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2,496,825

UNITARY CERAMIC ELECTRON GUN

Filed April 10, 1947

2 Sheets-Sheet 1

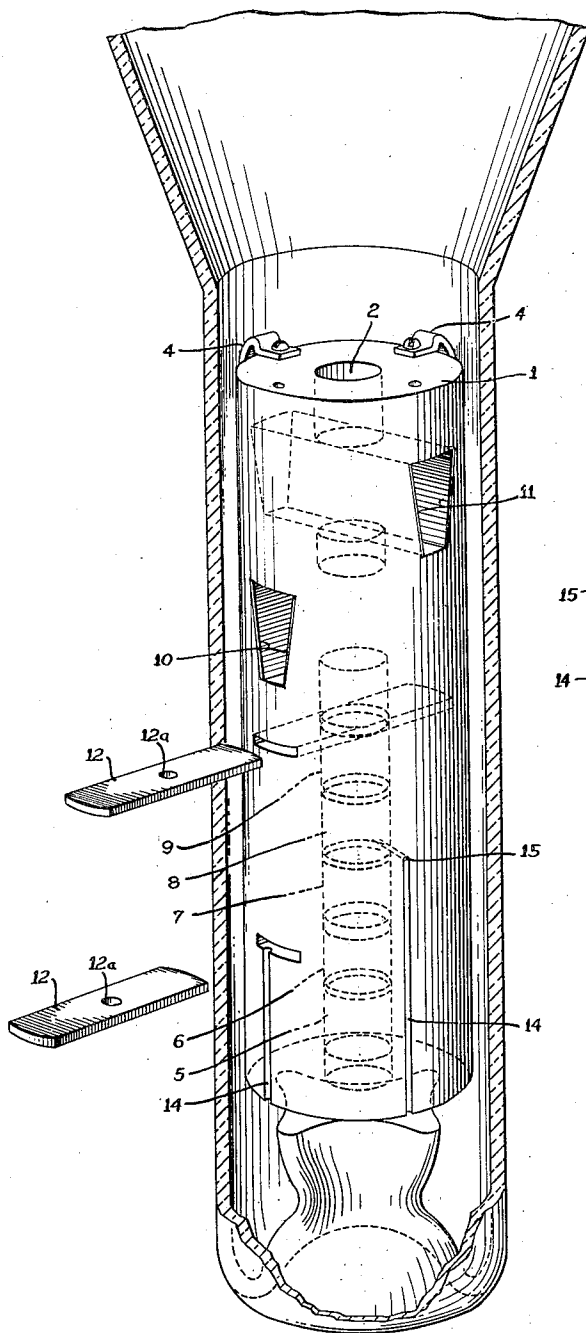


FIG. I.

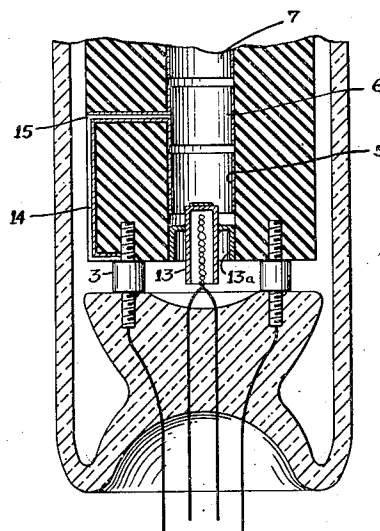


FIG. 1a.

