June 5, 1962 R. J. NEY 3,038,094

RUGGEDIZED ELECTRIC DISCHARGE DEVICE STRUCTURE

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FIG. 1.

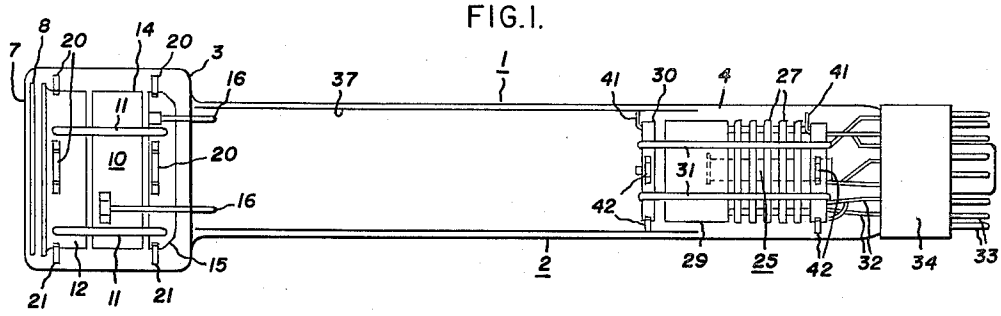


FIG. 2.

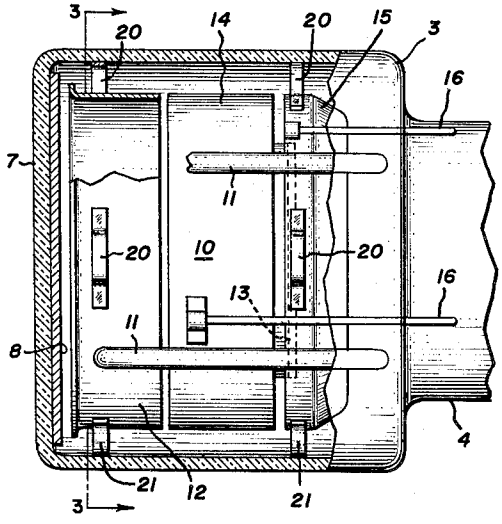
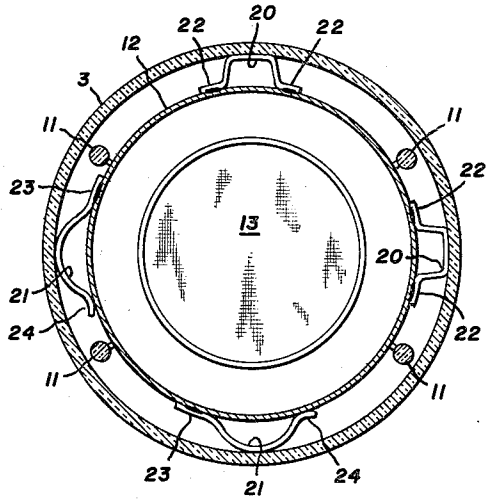


FIG. 3.



INVENTOR:
ROBERT J. NEY,
BY Philip J. Schlamp
HIS ATTORNEY.

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FIG.4.

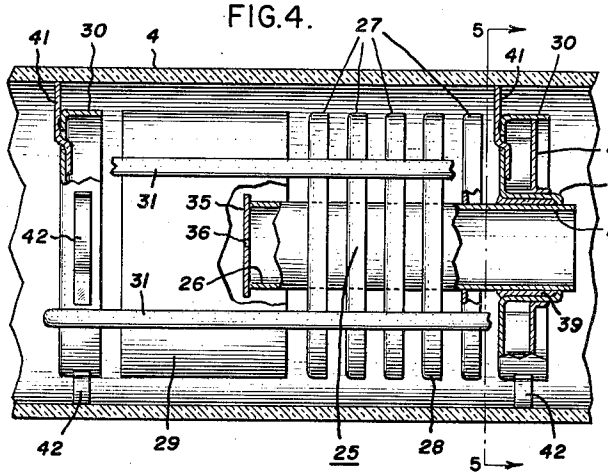


FIG.5.

