Dec. 20, 1960 B. R. CORSON 2,965,792

ELECTRON DISCHARGE DEVICE

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Fig. 2.

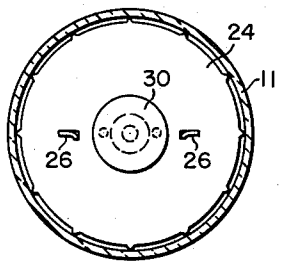


Fig. 1.

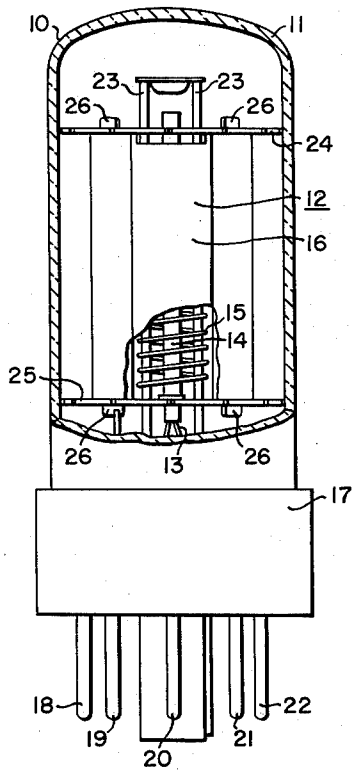


Fig. 3.

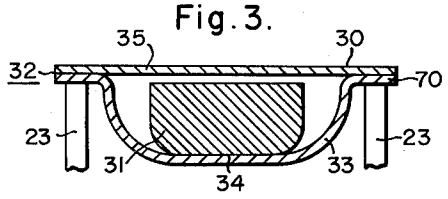


Fig. 4.

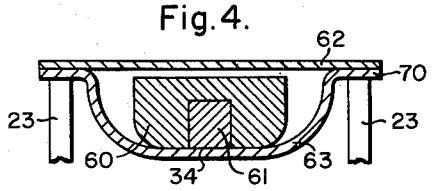


Fig. 5.

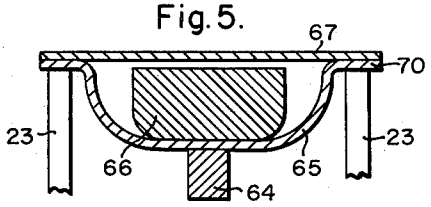


Fig. 6.

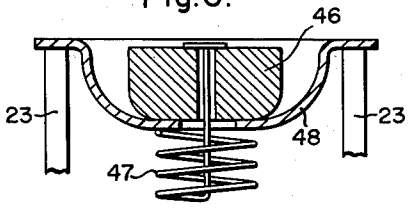
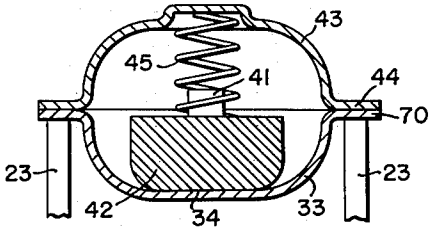


Fig. 7.



WITNESSES

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Fig. 9.

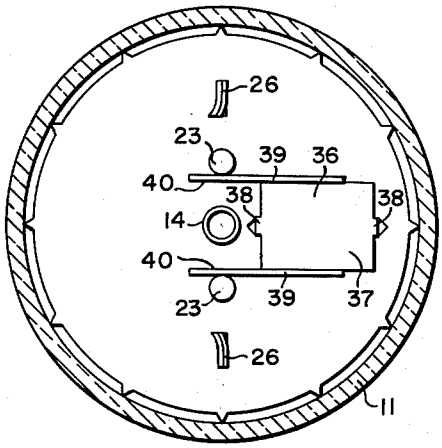


Fig. 10.