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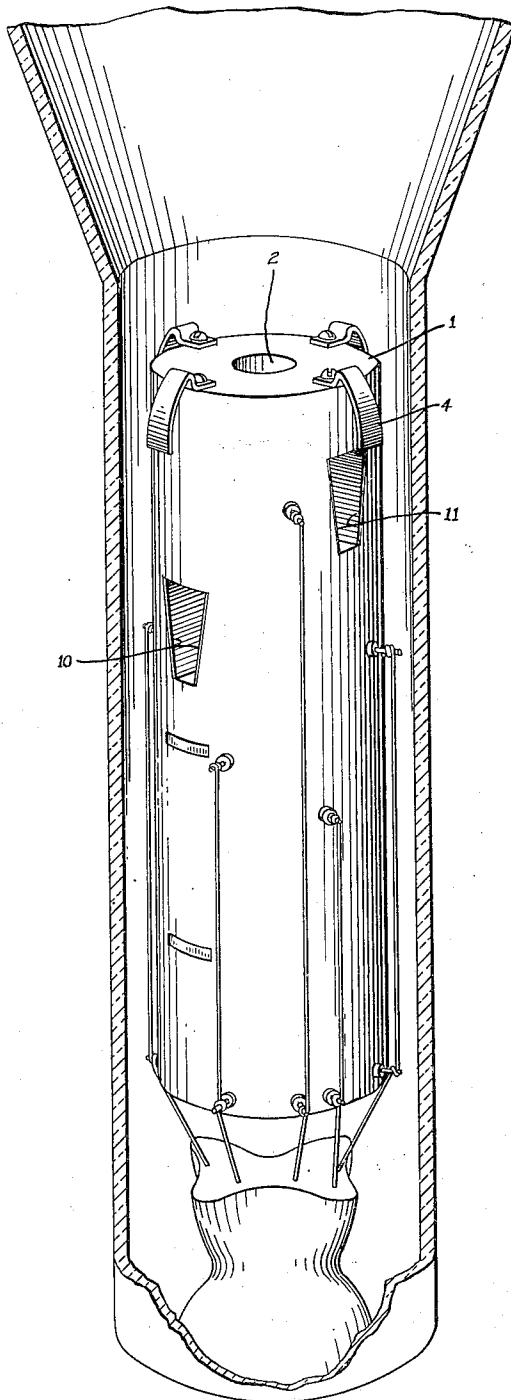
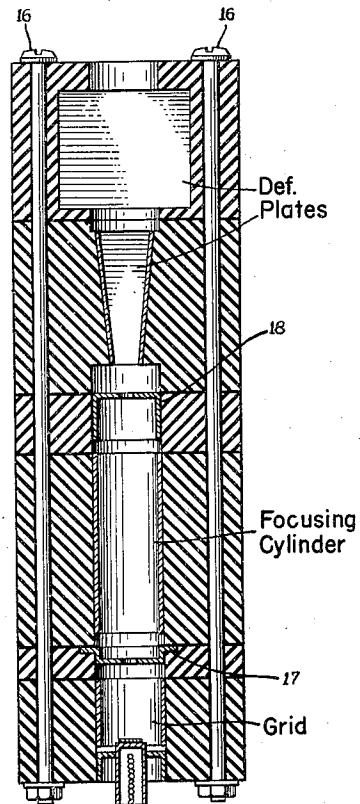
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UNITARY CERAMIC ELECTRON GUN

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1 Claim. (Cl. 250—27.5)

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This invention relates to cathode ray tubes, and more particularly to improvements in electron guns for cathode ray tubes.

The electron gun of a cathode ray tube comprises a plurality of electrodes and elements whose geometric shapes and spatial interrelationships are of critical importance. If certain electrodes are not exactly cylindrical in shape the scanning of the cathode ray beam (for example over an iconoscope, mosaic or a kinescope screen) will deviate from an ideal pattern and will produce intelligence distortions in the operation of the device. Moreover, even though the shapes and relative locations of the various electrodes may be accurate under static conditions, poor performance will result if the structure is flexible and therefore subject to vibration or other movement.

According to the prior art, it has been customary to construct the electron gun by assembling together a plurality of component parts, no one of which is as strong as the assembly. The parts include slender rods or sheets and/or some of them may be of relatively elastic metal.