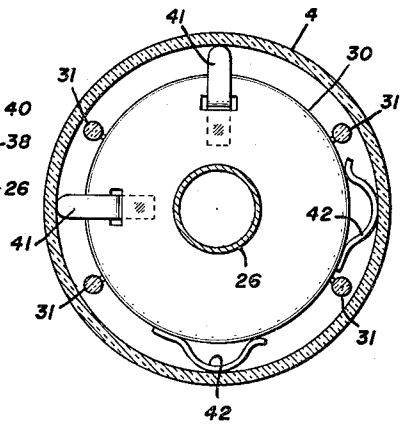


FIG.6.

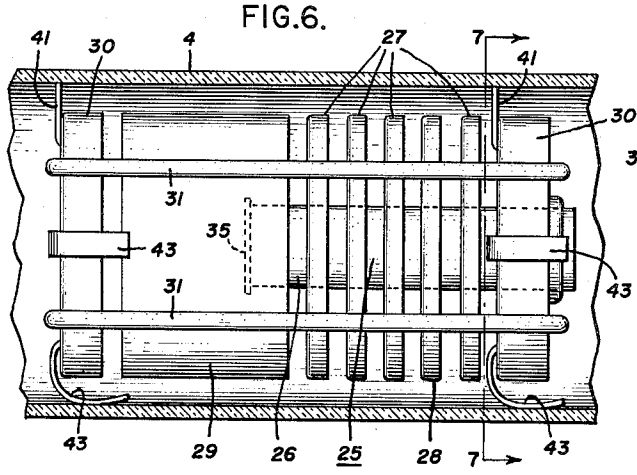
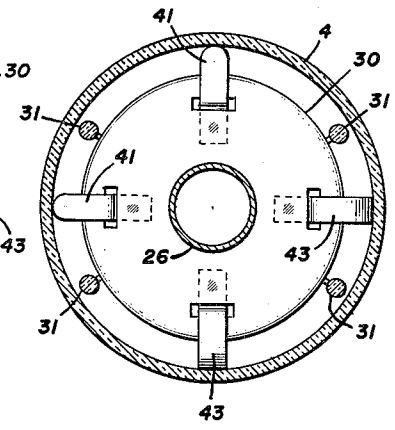


FIG.7.



INVENTOR:
ROBERT J. NEY,
BY Philip J. Schulman Jr
HIS ATTORNEY.

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3,038,094

RUGGEDIZED ELECTRIC DISCHARGE DEVICE STRUCTURE

Robert J. Ney, Schenectady, N.Y., assignor to General Electric Company, a corporation of New York

Filed Nov. 10, 1958, Ser. No. 772,980
9 Claims. (Cl. 313—67)

My invention relates to electric discharge devices and pertains more particularly to an improved television camera tube construction including improved means for rigidly mounting electrode assemblies therein.

When television camera tubes, such as those known as image orthicons, are employed, for example, in vibrating vehicles the vibration and resultant relative movement of electrode elements therein tend to affect adversely the picture quality. For example, in such tubes a photocathode is generally mounted on the internal surface of a faceplate comprising an end wall of the envelope and an electron gun mounted in the opposite end of the tube directs an impinging electron beam on a target electrode which is mounted in the envelope intermediate the gun and photocathode and adjacent the latter for cooperating electrically therewith. In this arrangement the electron gun includes a very small axially disposed aperture for defining the beam and any substantially excursion of the gun aperture from the axis of the envelope, due to vibration of the gun, or movement of the target electrode, due to vibration of the assembly in which it is mounted, results in relative movements between these elements and between these elements and the photocathode mounted on the envelope. Such relative movements tend to introduce microphonic interference or subtract from picture quality. Further, electrical connections are generally made to the various electrodes in the tube through conductive leads extending through and sealed in the wall of the tube envelope and substantial vibratory movement of the electrodes tends to fatigue and fracture the leads.

Heretofore, electrode vibration in camera tubes has been damped by use of a plurality of compressed cantilever snubbers or spring clips spaced circumferentially completely about the electrode assemblies and yieldably engaging the inner walls of the tube envelope. This type of damping means has proved adequate, for example, in studio television camera use where vibration is relatively slight. However, such mounting means have not proved adequate where the cameras are used in moving vehicles or other equipment subject to high vibration. Under operating conditions of the latter type and with tubes employing the mentioned prior art damping means, all of the above-discussed adverse effects are generally encountered.

