Aug. 7, 1956 L. E. GRIFFITHS 2,758,236

CONTROL OF ELECTRON EMISSION

Filed April 22, 1955

2 Sheets-Sheet 1

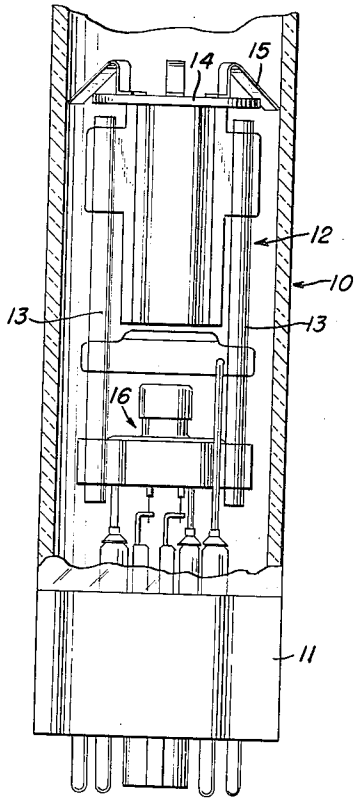


FIG. 1

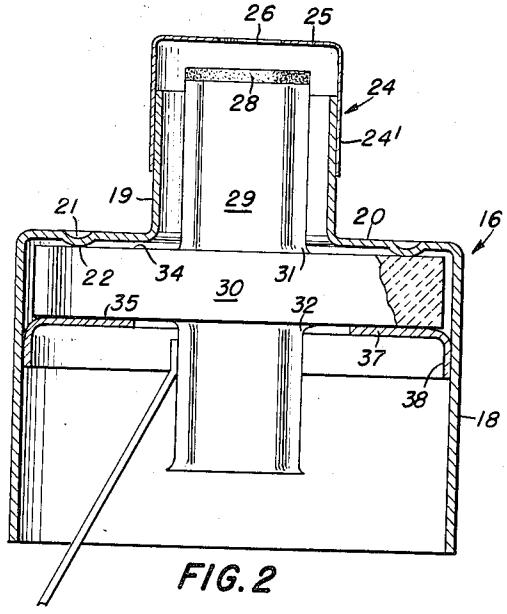


FIG. 2

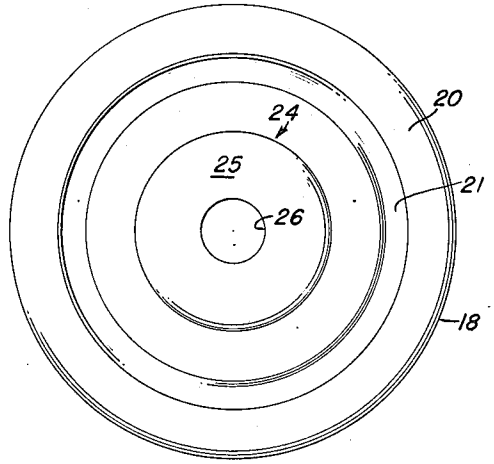


FIG. 3

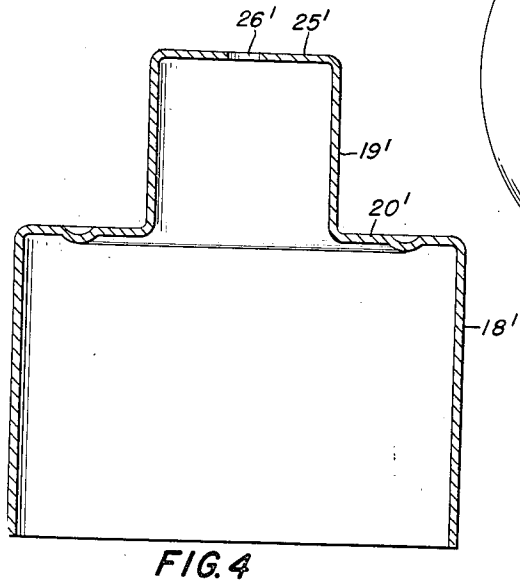


FIG. 4

INVENTOR

LEIGHTON E. GRIFFITHS

BY Leech and Radue

ATTORNEYS

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2 Sheets-Sheet 2

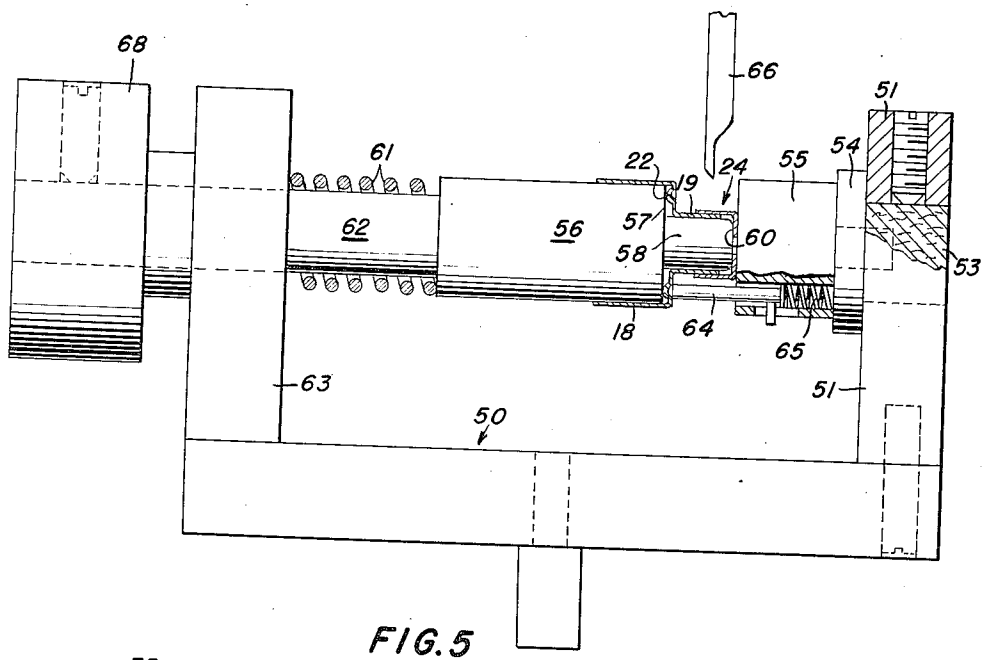


FIG. 5