Though a predetermined electrode, for example, a cylindrical anode, may be of correct shape before assembly, it may become distorted from welding it, or otherwise joining it, to one or more other parts of the gun. The accuracy with which the parts are spatially associated during assembly is not very great since this depends at least in part on the skill of the individual worker, and moreover even the completed assembly is subject to vibration and movement because of the elastic nature of its metal parts and/or because of the use of elongated rods and thin sheets.

It is an object of the present invention to improve the construction of an electron gun whereby the shape of its individual electrodes may easily be accurately controlled to conform to rigid standards.

It is a further object of this invention to improve the construction of an electron gun whereby it is a rigid assembly in which predetermined spatial relationships between various electrodes and parts are conveniently attained and closely maintained.

It is a still further object of this invention to devise a novel construction for an electron gun which makes possible economies in manufacture.

Generally the present invention consists of forming the electron gun with one main part made in sturdy proportions and of a rigid material such as a ceramic material. Electrodes, such as the well known coaxially aligned cylindrical

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anodes, are formed as conductive coatings applied to appropriate internal surfaces of the main part. Such internal surfaces may be accurately formed inside of a ceramic mass by molding in accordance with advanced techniques now employed in the ceramic art, or they may even be bored accurately into a less accurately cast ceramic body. Other electrodes which are not cylindrical are nevertheless similarly formed, that is by applying coatings to pre-formed internal surfaces of the ceramic gun body.

Certain uses of non-metallic structural materials in vacuum tubes are well known. For example, the support for an emissive cathode has been formed of carbon in preference to certain metals which exhibit a tendency to "poison" the emitter and/or to exude residual gas. Graphite anodes are useful for their ability both to withstand and to radiate large amounts of anode heat. And, of course, ceramic materials have been used for their insulating quality. However, herein a ceramic material is preferred for the main part of the electron gun because of its inherent rigidity and its adaptability to precise molding by inexpensive and known manufacturing processes. At the same time, its insulating property simplifies the problem of electrically isolating the various electrodes.

Other objects, features and advantages of this invention will be apparent to those skilled in the art from the following description of this invention, the appended claim and the accompanying drawings, in which

Fig. 1 shows a gun structure including electrodes to form a cathode ray and deflecting plates for sweeping it, and in which a novel means for connecting the elements of the gun to external circuits is provided;

Fig. 1a shows a method of supporting the electron gun in the glass envelope of the cathode ray tube;

Fig. 2 shows an alternate method of connecting the electrodes of the gun to external circuits through a press in the cathode ray tube; and

Fig. 3 shows another embodiment of this invention in which the main body portion of the gun is an assembly of several rigid ceramic portions rigidly associated together.

In Fig. 1, 1 is a ceramic body having a central opening 2 extending from one of its ends to the other along its axis. Though the exact outer conformation of body 1 is of secondary importance, it may be cylindrical as shown in Fig. 2. It is essential that it fit into the neck of the cathode ray tube and that it lend itself to con-

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venient and rugged mounting therein. In the embodiment of Fig. 1, body 1, as shown in Fig. 1a, is supported at one end on studs 3 which are fused into a press at the corresponding end of the tube neck. At the opposite end a number of springs 4 are joined to the body and have fingers which press outward against the inner wall of the tube neck to center the gun and maintain it rigidly therein.

In the embodiment shown, opening 2 has a uniform diameter over a substantial portion of its length. Obviously, however, it often will be desirable for the various anodes and other electrodes formed by layers on the inside of this opening to be of different sizes and, accordingly, the diameter of this opening will vary at different points along its length depending on the gun design.

Grid 5, second grid 6, accelerator 7, focusing anode 8, and second anode 9 are shown herein in Figs. 1 and 1a as examples of coaxial electrodes which, according to this invention, are formed by coatings on the inside surface of different portions of opening 2. These coatings need not be very thick to perform their required electrical functions. It is well known that electrodes employed in the gun of a cathode ray tube do not carry much current and that, therefore, they need not be of heavy metallic construction. Therefore, it is feasible to employ layers of such thinness that the precise structure of the ceramic cylinder 1 is negligibly affected by their addition. At the same time, there are many known processes according to any one of which makes it convenient to form these elements as thin layers.

