voltage regulator circuit in which the tube of this invention may be used; and

Fig. 8 is a fragmentary view illustrating another modified form of the tube.

While I have herein illustrated and shall describe a preferred embodiment of this invention, the invention is not limited to the particular form shown, it being understood that modifications and changes may be made by those skilled in the art without departing from the spirit and scope of the invention as set out in the accompanying claims.

In a conventional vacuum tube, as for example a triode having a cathode, a grid and an anode, the flow of electrons from the cathode to the anode which is caused by the application of a positive potential to the anode may be controlled by a potential, generally negative, applied to the grid. A large number of electrons are emitted from the cathode and the grid acts in the manner of a gate or valve allowing only a portion of the electrons to pass it and travel on to the anode. In such a conventional tube the anode current is a function of the three-halves power of the grid voltage, $I_b = K(e_g - e_c)^{1.5}$ (where I_b is the plate current, K is the perveance of the tube, e_g is the grid voltage and e_c is the cutoff voltage for the tube, e_c is frequently expressed as

$$\frac{e_p}{\mu \text{ factor}})$$

In the tube of this invention the grid structure is so designed and so placed adjacent the emitting surface of the cathode that the control voltage applied to the grid actually affects or controls the emission of electrons from the surface of the cathode. The space charge is quite limited due to the grid-cathode arrangement. Because of this action the grid voltage exerts a much greater influence on the electron flow than in the tube above described where the grid acts as a gate. It has been found that where the grid controls the emission of electrons from the cathode the plate current is a function of the 2.45

power of the grid voltage ($I_b = K(e_g - e_c)^{2.45}$). This added degree of control of the grid is of course desirable in many types of tubes, but it is particularly important in tubes designed for ultra high voltage use as the high potential of the anode makes it difficult to design a grid with adequate control to provide a high gain or transconductance.

Referring now more particularly to the drawings, an electron tube 10 embodying the invention is shown in Figs. 1 and 2. The tube 10 is of the coplanar electrode type and is provided with a standard octal-base 11 and an evacuated housing for the elements thereof which may be a glass bulb 12. The tube illustrated is a triode and has anode 13, a grid 14 and a cathode 15; the grid 14 and cathode 15 form a substantially independent assembly unit indicated generally as 16. Although a triode embodiment is illustrated herein it is to be understood that this invention may readily be adapted for other types of tubes, as tetrodes or pentodes.

The cathode and grid assembly 16 includes a grid cup 17 having a cylindrical opening 17a in the closed end thereof. The grid 14, which may be a foraminous or perforate element such as a piece of wire mesh, is placed in the grid cup 17 and positioned over the grid cup opening 17a being secured in place by a flanged grid retainer ring 18 which bears against the lower surface thereof. Grid retainer ring 18 is held in place inside grid cup 17 by a cathode support 19, which is preferably made of an insulating material such as a ceramic, and cathode retainer disk 20 which bears against the lower face of cathode support 19 and which may be suitably secured to grid cup 17, as by spot welding.

The cathode 15 is securely held in a central opening 19a of cathode support 19 and the emitting surface 15a thereof extends up into the interior of grid retainer ring 18 so as to be extremely close to grid 14. Cathode retainer 20, which is secured to grid cup 17, has a central opening 20a to insure that it is electrically isolated from cathode 15. Coiled heater element 21 extends upwardly into the interior of cathode 15.

The cathode grid assembly 16 is supported within the tube housing 12 by means of wires 22 which have one end secured to the grid cup 17 and the other end embedded in the housing 12. At least one of these wires, as 22a, is extended on through the housing 12 and provides means for making an electrical connection to the grid 14 of the tube. Electrical connections are made to the heater by wires 23a and to the cathode by wire 23b all of which also pass through the tube housing 12. Each of these wires, 22a, 23a and 23b may be suitably connected to pins 24 of socket 11.

The anode structure 13 comprises an elongated generally tubular member 13a which extends lengthwise of the tube 10 and has its lower end positioned adjacent the cathode grid structure 16. The tubular member 13a is provided at its lower end, immediately adjacent grid cup 17, with an inverted cup-like member 13b which has a centrally located opening 13b' in the closed end thereof. This opening is in direct alignment with cathode 15 and opening 17a in grid cup 17. The upper end of anode tube 13a is closed by an imperforate plate member 13c which has an outwardly extending flange 13c' of substantial size.