Accordingly, a primary object of my invention is to provide a new and improved television camera tube construction including new and improved means for minimizing microphonic interference under highly vibratory conditions of operation.

Another object of my invention is to provide a new and improved means for increasing the natural frequency of electrode assemblies in electric discharge devices for thus minimizing vibratory movements of such assemblies.

Another object of my invention is to provide a new and improved means for mounting electrode assemblies in television camera tubes more rigidly in respect to the tube envelopes.

Another object of my invention is to provide new and improved means for more effectively maintaining an electron beam source coaxially aligned in an electric discharge device envelope.

Another object of my invention is to provide new and improved means for decreasing relative movements between an electron gun and target electrode assemblies

mounted in the envelope of a tube and between these assemblies and a photocathode mounted on a wall portion of a tube envelope containing these assemblies.

Another object of my invention is to provide new and improved means for minimizing failure of tube components resulting from fatigue due to excessive vibratory movements of elements mounted in the tube.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In carrying out the objects of my invention I provide an electric discharge device of the camera tube type including an insulative envelope having a photocathode on an end wall and containing an electron gun-dynode assembly in the opposite end of the envelope and an interpositioned image section assembly including a target electrode. The electrode assemblies are each mounted rigidly in the envelope by radially extending high spring constant elements which rigidly engage the wall of the envelope on one side of the assemblies and radially extending elements of lower spring constants which are under compression and yieldably engage the envelope wall on the sides opposite the rigid elements. In the electron gun-dynode assembly, support rings carry the radially extending elements and a low-mass support arrangement in one ring provides a single-end support for the gun of the assembly.

For a better understanding of my invention reference may be had to the accompanying drawing in which:

FIGURE 1 is a somewhat schematic side elevational view of a television camera tube of the image orthicon type in which my invention is incorporated;

FIGURE 2 is an enlarged fragmentary partially sectionalized view of the image section of the device of FIGURE 1 wherein is illustrated one form of my improved mounting means;

FIGURE 3 is a sectional view taken along the line 3—3 in FIGURE 2;

FIGURE 4 is an enlarged fragmentary partially sectionalized view of the multiplier section of the device of FIGURE 1 illustrating certain features of my invention in greater detail;

FIGURE 5 is a sectional view taken along the line 5—5 in FIGURE 4;

FIGURE 6 is an enlarged fragmentary partially sectionalized view of a modified form of my invention; and

FIGURE 7 is a sectional view taken along the line 7—7 in FIGURE 6.

Referring to FIGURE 1, there is shown therein my invention incorporated in a camera tube of the image orthicon type and generally designated **1**. The tube **1** comprises an insulative, and preferably glass, envelope **2** including an enlarged head portion **3** and an elongated neck portion **4**. The head portion houses the image section of the device while the neck portion houses both the multiplier and beam forming sections, all of which will be described in greater detail hereinafter.

As perhaps better seen in FIGURE 2, the head portion **3** of the envelope includes a transparent faceplate **7** on the inner surface of which is provided a suitable photocathode **8** which is included in the image section. Additionally, the image section includes a plurality of cylindrical grid electrodes. These electrodes are mounted together coaxially and to comprise a unitary assembly **10** by being each suitably secured to a plurality of circumferentially spaced insulative rods or stalks **11**. The assembly **10** thus provided includes an accelerating grid **12** for controlling the velocity of electrons moving away from the photocathode and toward a target electrode assembly **13** mounted in a support ring **14**. The target

electrode included in this assembly can be of the type disclosed and claimed in U.S. patent application Serial No. 737,348 of Herbert J. Hannam filed May 23, 1958, and assigned to the same assignee as the present invention. The remaining electrode of the assembly **10** is a decelerator grid **15** for controlling the impinging force of electrons striking the target from an electron beam source located in the neck portion of the envelope. Extending through the back portion of the head **3** and sealed therein are a plurality of conductive leads **16** which make electrical connections to the various electrodes included in the image section **10**.

Provided for holding the assembly **10** rigidly in place in the envelope head is one form of my invention. This form is perhaps best seen in FIGURE 3 wherein each of the electrodes **12** and **15** is provided with a pair of bumper extensions or elements **20** spaced approximately 90 degrees apart and a pair of elliptical spring clips **21** with each of the spring clips **21** approximately diametrically oppoiste one of the bumper elements **20**.