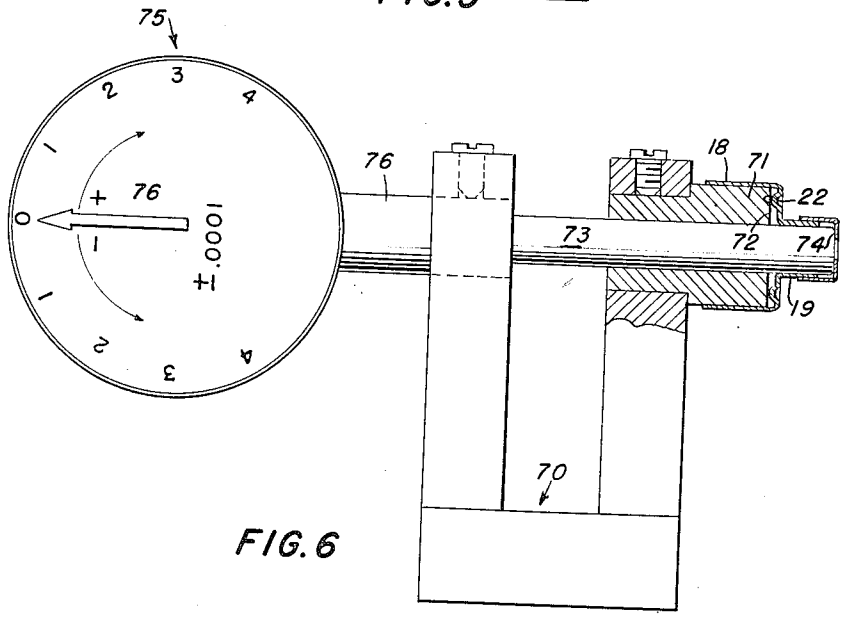


FIG. 6

INVENTOR

LEIGHTON E. GRIFFITHS

BY Leech and Radue

ATTORNEYS

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CONTROL OF ELECTRON EMISSION

Leighton E. Griffiths, Newark, N. J., assignor to Griffiths Electronics, Inc., Newark, N. J., a corporation of New Jersey

Application April 22, 1955, Serial No. 503,297

12 Claims. (Cl. 313—82)

This invention relates to electronic devices and more particularly to the accurate control of electron emission from such devices.