The anode structure used herein is designed to provide for distributed dissipation of the plate power to prevent overheating. Only a portion of the electrons emitted by the cathode will pass through opening 13b' in cup member 13b, the rest impinging on the cup. That portion of the electrons which does pass through opening 13b' will travel on through the tube and strike plate 13c. Thus part of the plate power is developed as heat in cup 13b while the remainder is developed in plate 13c. This prevents overheating of plate 13c which might occur if cup 13b were not provided. The flange 13c' on plate 13c insures that the anode has sufficient heat dissipating surface.

The lower lip 13b' of cup member 13b is preferably curved as shown to minimize the possibility of arcing between anode 13 and grid cup 17. All the low voltage elements, heater 21, cathode 15 and grid 14, are mounted inside grid cup 17. The outer surface of the grid cup 17 is smooth and has a minimum of sharp edges reducing the possibility of cold emission or corona discharge from the low voltage elements; the upper edge 17', adjacent the lower lip 13b' of the anode, in particular being rounded as shown.

Cathode and grid assembly 16 and anode 13 are mounted together to form one integral unit by means of a pair of elongated rods 23 which may be of glass or any other suitable insulating material. A plurality of pins 23a extend radially from either side of both the grid cup 17 and anode tube 13a and have their ends embedded in the support rods 23; the pins 23a are attached to anode tube 13a intermediate the cup 13b and plate 13c, the coolest portion of the anode. The entire cathode, grid and anode unit may be preassembled and inserted in the tube housing 12 in one operation.

A spacer ring 25, which may be of mica, is secured to the top of anode cap 13c and engages the inner surface of the housing 12 maintaining the proper positioning of the tube elements within the housing. A suitable getter assembly 26 is also secured to the upper surface of anode cap 13c.

Electrical connection may be made to the anode 13 through the surface of the tube housing 12 adjacent thereto. A conductor 27 is sealed into the housing and extends therethrough at the top thereof. The outer end of conductor 27 is electrically connected to plate cap connection 28 mounted on the outer surface of the housing 12. A connector wire 29 is secured to the inner end of conductor 27 and has an end portion 29a which resiliently, frictionally engages end plate 13c of anode 13. Connector 29 is preferably made of a material which retains its resiliency under conditions of high heat, such as a nickel-chrome-iron alloy produced by the International Nickel Company under the name "Incanal."

As mentioned briefly above, the grid 14 is so arranged and so positioned with respect to the electron emitting surface 15a of cathode 15 that it screens the cathode from the anode and actually affects or controls the emission of electrons therefrom. It is believed that this action is due to the establishment by the grid of a widely varying voltage gradient across the surface of the cathode; that is, a voltage applied between the anode 13 and the cathode 15 sets up a generally uniform electrostatic field across the cathode surface and when a voltage is applied between the grid and cathode this electrostatic field is substantially modified.

The result of this action may be seen graphically in Fig. 4 in which the emitting surface 15a of the cathode and two of the wires 14a and 14b of the grid are shown together with a graphic illustration of the flow of electrons therearound. This figure is designed to illustrate the effect on electron emission of different voltages on the grid. The wire 14a is illustrated as having a voltage equal to 50% of the cutoff voltage for the tube applied to it. Under this condition electrons will be emitted from portion 15a' of the cathode surface and will flow generally in the path designated by the cross-hatched area 32'. As can be seen from the drawings the flow or beam of electrons expand in the space between the cathode surface 15a and the grid 14, then contract reaching a minimum size at a point substantially beyond the grid structure and then expand again.

Grid wire 15a'' is illustrated as having a voltage equal to 80% of the cutoff voltage applied thereto. It may readily be seen from the diagram that the area of electron emission 15a'' associated with this grid wire is substantially less than the portion 15a' associated with the grid wire 14a'. The electrons however follow the same pattern of expanding their area of flow between the

cathode and grid, contracting to a minimum point the grid and then expanding again, cross-hatched area 32".

Grid wire 14a''' is shown with a voltage equal to 10% of the cutoff voltage applied thereto; here the area 15a''' from which electrons may be emitted is substantially larger than that in either of the previous examples. The flow of electrons however follows the same general pattern, cross-hatched area 32'''. As a result, the electrons leave the cathode from a number of discrete areas and travel down the tube toward the anode in a number of separate discrete streams or beams, rather than in a conglomerate stream as in a conventional tube.