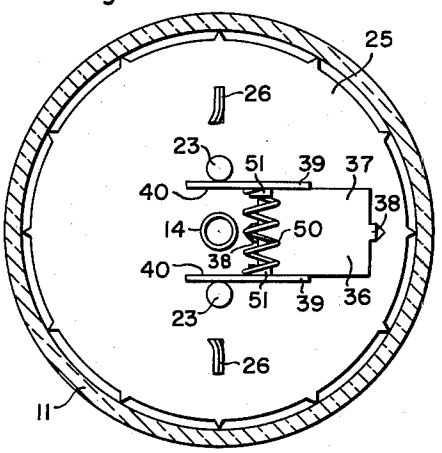


Fig. 8.

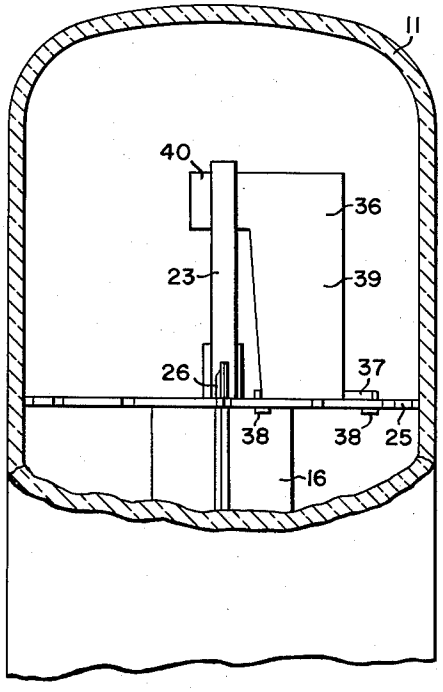
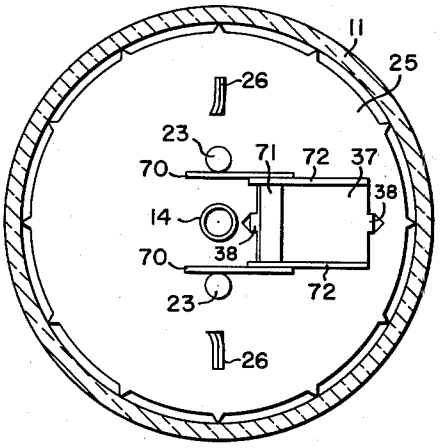


Fig. 11.



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2,965,792

ELECTRON DISCHARGE DEVICE

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Filed Jan. 29, 1959, Ser. No. 789,881

4 Claims. (Cl. 313—269)

This invention relates to electron discharge tubes and more particularly to vibration damping means for the electrodes thereof.

Microphonism in a radio tube is the generation of an undesired electrical output as a result of an externally applied mechanical excitation. The electric output is generated by motion of the electrodes with respect to each other. In general, this motion will depend on the nature of the electrodes, the nature of the mechanical excitation, and the means for supporting the electrodes within an electrode assembly.

One type of motion is the flexural deflection of the electrodes. This invention is concerned with those electrodes which exhibit relatively lightly damped periodic flexural deflections of relatively long duration and is particularly concerned with a means for shortening the ringing time of such electrodes. For example, virtually all tubes using grids will exhibit as one of the components of microphonism a damped oscillation of a relatively high frequency, say in excess of 1000 cycles, due to the flexural deflection of the grid.

A conventional grid comprises support members upon which is supported a thin wire or mesh grid. When the support members or side rods of such electrodes are supported top and bottom by insulating spacers, a vibration "node" exists at each of the spacers and a vibration "loop" occurs midway between these spacers when the side rods are vibrating in the fundamental mode. It is necessary to mount the vibration absorber on a part of the element to be damped that is in motion; it must be mounted at a "loop" rather than at a "node." The space between the insulating spacers contains all the active elements of the tube, so it would be difficult to mount vibration absorbers for individual electrodes there.