It is a general object of the present invention to provide a novel and improved electronic device for the control of electron emission.

More specifically it is an important object of the invention to provide an improved assembly of cathode and first grid in the so-called electron-gun of a cathode ray or television tube.

Another important object of the invention resides in the arrangement, in an electron-gun, of a flat topped cathode tube and a first grid having a flat, perforated disc together with provisions for accurate and controlled spacing between the top and disc to thereby control the electron beam for divergence.

Still another important object of the invention comprises a construction permitting the use of thinner metal for the perforated grid disc without sacrifice of space control in respect to the coated top area of the cathode whereby a lower operating voltage may be used.

A further important object of the invention comprises an arrangement of the first grid supporting shell and the insulating mounting disc for the cathode tube whereby material evaporated from the cathode tube during the processing and evacuation of the cathode ray tube is prevented from forming an undesirable path of conductivity between the cathode and grid.

A still further important object of the invention comprises the arrangement of the number one grid carrying cylinder to so cooperate with the ceramic disc support for the cathode tube that very accurate predetermined spacing between cathode and grid is automatically effected on assembly.

Among the features of the invention contributing to its effectiveness and facilitating the assembly of the parts may be enumerated the following:

Arrangement of the number one grid cylinder for unitary or two part formation with adequate spacing and sizing control;

Use of an annular boss integral with the number one grid cylinder to act as cathode-ceramic positioning shoulder;

Construction of grid disc of substantially lesser diameter than the grid cylinder whereby less distortion or warping of the actual grid is achieved and grid-cathode spacing more adequately controlled;

Facility for using thinner grid disc;

Ability to use jigs and test equipment to insure grid-cathode spacing to great exactitude.

Other and further objects and features of hte invention will be more apparent to those skilled in the art upon a consideration of the accompanying drawings and following specification, wherein are disclosed embodiments of the invention, with the understanding, however, that such changes and modifications may be made therein as fall within the scope of the appended claims without departing from the spirit of the invention.

In said drawings:

Fig. 1 is a side elevation of an electron gun, including the devices of the present invention, shown in position in the neck of a cathode-ray or television picture tube, which is shown as broken away for a clearer illustration of the invention;

Fig. 2 is an enlarged longitudinal central section through the grid cylinder, grid tube and cathode assembly illustrating the major features of the invention;

Fig. 3 is a top plan view of the assembly of Fig. 2;

Fig. 4 is a longitudinal central section through a unitary grid cylinder-grid tube unit;

Fig. 5 is a side elevation of an assembly tool for sizing and welding the parts of a grid cylinder-grid tube assembly; and

Fig. 6 is a side elevation of a measuring and testing device used to determine the spacing between the under face of the grid disc and the ceramic disc engaging boss on the grid cylinder annulus.

Cathode ray tubes of the type used for television reception, where they are referred to as "picture tubes," each include one or more so-called "electron guns" arranged in the tube neck and adapted to direct a concentrated beam or ray of electrons toward the fluorescent viewing screen to produce the desired picture effect after proper deflection in a well understood manner. The construction of the electron gun, in order to produce a suitable beam of proper concentration and the like, calls for the maintenance of extremely fine tolerances for the assembling of certain of the parts, and the present invention deals with the construction, arrangement and the assembly means for these parts to control the electron emission from the cathode and insure its proper directing and concentrating by means of a control electrode hereinafter referred to as the first or number one grid but actually comprising a thin metal disc with a single central perforation.