The bumper elements **20** each comprise a generally U-shaped or bail-like structure each end of which includes a foot portion **22** secured, as by spot welding, to its associated electrode. The bowed or bight portions of the elements **20** rigidly engage the inner surface of the envelope wall. Additionally, the elements **20** are constructed to be rigid or, that is, to have a high spring constant which is preferably in the order of the spring constant of the glass envelope wall which it engages.

The spring clips **21** are also generally U-shaped or bail-like and each has a foot portion **23** secured, as by spot welding also, to the associated electrode, and a bowed or bight portion in compression and yieldably engaging the wall of the envelope. The clips **21** each extend partially about the circumference of its associated electrode with the free end comprising a foot portion **24** in sliding engagement with the outer surface of the electrode. The spring clips **21** have a substantially lower spring constant relative to those of the elements **20** and the envelope wall. I have found Inconel X and tungsten suitable materials from which to form the spring clips **21**. These materials are high yield strength materials at elevated temperatures and thus provide desired spring characteristics even after bakeout of the tube. The manner in which the just-described arrangement including opposed envelope engaging elements of different spring constants is effective for minimizing electrode vibrations will be described hereinafter in detail in a joint consideration of this arrangement and a modified form employable with an electron gun-dynode assembly **25** in the multiplier section of the tube.

As perhaps better seen in FIGURE 4, the electron gun-dynode assembly **25** comprises an electron beam source in the form of an electron gun **26**, a plurality of dynode elements **27**, an anode **28** mounted between the last and the penultimate dynode, a multiplier focusing grid **29** and a pair of cup-shaped assembly supporting rings **30**, with each of the latter mounted at an end of the assembly. These elements are all coaxially arranged and suitably mounted in insulated longitudinally spaced relation by being suitably secured to a plurality of circumferentially spaced insulative rods or stalks **31**. A plurality of leads **32** are sealed through the end of the tube envelope with the inner ends connected, as by welding, to electrode elements in the assembly **25** and the outer ends suitably connected to separate prongs **33** carried in an insulative base **34**.

The electron gun **26** comprises a tubular element containing an emitter (not shown) and carrying at one end a disk **35** including an aperture **36** aligned coaxially in the envelope. The end of the gun **26** opposite the disk **35** is fitted in an elongated cylindrical collar **37** formed centrally on the rear support ring **30**. A space between the collar **38** and the gun is filled with a quantity of solder material **39**. A ring **40** is fitted in the support ring **30** with the outer edge secured to the cylindrical wall or rim of the ring **30** and the inner edge secured to the collar **38**. This arrangement provides a low-mass rigid mount for the gun **26**.

The disk aperture **36** of the gun is approximately 1/500 of an inch in diameter and directs a thin beam of electrons toward the target electrode. Focusing of the beam is effected by a cylindrical grid comprising a coating of conductive material **37** on the inner wall of the scanning section **3** of the tube neck, and by an axial magnetic field supplied by magnetic means not shown; and the focused beam is effective for producing a spot size of approximately 1 to 2 mils on the target electrode. In operation, suitable deflection means (also not shown) are provided to scan the target with the beam and the beam surrenders electrons to the target electrode in accordance with charges on incremental portions thereof determined by the photocathode; and the remaining electrons of the beam are returned to the gun to provide an electron-deficiency signal. However, the returning electrons do not follow the same path as those approaching the target due to slight field distortions. As a result, the returning electrons normally do not re-enter the aperture **36**. Instead, these electrons land on the disk **35**, which serves as the first dynode, and cause secondary electrons to be ejected from the disk. The other dynodes are electron-permeable and the secondary electrons ejected from the disk **35** cascade through the succeeding dynodes, thus to effect a plurality of stages of electron multiplication before leaving the tube via the anode **28** and as an amplified video signal.

It will be seen from the foregoing that the photocathode, by being mounted directly on the inner surface of the faceplate **7**, is rigidly mounted in the envelope and that any lateral movement of the electron gun relative to the envelope will move the aperture **36** out of alignment with the tube axis and thus distort the beam direction, and move the point of origin of the beam relative to the photocathode, causing microphonic interference tending adversely to affect the picture quality. The extent of such interference possible in prior art devices will be better understood from the fact that in such prior art devices and under conditions of 10 g.'s of acceleration the aperture **36** can move in the order of 60 mils out of alignment. This will result in a 60 mil line impinging on the target rather than the desired 1 to 2 mil spot. Such a condition results in smearing of the image or a considerable drop in resolution. Additionally, excessive relative movement of the electrode assemblies tends to fatigue and fracture the leads **16** and **32** extending through the envelope wall and connected to the assemblies.