Deflection plates, according to this invention, consist of conductive coatings applied to pairs of opposed flat surfaces, such as those shown at 10 and 11. Each pair of these surfaces may be formed by opposed sides of a transverse opening extending across body 1 and, if necessary to facilitate molding, passing completely through it. Obviously the molded internal contour of body 1 in one of its portions which forms a foundation for a pair of deflection plates is not curved cylindrically like most of opening 2. Instead it has the shape needed to form the particular kind of plate desired.

It is obvious that the portion of this gun structure which comprises the deflection plates may be dispensed with in cathode ray tubes employing magnetic deflection.

According to present practice, it is customary to employ membranes or partitions placed transversely to the gun axis and having limiting orifices to confine the beam and assist in focusing it. To provide such elements in the present electron gun, metal diaphragms may be added so as to intersect opening 2 at the correct positions. Diaphragms 12 which are of a convenient type are shown in Fig. 1. They are shown withdrawn from narrow transverse slots which pass through body 1 and are adapted to receive and support them. In constructing the gun, such a diaphragm may be inserted in such a slot and cemented in place with the hole 12a falling upon the axis opening 2.

In Fig. 1a there is shown a convenient way of installing a cathode in this gun. The exact structure of the cathode itself is not a part of this invention and may be of any suitable known kind. It may be convenient in some embodiments to support it independently of the gun directly in the press of the tube neck at a point

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opposite to the lower end of opening 2. However in the embodiment herein, as shown in Fig. 1a, the cathode thimble is welded (or otherwise fastened) through the center of a support-cup 13a which, in turn, is pressed into the end of opening 2 where, if desired, it may be cemented.

In the embodiment shown in Fig. 1, electrical connections to the various electrode films are made by forming grooves (for example grooves 14) which extend along the surface of cylinder 1 from its bottom end to several points on its outer surface which are opposite to the locations of the various electrodes inside, by forming a transverse hole (such as holes 15) at each such point to connect the groove to the portion of the inner surface of opening 2 which shapes the electrode and by coating the groove and the hole with suitable conductive material. The conductive material may terminate at a wire or terminal of any suitable nature at the bottom end of each groove in cylinder 1. All such wires (or wires from all such terminals as shown in Fig. 1a) may then be extended through the press at the end of the tube neck in the usual manner.

Each stud 3, as shown in Fig. 1a, has one of its ends fused into the glass press while its upper end is screwed into a hole in the bottom end of ceramic cylinder 1. A number of studs arranged in this way will provide, in combination with springs 4, a satisfactory support for the gun. At the same time, if a sufficient number of studs is used, each of the above-described grooves may terminate at one of them at the bottom end of the cylinder. If, then, wire leads, which extend part of the way into the press, connect individually with the bottom ends of the studs, it will be possible electrically to connect any of the gun electrodes to external circuits.

In Fig. 2, the cylinder, the electrodes, the deflecting plates and the supporting springs are substantially as shown in Fig. 1 and as described above. However, in this embodiment a number of studs similar to studs 3 are screwed into the holes in the ceramic cylinder at the points opposite to the location of the various electrodes and into other holes formed around its bottom edge. Wires may be connected between appropriate studs to serve as leads running along the cylinder from the various electrodes to studs in the circumferential row at the bottom of the cylinder. Wires from this row of studs may be brought through the press to do double service as leads and supports.

In Fig. 3 the gun is formed of a plurality of short cylindrical ceramic elements which are held rigidly together by long bolts 16 extending through all of them. This construction will simplify the molding of the body of the gun, particularly if various electrodes, such as the focusing anodes and accelerating anodes, are to be of different diameters. When the gun is formed according to Fig. 3, it will be convenient to use additional ways of constructing the diaphragms which have the beam limiting orifices (diaphragms 12 of Fig. 1). It will be convenient to form a diaphragm of ceramic material in one or more of the sections with or without applying a conductive coating to it. Alternatively, a metallic disc (with a limiting orifice) may be clamped between two ceramic sections as shown for accelerator 17, or as shown for second anode 18, a metallic cup (whose bottom comprises the diaphragm with a limiting orifice) may be pressed into a recess in one of the cylindrical elements. A diaphragm which is to be clamped between

two ceramic sections may be made of slightly larger diameter than the sections. In this way it will extend beyond the gun body and will lend itself for ready connection to leads.