Referring first to Fig. 1 for a general view of the associated parts of the electron gun, there is shown at **10** the glass neck of a picture tube fitted with the usual base **11** and contact pins. Within the neck and supported from the tube press by certain connection and supporting wires, forming no part of the present invention, is the complex assembly **12** generally referred to as an "electron gun." It includes a cathode, cathode heater, the number one grid, one or more additional grids and an anode arranged in the order named and longitudinally of the tube neck. As shown the various elements are mechanically connected together by means of suitable attachments to longitudinally directed ceramic rods **13** and the top element carries an insulating disc **14** fitted with spring fingers **15** for engaging the walls of the neck for stabilizing and centering the gun assembly therein.

The subassembly of the present invention is best illustrated in Fig. 2 as largely contained in or carried by what is termed the "grid cylinder" **18** having straight cylindrical walls. It supports a smaller diameter grid tube **19** coaxially thereof positioned thereabove and integrally connected thereto by the annulus **20**, the whole unit being formed as a one-piece structure from metal of appropriate gauge to supply the necessary mechanical strength. The clamps for attachment to the ceramic rods **18** are not illustrated in the detailed construction. The annulus **20** is circumferentially grooved at **21** to project a boss **22** a slight distance below the inner face of annulus **20** at a radius such that it is substantially closer to the walls of the cylinder **18** than those of the tube **19**. The purpose of this boss will appear later.

As shown in Fig. 2, the grid tube is completed by a cap **24** having cylindrical wall **24'** adapted to fit tightly over tube **19** and to be welded thereto, as will be described hereinafter. This cap has an integral disc **25**

partially closing the upper end and fitted with a central circular aperture **26** constituting the control for the electron beam.

As shown in Fig. 4, the grid disc **25'** is formed integrally with the walls of tube **19'** which is integral with annulus **20'** springing unitarily from walls **18'** of the grid cylinder. This construction produces substantially the same subassembly as the form illustrated in Fig. 2 and may be preferred by some users.

The cathode ray or electron beam is produced by an emissive coating **28** on the flat upper end of cathode tube **29** extending coaxially to tube **19** from near its upper end well down into the grid cylinder **18** as shown. It is mounted in a central aperture in a flat ceramic disc **30** in any one of several conventional manners, and as illustrated by being swaged outwardly at **31** and **32** to provide small beads overhanging the top face **34** and the bottom face **35** respectively of the ceramic disc.

Face **34** of this disc is flat and its assembly with the cathode tube is such as to provide an accurately controlled spacing between surface **34** and the top of the cathode tube where the coating is applied. This dimension is rigidly held to a tolerance of less than 0.0005 inches, which permits an assemblage such as shown in Fig. 2 to produce the desired controlled spacing between the under face of the grid disc **25** and the top surface of cathode tube **29**, which is so essential to the proper control of the beam from the electron gun. The tolerance here is of the same order, whereas the spacing itself may be of the order of 0.1 to 0.2 of an inch.

With minimum tolerance of spacing between the front face of the ceramic disc and the top of the cathode tube as just described, the spacing then between the cathode end and the under face of the grid disc is controlled by fixing the spacing between the under surface of the grid disc and a plane passing through the face of boss **22** on the annulus **20**.

With the cathode-ceramic disc face and the grid disc-boss dimensions fixed as just described, the positioning of the ceramic disc within the grid cylinder abutting boss **22** insures the desired cathode-grid spacing. The disc may be locked in the grid cylinder **18** by means of flanged annulus **37** whose skirt **38** is welded to the walls of cylinder **18** while held tightly against the under face of the ceramic disc. Optional securing means would comprise a bead rolled into the walls of cylinder **18** or prongs or tabs bent inwardly therefrom to engage under the disc.

Heretofore it has been the practice to construct the grid cylinder of uniform diameter throughout its length whereby the grid disc was of larger diameter, difficult to maintain absolutely flat or plane and subject to warpage from heating, whereby the accurate spacing required for uniformity in tube manufacture was not available. Moreover the cathode ceramic disc had to be engaged on its upper face by a ring or flange secured to the inner walls of the grid cylinder and the required spacing was effected by means of spacer washers available in various thicknesses and used in a hand assembly operation requiring accurate measurement of the cathode-grid spacing after assembly and the replacement of the spacer washer with one of another thickness in the event of improper spacing. This resulted in slow, tedious work which seriously delayed production.