It has been found that the free ends of the side rods which project beyond the insulating supports are in motion when the electrode is vibrating. The amplitude of vibration for a given distance from the node is greater toward the free end than toward the other node, and the free ends of the side rods are always "loops" regardless of the mode of vibration, whereas various points at or near the central loop of the fundamental mode becomes nodes when the electrode is vibrating in some modes other than the fundamental mode.

It is therefore an object of this invention to provide an improved vibration damping means for the electrodes in an electron tube.

It is another object of this invention to provide a vibration damping means that is connected to the free ends of electrode support members.

It is a further object of this invention to provide an improved frictional vibration damping means.

It is an additional object of this invention to provide a frictional energy consuming device that is fastened to the free ends of electrode support members.

These and other objects of this invention will be apparent from the following description, taken in accordance with the accompanying drawing, throughout which

like reference characters indicate like parts, which drawing forms a part of this application and in which:

Fig. 1 shows an electron tube embodying this invention with the envelope and a portion of the anode cut away;

Fig. 2 shows a top view of the tube shown in Figure 1 with the top of the envelope removed;

Fig. 3 is a cross-sectional view of the vibration damping means of the tube shown in Fig. 1;

Fig. 4 is a cross-sectional view of a vibration damper utilizing a permanent magnet;

Fig. 5 is a cross-sectional view of another embodiment of a vibration damper utilizing a permanent magnet;

Fig. 6 is a cross-sectional view of a vibration damper suitable for use in the tube shown in Fig. 1 which utilizes a biasing spring;

Fig. 7 is another embodiment of a vibration damper which utilizes a biasing spring;

Fig. 8 shows an expanded view of another vibration damping means suitable for use in the tube shown in Fig. 1;

Fig. 9 shows a top view of the vibration damping means shown in Fig. 8 with the top of the envelope removed;

Fig. 10 shows a top view of a vibration damper which utilizes a spring;

Fig. 11 shows a top view of a vibration damper which utilizes a permanent magnet.

Figure 1 shows a triode tube **10** which comprises an evacuated generally elongated tubular envelope **11** of suitable material such as glass, which encloses an electrode assembly generally designated **12**. The electrode assembly **12** comprises a plurality of electrodes **13**, **14**, **15** and **16** which are connected by leads extending through an electrically insulated terminal end wall portion of envelope **11** to suitable external contact pins **18**, **19**, **20**, **21**, **22** extending through the base **17** to provide external circuit connections.

The electrode assembly comprises a heater **13**, a cathode **14**, a control grid **15**, and an anode **16**, all extending longitudinally generally parallel to a common axis of the electrode assembly. In the tube shown, the cathode comprises an elongated tubular conductive member having an electron emissive coating on its outer surface which emits electrons when the heater **13** is heated to an elevated temperature. The heater comprises a conductive member of high electrical resistance which is installed inside the cathode.

The control grid **15** is made of very fine metal wire, for example, nickel wire about 2.5 mils in diameter which is wound as a helix on and secured to two inner side rods or grid posts **23**. The anode **16** comprises an elongated tubular member made of a conductive material and is arranged to receive the electrons emitted by the cathode as is well known in the art.

The grid posts **23** as well as the cathode **14**, and anode **16**, are held in their operative position in the electrode assembly by two similar generally flat insulating spacer elements **24** and **25**, made of a material having a high dielectric constant. The two spacers **24** and **25** are provided with apertures or openings to engage the supporting ends of the grid posts and of the other electrodes. The anode **16** has four spaced ears or tongues **26**, which interlockingly engage apertures in the two spacer members **24** and **25** so as to secure the two spacer members **24** and **25** to the upper and lower ends of the anode **16** and join the electrodes into a self-supporting assembly.

A frictional vibration damping means is attached to the free ends of the grid side rods **23** which extend above the top insulating spacer member **25**. According to one phase of the invention, the vibration damping means **30**, as shown more clearly in Fig. 3, com-

prises a seismic mass 31 in dry frictional sliding contact with a container 32. When the container 32 is fastened to a vibrating object the seismic mass tends to retain its position. The container rubs against the mass, draws energy from the vibrating object and dissipates this energy in the mass-container contact area as heat.