It has been found that certain physical relationships between the grid and cathode must be satisfied in order to establish control of the grid over the emission of electrons from the cathode surface. These physical limits are illustrated graphically in Fig. 5 where two physical parameters of the tube are plotted. The spacing factor, which is defined as the ratio of the center-to-center distance between wires of the grid to the distance from the cathode to the grid,

$$\frac{a}{d_{cg}}$$

(where a is the center-to-center distance between wires and d_{cg} is the distance from cathode to grid) is plotted along the abscissa, while the screening factor which is defined as the ratio of the grid wire diameter to the center-to-center spacing of the grid wires,

$$\frac{2rg}{a}$$

(where rg is the grid wire radius and a is the center-to-center distance between wires) is plotted along the ordinate. The L-shaped area 33 represents the limits of the spacing and screening factors which are used in the majority of conventional vacuum tubes. The positions of several conventional vacuum tubes are indicated in Fig. 5. Point 33a represents a 6J6, which has a spacing factor of 1.7 and a screening factor of 0.3; 33b represents a 6BG7, 1.6 and 0.2; and 33c represents a 2C39 or a 2C40, 2.0 and 0.1.

The area 34 represents the physical limits of the tube of this invention in which the grid controls the emission of electrons from the surface of the cathode. In general both the spacing factor and the screening factor are larger in this tube than in tubes of the prior art. It has been found that for satisfactory operation the spacing factor should be between 2.1 and 10 while the screening factor should be between 0.18 and 0.5. The tube dimensions should be kept in the area under curve 34a since in the area above this curve the size of the grid wires or elements becomes rather large and the cathode-grid spacing quite small. As a result the grid tends to run into or contact the cathode surface in this area.

The grid to anode spacing is limited to a certain extent by the desired voltage rating of the tube, for example a tube designed to operate with 5,000 volts on the anode should have grid to anode spacing of at least 0.016 inch while the minimum spacing for a tube designed to operate with 20,000 volts anode voltage is 0.1 inch. The spacing referred to is, of course, that between the grid and the most closely adjacent portion of the anode, for example, the curved lip of cup member 13b. The ratio of the grid to plate distance to the spacing between grid wires should be 0.8 or above and the ratio of the grid to plate distance to the grid to cathode distance should be at least 2.

A tube embodying grid control of cathode emission has been constructed and tested; it has the following physical and electrical characteristics. The grid is composed of 5.5 mil wire screen with a 50-50 mesh or 20 mils wire-to-wire spacing and the grid-to-cathode

spacing is 7 mils. Thus the spacing factor is 2.8 (20/7) and the screening factor 0.275

$$\left(\frac{5.5}{20}\right)$$

this point is indicated at 35 on the chart of Fig. 5. This tube has maximum ratings of 20,000 volts on the anode with an average anode current of 2.0 milliamperes. When the tube is operated with 5,000 volts on the anode and an anode current of 1.5 milliamperes, it has an amplification factor of 1,400, plate resistance of 2.0 megohms and transconductance of 740 microhms. The tube has an overall length of 5¾ inches (including base) and a diameter of 1¾ inches. A comparable tube of conventional design would be half again as large in volume.

The placement of cathode 15 inside grid cup 17 with the grid element positioned closely adjacent thereto limits the space charge which is largely unconfined in conventional tubes. This increases the effect of the grid over the emission of electrons from the cathode.

The combination of the rounded lower lip 13b'' of the anode and the rounded upper edge 17' of the grid cup serves to concentrate the voltage gradient from anode to grid between these two surfaces, reducing the voltage gradient existing in the grid-cathode space. This effect may be enhanced by arranging the elements so that the anode partially surrounds the grid cup as shown in Figure 6 or so that the lower lip of the anode is substantially larger than the grid cup as shown in Figure 8.

An important use for the high voltage triode of this invention is illustrated in Figure 7 which shows a shunt type voltage regulator circuit of the type which might be used in the cathode-ray tube anode supply voltage circuit of a color television receiver (the quality of color television reception is much more sensitive to variations in the anode voltage of the picture tube than is the case with black and white television and accordingly voltage regulation is needed where it is not generally used in black and white television receivers). In this circuit the tube 40 is shown as a triode having an anode 41, a cathode 42 and a control grid 43 and may be of the type shown in Fig. 1. A source of ultra high voltage, such as a rectifier operably connected across the horizontal output transformer of the television receiver is connected to lead 44 and supplies a rectified voltage of the order of 20,000 volts. Resistor 45 represents the internal impedance of the rectifier and may have a value of the order of 15 to 20 megohms. The screen of the picture tube (not shown) may be connected to wire 46. Anode 41 of tube 40 and a resistance bleeder network made up of resistor 47 and potentiometer 48 are connected to wire 46 and through resistance 45 to the voltage source. Resistor 47 may have a value of 120 to 200 megohms while potentiometer 48 has a value of the order of 3 megohms; the control grid 43 of tube 40 is returned to variable tap 48a on potentiometer 48. The cathode 42 of tube 40 is returned to a voltage of up to 500 volts which may be provided from the power supply circuits of the television receiver (not shown) and which is stabilized by VR150 tubes 49.