All such spacer washers are eliminated by the control of the distance between the plane defined by the boss **22** and the under face of the grid disc. By using a small diameter tube **19** the grid disc diameter is reduced and it can more readily be formed as a true flat and held there resistant to temperature changes. Moreover, because of its smaller diameter, it can be made of thinner metal and still be of adequate rigidity. It has been determined that the thinner the metal the more accurate the beam control effected by the grid disc. The small size of cap **24** carrying disc **25** makes it feasible for

manufacture from some metal such as tantalum which when heated in a field of ionization will attract and hold ionized gases, thus providing a "getter" for the cathode in close proximity thereto.

The boss **22**, in addition to its purpose of providing the grid-cathode spacing already described, separates the surface of the ceramic disc adjacent the cathode tube from the annulus **20** and insures improved insulation between the cathode and the grid. The cathode tube is usually constructed of nickel and during the operation of evacuating the cathode ray tube and otherwise processing it the various internal elements are heated to high temperature by induction heating while the air is pumped from the envelope. There is a certain amount of evaporation of the metal of the cathode and some of this may be deposited on the ceramic disc as a ring adjacent its circle of contact with the top face thereof, but this metal can never be projected a sufficient distance to coat the front face of the ceramic disc close to its ring of engagement with the boss, thus insuring a large spacing for proper insulation.

The finished assembly, as illustrated in Fig. 2, is extremely rigid, provides adequate insulation between the several electrical parts at all times and insures by the mere assembly operation the desired spacing between the cathode face and the under surface of the grid while permitting a thinner disc for better control.

Spacing between the under face of the grid disc and the plane of boss **22** in the preferred embodiment may be effected in an assembly apparatus illustrated in Fig. 5, which comprises a U frame **50** having arm **51** provided with a circular opening to receive insulating stud **53** of insulation pad **54** mounting the metal anvil **55** out of electrical contact with the frame. Arranged to confront this anvil is the grid cylinder support head **56** having a face **57** to engage boss **22** and a reduced stud **58** to enter the grid tube **19**. The top face **60** of stud **58** has the desired grid disc-boss plane spacing from face **57** to limit the amount of telescoping of cap **24**, carrying the grid disc which is loosely placed over the tube **19**. The head **56** is pressed toward anvil **55** by suitable means such as spring **61** surrounding sliding stem **62** of head **56** which passes through frame arm **63** to telescope parts **19** and **24** to the proper spacing. To insure boss **22** seating on rim **57** of head **56** the anvil **55** is fitted with a plurality of slidable pins **64** engaging the outer face of the annulus under the action of their springs **65**. While holding this accurate assemblage a welding tool **66** is brought down and produces a spot weld between the sleeve of the cap and the tube **19**. Thereafter the handle **68** is rotated 90 to 120° in steps and additional spot welds made to hold the cap squarely in position at its desired spacing.

After the rough stamping operation which produces the unitary grid structure of Fig. 4, accurate sizing may be effected by mounting the assembly on a suitable tool or jig and exerting pressure on the disc **25'** until it is brought to the correct spacing by contact with appropriate control surfaces.

Either form of grid cylinder may be tested for the accuracy of spacing heretofore emphasized by means of the test tool of Fig. 6, having U-shaped frame **70**, one arm of which carries a cylindrical anvil **71** adapted to closely receive grid cylinder **18** and having face **72** against which boss **22** fits. A rod **73** slidable through a central aperture in anvil **71** is sized to enter the grid tube **19** and has a flat head **74** to engage the under face of the grid disc. This rod **73** is the measuring rod of a dial gauge **75** carried by the other arm of the U-shaped frame by means of tube **76** through which rod **73** slides. This tube is adjustable in the frame arm as shown to provide the initial setting which is such that when the grid tube assembly is positioned as shown with the boss engaging the face **72** of the anvil the proper adjustment of spacing between the boss plane and the under face

of the grid disc is indicated by a zero setting of the hand 76 of the dial gauge. Plus or minus graduations on the gauge show variations in ten thousandths of an inch whereby the devices may be measured rapidly and accurately and those with excess tolerances rejected.