My improved structure is adapted for minimizing vibratory movement of the elements comprising the electron gun-dynode assembly and to accomplish this the latter assembly is constructed to include a pair of relatively rigid snubber bars or extensions **40** secured to each of the support rings **30**. The bars **41** of each pair are circumferentially spaced approximately 90 degrees apart and extend radially straight and perpendicularly engage the wall of the envelope neck. Also secured to each support ring **30** are a pair of elliptical spring clips **42** which can be identical in material, structure and function to those designated **21** of the image section assembly and shown in FIGURES 1–3. The spring clips **41** are each located diametrically opposite one of the bars **40** and include elongated bent portions which extend tangentially of the envelope and which are compressed and yieldably engage the wall of the envelope neck. In this arrangement the bars **41**, like the bumper elements **20** of the image section electrode assembly, have high spring constants and the spring clips **42**, like the spring clips **21**, in the previously described section, have substantially lower spring constants. Additionally, the spring clips **42** are provided with an initial compression or, in other words, are compressed by insertion of the assembly in the tube envelope.

The bars 41 provide substantially high rigidity. However, if desired, bumper elements of the type designated 20 in FIGURES 1–3 can be substituted therefor.

Illustrated in FIGURES 6 and 7 is a modified form of my arrangement for rigidly mounting an electron gun-dynode assembly which can be identical to that of FIGURES 4 and 5 except for the type of spring clips employed. In the presently considered structure the spring clips 42 are cantilever and comprise elongated bent portions which extend longitudinally in the envelope and are compressed for yieldably engaging the wall of the envelope neck. The material of the cantilever spring clips 43 can be the same as that of the previously described elliptical spring clips.

In my improved structure the elements 20 and 41 preferably are constructed to have spring constants comparable to that of the glass envelope wall and the support rings 30 and essentially govern the natural frequency of the system. In fact, up to a certain value of dynamic loading which can be designed to be above that to be experienced by the tube under the worst vibratory conditions contemplated, the elements 20 and 41 act as if they were integral parts of the envelope. For example, I have with my structure been able to increase the natural frequency of the elements approximately 10 to 15 times higher than the highest impressed frequency for thereby minimizing undesirable electrode deflection. Thus, my improved arrangement serves effectively to hold the electrode assemblies 10 and 25 in as rigidly fixed positions in the envelope as would support structure sealed into the glass wall of the envelope. It does not, however, involve the shortcomings of sealed-in support structures such, for example, as difficulties resulting from differences in thermal expansion between materials, the making of glass-to-metal seals about the supports, and the generally substantial difficulties encountered in sealing structures in a fixed position in a glass envelope. Instead, my improved structure affords relatively simple assembly involving merely insertion of the electrodes in the envelope. The high spring constant straight extensions 20 and 41 rigidly abut the glass wall of the envelope, and the yieldable spring clips 21, 42, and 43 hold these extensions 20 and 41 in rigid abutment with the glass wall while serving also to accommodate differences in expansion between the glass and metal parts of the electrode assemblies. Thus, my structure is effective for rigidly mounting electrode assemblies in a tube envelope and, in camera tubes, is effective for maintaining the electron gun-dynode assembly so positioned as to minimize to a negligible amount any excursion of the gun aperture 36 which would adversely affect picture quality due to microphonic interferences. Also, it is effective for minimizing microphonic interferences due to vibratory movements of the electrode assemblies, including the radial motion of the target electrode, in the image section of the tube.