The cathode 42 of tube 40 is maintained at a stable voltage of 500 volts and a voltage of up to 500 volts may be applied to the control grid 43 providing a variable negative bias for the tube. A relatively small constant current i_b is drawn by the bleeder resistors and may be disregarded for the purposes of the subsequent discussion. Power supply 44 also furnishes anode current i_p for tube 40 and a current i_c for the cathode-ray tube. If the current i_c should begin to rise causing a decrease in the potential applied to the anode of tube 40 and to the picture tube because of the internal impedance 45 of the power supply this drop in voltage will be passed on to the grid 43 of tube 40 causing it to become more negative with respect to the cathode and causing a decrease in

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the plate current i_p drawn by the tube. This reduces the shunt tube drain on the power supply and allows the anode voltage to return to its original value. Conversely, if the current i_L , drawn by the cathode-ray tube should begin to drop, the anode and grid voltage of tube 40 would both rise causing a corresponding increase in plate current i_p , again returning the anode voltage to its nominal value.

It is necessary that a tube used in a circuit of this nature have a relatively high gain and transconductance in order to operate satisfactorily. It has been determined that the stability of the anode voltage is approximately equal to

$$\frac{m}{g_m}$$

where m is the ratio of the anode voltage to the cathode voltage and g_m is the transconductance of the tube. However, as the cathode voltage approaches zero, m approaches μ ; the amplification factor and the anode voltage stability approaches

$$\frac{\mu}{g_m}$$

As pointed out previously, conventional tubes designed for use in such circuits are larger physically because it is necessary to make the elements thereof large in order to achieve the desired transconductance. With the tube of this invention, however, the control of the grid over the anode current is substantially greater than in a conventional tube (this is a measure of the transconductance of the tube) and accordingly the physical size of the tube may be much smaller.

The resistor 47, which has a value of 200 megohms and at 20,000 volts must dissipate 2 watts of heat, may advantageously be incorporated in the tube structure by depositing a thin resistance film, of a suitable material as chromic oxide (Cr_2O_3) on the surface of the tube bulb or housing 12 as indicated by reference numeral 50 in Fig. 1. This film may make electrical contact with plate cap 28 at the top of the bulb of the tube, making the resistor an integral part of the tube. The lower end of the resistance film 50 may terminate in a silver conductive layer 51 applied to the tube base 11 and connection may be made through the tube base to one of the pins 24', providing an easy means for incorporating the resistor into the circuit. The resistance coating extends around only a portion of the tube housing 12 as shown in Figs. 1 and 2 in order that the exposed radiating surface of the tube will not be unduly limited; in many situations, however, the resistance coating may be applied to the entire bulb surface as shown in Fig. 8. It is desirable however where only a portion of the bulb is coated that a thin band 50a of the resistance coating be extended completely around the tube housing 12 in the vicinity of the space between the grid cup 17 and the anode 13 in order that the electrostatic field set up by a voltage impressed across the resistor, here composed of film 50, will not adversely affect or modify the flow of electrons. On the other hand it may be desirable to deflect the bundle of beams to one side in which case this effect can be beneficial.

A modification of this arrangement is shown in Fig. 6 in which a resistive coating 53 is applied to the inner surface of the tube housing 12. As in Fig. 1 the resistive coating 53 may be electrically connected to the anode 13 at the top of the tube and the lower end thereof may be brought out to a pin on the base of the tube. In Fig. 6 alternate means for shielding the electron flow from the electrostatic field set up about resistive coating 53 is shown. Here the lower closure 13b of the anode 13 is extended down so that it surrounds and extends below the upper surface of the grid cup 17. The electron flow in this tube takes place entirely within these metal shields.