I claim:

1. For use in an electron gun for cathode ray tubes having a cathode mounted in an insulating disc with its emissive face spaced a predetermined distance above the upper face of said disc, in combination, a number one grid cylinder having tandem arranged coaxial large and small diameter cylindrical portions and an integral connecting annulus, a perforated grid disc permanently secured to and closing the remote end of the small diameter portion and integral means extending below the under face of said annulus near its outer periphery having exact predetermined spacing from the inner face of said disc to position the insulating cathode carrying disc with the emissive cathode face a predetermined distance from the under surface of said grid disc.

2. For use in an electron gun for cathode ray tubes, in combination, an elongated cathode element having an emissive end face normal to the element axis, an insulating disc supporting said element with the said end face at a predetermined distance beyond the adjacent face of the disc, a grid cylinder portion to closely receive the disc, a smaller diameter portion axially beyond the first portion, a perforated end disc closing said second portion, an annulus connecting the oppositely facing adjacent ends of said grid cylinder portions and integral boss means on the inner face of the said annulus to be engaged by the said adjacent face of the insulating disc to fix the spacing between the inner face of said perforated end disc and the emissive end face of said cathode.

3. The apparatus as defined in claim 2 in which said boss means is radially remote from the cathode element.

4. The apparatus as defined in claim 2 in which said boss means spaces all of the area of the annulus from the confronting face of the insulating disc whereby material evaporated from the cathode element during the cathode ray tube processing does not provide a conducting path between the cathode element and grid tube.

5. A cathode and first grid assembly for an electron gun, in combination, a metal grid cylinder having an annular head at one end, an insulating disc in said cylinder with one face confronting said head, means engaging the other disc face to secure it in the cylinder, a grid tube projecting from the inner periphery of the head, a thin, flat centrally perforated metal disc closing the outer end of said tube, a cathode tube extending through and secured in a central aperture in said insulating disc, being spaced radially inwardly from the grid tube and having a flat closed end at a predetermined distance from said one face of the insulating disc, and means integral with said annulus engaging said one face of the insulating disc, the plane defined by said last mentioned means having a spacing from the under face of the grid disc to provide a predetermined spacing between grid disc and cathode flat end.

6. The assembly as defined in claim 5 in which said means integral with the annulus is a coaxial bead spaced nearer the grid cylinder than the grid tube.

7. The assembly as defined in claim 5 in which at least a portion of the grid tube close to the end of the cathode is formed of a metal capable of acting as a getter when heated during evacuation.

8. The combination in an electron gun with a cathode tube mounted intermediate its ends in the center of a ceramic disc and having a flat emitter end at a predetermined spacing from the front face of the disc; of a flat perforated, first grid disc spaced a predetermined distance from said emitter end, a tube of the order of twice the diameter of the cathode tube supporting said disc, a radial flange at the remote end of said tube from said disc of a diameter of the order of said ceramic disc, means to secure the tube and flange to said ceramic disc, and means projecting from the under face of said flange contacting said ceramic disc to determine the spacing between said grid disc and said cathode emitter end.

9. The combination claimed in claim 8 in which the grid disc is of thinner metal than said tube and flange supporting it.

10. The combination claimed in claim 8 in which said last mentioned means makes only limited contact with the ceramic disc and remote from the cathode tube to eliminate leakage paths from cathode tube metal evaporated onto the ceramic when processing the cathode ray tube in which the electron gun is used.

11. An assembly unit for electron tubes of the type described, comprising a pair of nested electrodes, the inner electrode being cylindrical and having a closed end in close proximity to the corresponding end of the outer electrode, the outer electrode comprising two stepped cylinders the smaller of which carries said end having a small central opening coaxial with the longitudina axis of both electrodes, a rigid insulator disc bridged across the interior of the larger cylinder of the outer electrode, said inner electrode extending through said disc and being secured therein with said closed end at a predetermined spacing from the corresponding face of said disc, and means at the junction of the cylinders of the outer electrode at a predetermined distance from said end with the central opening to engage said face of said disc to determine said proximity.

12. The assembly unit of claim 10 in which said last mentioned means engages the disc remotely from the inner electrode and comprises the sole contact between the second electrode and the aforementioned face of the disc.

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