In making comparison tests between my structure and image orthicon camera tubes employing prior mounting means, and specifically spring clips located at 90 degree intervals completely about the electron gun structure, I have submitted both types of structure to impressed maximum accelerations of 10 g's. The prior art structure was found to have 2 major resonant frequencies, in the range of 5 to 500 cycles per second (c.p.s.). The resonant condition occurred at 140 to 200 c.p.s. and 310 to 340 c.p.s., respectively, with the result that the double amplitude of the gun aperture at resonance were 35 to 58 mils and 25 to 32 mils, respectively. As pointed out above, such excursions of the gun aperture generally result in comparable excursions of the beam on the target electrode and, inasmuch as the spot size to be scanned on the target electrode is in the order of only 1 to 2 mils, the gun aperture excursions result in substantial smearing of the picture or a substantial drop in image resolution. It will be seen that any substantial lateral movement of the target electrode relative to the beam would have the same undesirable effect.

In contrast, my improved electrode mounting structure maintains the various electrode assemblies each substantially rigid relative to the envelope and, thus, to each other. In testing tubes including electrodes mounted according to my invention and in subjecting such tubes to the same vibratory conditions as the above-discussed prior art structure, I observed a marked absence of resonant frequencies over the specified range of 5 to 500 c.p.s. and the maximum deflection observed was only about 2 mils. Thus, my structure has been found particularly effective for avoiding picture smearing or poor image resolution due to microphonic interference or undesirable effects due to the relative movement of the electrodes in the device. The reduced movement of the electrode assemblies is also effective for minimizing fatiguing of the conductive leads extending through the envelope and, thus, is effective for prolonging the lives thereof.

It will be understood from the foregoing that while I have shown my invention applied to a camera tube it is equally applicable to any tube construction wherein it is desirable to mount rigidly electrode means in an envelope construction. Additionally, it is to be understood from the foregoing that in some applications the different types of extensions 20 and 41 can be interchangeably or alternatively employed as can the different types of spring clips 21, 42 and 43. I have found, however, that the elliptical type of spring elements are particularly adaptable in devices which are ordinarily subjected to elevated temperatures in processing. This type of element does not have to be stressed near its elastic limit, as do some cantilever springs, to be effective. Thus, when heated, as during bakeout, the elliptical springs do not tend to yield plasticly or to lose any appreciable portion of their spring constant.

While I have shown and described specific embodiments of my invention I do not desire my invention to be limited to the particular forms shown and described, and I intend by the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric discharge device comprising an envelope, an electrode assembly contained generally coaxially in said envelope, and means for rigidly mounting said assembly in said envelope including a first pair of circumferentially spaced rigid bail-like elements each extending in a direction transverse the axis of said envelope and having both ends thereof secured to said electrode assembly, said first pair of bail-like elements having a spring constant comparable to that of said envelope and rigidly engaging the wall of said envelope, and a second pair of bail-like elements each diametrically disposed relative to one of said first pair of elements and each extending in a direction transverse the axis of said envelope and having one end secured to said electrode assembly with the other slideably engaging same, said second pair of elements being under compression and having a substantially lower spring constant than said first pair of elements and yieldably engaging said envelope wall for maintaining said first pair of elements in said engagement with the wall of said envelope.

2. An electric discharge device comprising an envelope, an electrode assembly contained generally coaxially in said envelope, and means for rigidly mounting said assembly in said envelope including a pair of circumferentially spaced rigid bail-like elements each extending radially from said electrode assembly, said bail-like elements having bight portions conforming to and making substantial surface contact with the inner surface of said envelope, having a spring constant comparable to that of said envelope and rigidly engaging the wall of said envelope, and a pair of elliptical spring elements each diametrically disposed relative to one of said bail-like elements and each

extending in a direction transverse the axis of said envelope and having one end secured to said electrode assembly with the other slideably engaging same, said spring elements being under compression and having a lower spring constant than said bail-like elements and yieldably engaging said envelope wall.

3. An electric discharge device comprising an envelope, an electrode assembly contained generally coaxially in said envelope, and means for rigidly mounting said assembly in said envelope including a pair of circumferentially spaced rigid rod-like elements extending radially from said electrode assembly, said rod-like elements having a spring constant comparable to that of said envelope and having the ends thereof abutting the wall of said envelope, and a pair of cantilever spring elements each having an end secured to said electrode assembly diametrically opposite one end of said rod-like elements and extending coextensively with the axis of said electrode assembly, said spring elements being compressed and having a lower spring constant than said rod-like elements and yieldably engaging said envelope wall.