In many television receivers, and particularly in color

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receivers, the cathode-ray tube is provided with a convergence electrode which aids in proper color register focusing of the electron beam. This electrode must be provided with a very high voltage of the order of one-half the voltage applied to the screen of the cathode-ray tube. The necessary voltage is readily obtainable from the resistance coating 50. As shown in Fig. 1, a band 54 may be suitably clamped around the tube housing 12 as by bolt 55. A wire 56 secured to band 54 is connected to the convergence electrode of the cathode-ray tube (not shown). The high contact resistance of such a connection is not troublesome inasmuch as the current drain is extremely low, being of the order of a few microamperes.

The anode connector 29 shown in Fig. 1 and heretofore briefly described has a number of advantages. In the past where an element of a tube was provided with a connection through the tube housing adjacent thereto it has been necessary to mount this element in place in the tube integrally with the connection through the housing or glass bulb. When the remaining tube elements, which are supported by the base of the tube, are inserted a problem is always presented in properly aligning these tube elements with that previously secured inside the tube. As shown in Fig. 1, resilient connector means 29 are secured to conductor 27, which extends through tube housing 12, and frictionally engage anode 13. Thus the anode may be assembled integrally with the cathode grid structure 16 and proper alignment thereof assured before these elements are inserted in the tube housing substantially reducing the intricate job of tube assembly.

The steps in assembling a tube of this type include piercing the bulb 12 at the top thereof, and sealing the conductive means 27 therethrough, the resilient connecting member being brazed or welded to the inner end of conductor 27. The preassembled tube elements including the cathode, anode and grid are then inserted into the bulb 12 with the anode 13 frictionally engaging the end 29a of resilient connector 29. The tube is then sealed and exhausted in the usual manner.

A modified tube construction is illustrated in Fig. 8 where the anode 60 is not physically connected to the cathode-grid assembly. Instead, the anode 60 and anode cap 60a are sealed into the bulb or housing 61 and are completely supported thereby. The cathode-grid assembly 16 is substantially identical with that previously discussed in connection with Figs. 1 and 6. This structure has the advantages of increasing the rated power dissipation of the tube since not only is heat dissipated by radiation, but also by conduction through the plate cap. This increased dissipation eliminates the need for a structure providing distributed dissipation such as shown in Fig. 1. In addition, the elimination of support rods 23 permits a reduction of tube diameter. As pointed out previously, the resistance coating 50 may cover the entire tube housing.

I claim:

1. An electron tube, comprising: an anode; a cathode; means supporting and housing said anode and said cathode; a high resistance coating on at least a portion of said supporting and housing means; and connector means in electrically conductive relation with said coating for making a plurality of connections between said high resistance coating and an external circuit.

2. An electron tube comprising: an anode; a cathode; means supporting and housing said anode and said cathode in operative relation; a resistive coating on at least a portion of said supporting and housing means; and connector means in electrical conductive contact with said coating for making a plurality of spaced connections between the coating and an external circuit the arrangement being such that the electrostatic field resulting from a voltage applied to said resistive coating has no effect on the flow of electrons from said cathode to said anode.

3. An electron tube of the character described in claim

1 wherein a circuit connection is made to said anode through said housing means and adjacent said anode, said resistive coating being applied to the surface of said housing and contacting said anode connection.

4. An electron tube comprising: an evacuated envelope; anode means in said envelope; and a cathode and grid assembly in said envelope including a grid cup with a closed end facing said anode means and having an opening in the closed end thereof, a wire mesh grid in said cup and extending across said opening, a grid retainer in said cup and bearing against said grid, an insulating cathode support in said cup and bearing against said grid retainer and being spaced thereby from said grid, and a cathode carried in said cup by said cathode support, said cathode having an emissive surface adjacent said grid and aligned with said opening, said grid and cathode being within said grid cup and shielded thereby, the ratio of the wire diameter of said grid to the spacing of said mesh being at least 0.18 and less than 0.5, and the ratio of said mesh spacing to the spacing of said grid from said cathode being at least 2.1 and less than 10.

5. An electron tube comprising: an evacuated envelope; anode means in said envelope; and a cathode and grid assembly in said envelope spaced from said anode, including a grid cup having a closed end facing said anode means and an opening in the closed end thereof, a wire mesh grid in said cup and extending across said opening, a grid retainer in said cup and bearing against said grid, an insulating cathode support in said cup bearing against said grid retainer and being spaced thereby from said grid, and a cathode carried in said cup by said cathode support both said grid and said cathode being housed within said grid cup.

6. In an electron tube including a housing of insulating material, means comprising: a resistive coating on said housing; spaced connector means in electrical conductive contact with said coating for connection to an external circuit for applying a voltage to said resistive coating; and connector means intermediate said spaced connector means and in conductive contact with said coating for obtaining an intermediate voltage from said resistive coating.