Even in the embodiment of Fig. 3 extreme accuracy and rigidity is attained. The only thin elongated elements employed are bolts 16 and they fit tightly through holes in the ceramic elements (in which they may be cemented) and are drawn up to sufficient tension so that the assembly is a strong unitary structure.

For the purpose of the claims herein, the expression "unitary gun structure" is intended to describe either a structure-like body 1 which may be molded (or otherwise formed) as a single part, or a rigid body assembled of several parts (two or more) as shown in Fig. 3.

It is obvious that it is possible without departing from the scope of this invention, to form in this way as many or as few of the electrodes of an electron gun as may be desired or as may prove to be convenient for manufacture.

It is also obvious that in constructing an embodiment such as that of Fig. 3 any one of a number of means may be employed to fasten together the sections. For example they may be cemented or fused together, or they may be clamped together within a sturdy split sleeve adapted to be clamped tightly around the individual cylindrical parts and to relate them all to its own axis.

It is also obvious that the conductive electrodes may be formed on the surfaces inside of this gun in a variety of well known ways (such as sputtering on, evaporating on, plating on, spraying on, etc.) and that they may even consist of thin sheet metal pressed into the ceramic body or cemented therein. The latter construction possibly would be more expensive and probably would tend to result in more appreciable departures from the original internal dimensions of the pre-cast or pre-formed body portion. Therefore, for most purposes it will not be preferred.

It is obvious that electron guns constructed according to this invention may be employed in devices other than kinescopes and iconoscopes. In fact they may be used in any form of vacuum tube which requires means for producing and projecting a cathode ray. Of course the gun will be included within the evacuated envelope of such a tube.

It is also obvious that the outside shape of the unitary gun structure does not have to be geometrically cylindrical though that shape may be suitable for its installation in the cylindrical neck of an evacuated envelope. The important conformations are mostly internal. Therefore the term "cylindrical" as used in the claims is intended to be descriptive of an elongated body mass so shaped externally that it will fit

conveniently into the tube envelope and that it will contain an ample volume of material in which to form an axial opening which will permit the passage of electrons and will define surfaces forming foundations for the various electrodes.

It is within the scope of this invention to form the gun body of insulating materials other than ceramics. For example if the body were made of glass it would have both the necessary dielectric properties and the desired rigidity. Likewise a plastic material which will not exude gas under vacuum would have these desired characteristics.

What is claimed is:

In a vacuum tube, an evacuated envelope, an electron gun, comprising a unitary gun structure of rigid insulating material having an axial opening for passing an electron beam, a source of electrons near one end of said axial opening, at least one slot passing through said gun structure at right angles to said axial opening, at least one plate made of ceramic material being supported within the unitary gun structure by said slot and having a conductive coating applied to at least one surface and one side wall, said plate having a beam limiting orifice near to the axis of said axial opening to form a diaphragm, said axial opening having portions of its internal surface preformed with the shapes of the electrodes of the gun, a plurality of electrodes consisting of conductive layers applied to said portions, the electrodes being spatially related to one another in a predetermined manner, a plurality of transverse holes through said rigid body leading to said conductive layers and to said coating of said plate, a plurality of grooves extending along the surface of said rigid body from the bottom end thereof to said transverse holes, coatings of conductive material applied to the walls of said grooves and said holes, said coatings having a low resistance value and terminating at the bottom end of said grooves in terminals, connections between said terminals and wires extending through the envelope, and means for supporting the gun structure in the envelope.

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