4. An electric discharge device comprising an elongated envelope, an electrode assembly including an electron gun having an aperture at one end thereof and coaxial with the longitudinal axis of said envelope and a coaxial gun support ring having said gun rigidly mounted centrally therein and extending transversely in said envelope, and a pair of rod-like elements spaced approximately 90 degrees apart and secured to and extending radially from said ring, said rod-like elements being rigid and having the ends thereof abutting the wall of said envelope, and a pair of spring elements each diametrically opposite one of said rod-like elements and having a spring constant lower than that of said rod-like elements, said spring elements being compressed and yieldably engaging said envelope wall for maintaining said rod-like elements in abutting relation with the opposite wall of said envelope, whereby excursion of said gun aperture out of said coaxial position under vibratory conditions is minimized.

5. A device according to claim 4, wherein said support ring includes a concentric outer rim and a central collar, said gun includes a tubular member positioned in and bonded to said collar, and a ring is secured in said support ring between said rim and collar for thereby providing a low-mass rigid mount for said gun.

6. A television camera tube comprising an elongated envelope, a unitary electrode assembly in said envelope including a plurality of coaxial longitudinally spaced electrodes and a centrally extending electron gun having a coaxially disposed electron aperture, said assembly being supported between a pair of longitudinally spaced coaxial support rings extending transversely in said envelope, a plurality of conductive leads extending through a base portion of said envelope and connected to said electrodes and gun, a pair of circumferentially spaced rigid radial extensions on each of said support rings engaging the wall of said envelope, and another pair of extensions on the diametrically opposite side of each of said rings, said last-mentioned extensions having a substantially lower spring constant relative to the other extensions and yieldably engaging the wall of said envelope, whereby excursions of said gun aperture out of said coaxial position and stresses on said leads under vibratory conditions of said tube are minimized.

7. A television camera tube comprising an elongated envelope, a unitary electrode assembly in said envelope including a plurality of coaxial longitudinally spaced tubular grids and a transverse target electrode, a pair of circumferentially spaced rigid radial extensions on each of said grids engaging the wall of said envelope, a plurality of leads extending through the wall of said envelope and making electrical connections to said assembly, and another pair of extensions on the diametrically opposite side of each of said grids, said last-mentioned extensions having a substantially lower spring constant relative to the other extensions and yieldably engaging the wall of said envelope for maintaining said first-mentioned radial extensions in engagement with the wall of said envelope, whereby movements of said assembly relative to said envelope and stresses in said leads under vibratory conditions of said tube are minimized.

8. An image orthicon comprising an elongated envelope including an elongated neck portion and an enlarged head portion, a photocathode mounted on the transverse end wall of said head portion, a unitary electrode assembly contained in said neck portion and including a plurality of coaxially longitudinally spaced dynodes and a centrally extending electron gun having a coaxially disposed electron aperture, said assembly being supported between a pair of longitudinally spaced coaxial support rings extending transversely in said envelope, a plurality of conductive leads sealed in the end of said neck portion of said envelope and connected to said dynodes and gun, a unitary image assembly contained in said head portion of said envelope and including a pair of coaxial longitudinally spaced tubular grids, a transverse target electrode interposed between said photocathode and gun and a plurality of leads sealed in said envelope head portion and connected to said image assembly, a pair of rigid extensions spaced approximately 90 degrees apart and secured to and extending radially from each of said support rings and said tubular grids, said extensions having a spring constant comparable to that of said envelope wall and abutting said wall, and a pair of radial extensions diametrically opposite each of said first-mentioned pairs of extensions having a spring constant lower than that of said first-mentioned extensions, said last-mentioned extensions being normally under compression and yieldably engaging the wall of said envelope, whereby movements of said assemblies out of said coaxial positions and stresses in said leads under vibratory conditions of said tube are minimized.

9. An electric discharge device comprising an envelope, an electrode assembly contained in said envelope, and means for mounting said assembly in said envelope in a manner to afford an extremely high resonant frequency under vibratory conditions of said device including a plurality of circumferentially spaced radial extensions on said assembly, the extensions on one side of said assembly constituting a pair of rigid members each having a substantial surface portion conforming to and abutting the inner surface of the wall of said envelope, said last-mentioned extensions being of predetermined lengths for accurately positioning said assembly relative to said envelope, and the extensions on the opposite side constituting a pair of springs under compression and engaging said envelope wall for maintaining said rigid extensions in said abutment with said envelope wall under vibratory conditions.

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