7. A vacuum tube including: an anode assembly; and a cathode-grid assembly forming electrons into multiple discrete beams, including means defining an area of electron flow between the cathode and anode, both said anode and said cathode-grid assemblies having portions relatively adjacent each other and remote from the area of electron flow, the potential gradient from a voltage impressed between said anode and said grid being concentrated between said portions.

8. An ultra high vacuum tube including: an anode having a flared open end portion with rounded edges; and a cathode-grid assembly including a grid cup enclosing the cathode and presenting a closed end having a rounded surface to said anode the closed end of the grid cup having a central opening therein defining an area of electron flow, the rounded edge portion of said anode and the rounded surface of said grid cup being relatively closely spaced and remote from the area of electron flow, the potential gradient from a voltage impressed between said anode and said grid being concentrated between said edge portion and said surface.

9. An electron tube comprising: a plurality of electrodes; insulating means housing said electrodes; a conductive coating on at least a portion of said housing and forming a circuit element; and connector means in electrical conductive contact with said coating for making a plurality of spaced connections between the coating and an external circuit, at least one of said connector means being connected with one of said electrodes, said coating forming a portion of the circuit associated with said tube.

10. A high voltage vacuum tube comprising: a controlled electron source including a cathode-grid assembly

for forming electrons emitted from said cathode into multiple beams; a shield for said cathode-grid assembly; and an anode spaced axially from said cathode-grid assembly with said shield interposed therebetween, the anode comprising an elongated, generally cylindrical member having an open end facing said electron source whereby the multiple beams of electrons from said cathode enter said anode and are trapped therewithin.

11. A high voltage vacuum tube comprising: a controlled electron source including a cathode-grid assembly for forming electrons emitted from said cathode into multiple beams; a shield for said cathode-grid assembly comprising a cup-shaped member having a closed end with an opening therein, the sides of said cup enclosing and shielding said cathode-grid assembly and the opening in the closed end thereof defining the area of said electron beams; and an anode spaced axially from said cathode-grid assembly with said shield interposed therebetween, the anode comprising an elongated, generally cylindrical member having an open end facing said electron source whereby the multiple beams of electrons from said cathode enter said anode and are trapped therewithin.

12. A high voltage vacuum tube comprising: a controlled electron source including a cathode-grid assembly for forming electrons emitted from said cathode into multiple beams; a shield for said cathode-grid assembly comprising a cup-shaped member having a closed end with an opening therein, the sides of said cup enclosing and shielding said cathode-grid assembly and the opening in the closed end thereof defining the area of said electron beams; and an anode comprising an elongated cylindrical member of substantially the same diameter of said cup and axially aligned therewith, said anode having an open end spaced from the closed end of said cup and having a closed end remote therefrom, the depth of said anode being substantially greater than the diameter thereof, whereby the electron beams from said cathode enter said anode and are trapped therewithin.

13. An electron tube, comprising: an evacuated envelope; anode means in said envelope; and a cathode and grid assembly in said envelope spaced from said anode, including a grid cup having a closed end facing said anode means and an opening in the closed end thereof, a grid extending across the opening in the closed end of said cup, a cathode having an emissive surface, and means including an insulating support member supporting said cathode in said cup with the emissive surface thereof in a predetermined relation to said grid.

14. An electron tube, comprising: an evacuated envelope, anode means in said envelope and a cathode and grid assembly, including an emissive surface on said cathode, in said envelope, said cathode and grid assembly including a grid cup with a closed end facing said anode means and having an opening in the closed end thereof, a grid extending across the opening in the closed end of said cup and having solid portions and openings there-through, and means, including an insulating cathode support member, supporting said cathode in said cup with said emissive surface in predetermined spaced relation to said grid, the cathode being shielded by said cup, the ratio of the width of the solid portions of said grid to the spacing between portions being at least 0.18 and less than 0.5, and the ratio of the spacing between solid portions to the spacing of the grid from the emissive surface of the cathode being at least 2.1 and less than 10.

15. A vacuum tube, comprising: a controlled electron source, including a cathode-grid assembly forming the electrons emitted from the cathode into multiple discrete beams; a shield for said cathode and grid means; and elongated anode means spaced axially from said cathode grid assembly, having an open end facing said electron source, a surface against which said beams impinge spaced from said open end, and means enclosing the side portions of said anode means between said open end

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and said surface, said anode means trapping said beams therein.

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