In the embodiment shown, the container comprises a cup-shaped portion 33 which has a substantially flat bottom planar portion 34 and a curved portion connecting the bottom portion 34 to a flange portion 70. The flange portion 70 is provided substantially parallel to the bottom portion that is suitable for mounting the container on the ends of the grid side rods 23. The container may be attached to the side rods by any suitable method, for example, by welding; and, in the embodiment shown, the container is attached so that the plane of the bottom portion 34 is at substantially a right angle to the longitudinal axis of the tube. The container may be made from any material that is suitable for use in a high vacuum tube and that can be suitably formed to the desired contour, for example, nickel or ceramic. The mass 31 comprises a substantially cylindrical member in which one end has a beveled or curved edge. The mass is positioned within the cup-shaped portion 33 so that the flat end surface having the curved edge is adjacent the bottom portion 34. After the mass 31 has been positioned within the cup-shaped portion 33 the container 32 is completed by attaching a cover 35 to close the top end of the container and thereby captivating the mass 31 within the container. If desired, the container may be made by embossing the cup-shaped portion from sheet metal, steel, for example, and providing integral flaps that are bent over to captivate the mass within the cup-shaped portion of the container.

In the embodiment of the invention shown in Figs. 8 and 9, a frictional vibration damping means 36 is attached to the top insulating spacer member 25 by any suitable means and frictionally engages the free ends of the grid side rods 23. The vibration damping means 36 comprises a flat rectangular base portion 37 having two lugs or tabs 38 provided on opposite sides that are bent at an angle to the base portion 37. Damping arms 39 are attached at substantially right angles to the base 37 on the sides of the base 37 not having tabs 38. The damping arms 39 are substantially flat planar members having flat extended portions 40 on the end not attached to the base.

The vibration damping means can be punched from a flat sheet and the tabs and damping arms bent to shape. In the embodiment shown, the vibration damping means is attached to the top insulating spacer member 25 by inserting the taps 38 through apertures in the spacer member 25 and bending the tabs so that the base portion 37 is fastened adjacent to the spacer member. The base 37 is positioned so that flat extensions 40 of the damping arms 39 frictionally engage the free ends of the grid side rods 23 and thereby damp the mechanical vibrations therein.

In certain cases, especially where there is a size limitation on the members, the coefficient of friction between the vibration damping members utilizing only the force of gravity on the mass is insufficient to provide adequate vibration damping. Figs. 6 and 7 show an embodiment in which the friction between the members is increased by the addition of a spring biasing means. The spring biasing means may be added inside the container as shown in Fig. 7 or outside the container as shown in Fig. 6.

In the embodiment shown in Fig. 7, the spring biasing means comprises a helical coiled spring member 45 one end of which is positioned over a raised cylindrical portion 41 on the mass 42. The spring is held in compression by a cover 43 which has a dome-shaped recess to receive the other end of the spring 45. The coefficient of friction between the mass 42 and the bottom surface 34 of the container 44 can be controlled by varying the compressive force exerted on the spring 45. The vibration absorbing means may be as shown in Fig. 6 in which the spring biasing means is mounted outside the container. In this embodiment, the mass 46 and the cup-shaped portion of the container 48, each have a central aperture. The biasing spring 47 comprises a helical spring member which has a free end that re-enters the body of the spring 47 along the axis. The free end is passed through the apertures in the container 48 and mass 46 and then fastened after the desired spring tension has been attained. No cover is required for the container 48 in this embodiment.

As shown in Fig. 10, a spring biasing means 50 is attached to the vibration absorber 36 to increase the coefficient of friction between the ends 40 of the damping arms 39 and the free ends of the grid side rods 23. The members are the same as in Figs. 8 and 9 except that a positioning means 51 is provided to hold the spring 50 in place. In the embodiment shown, the positioning means 51 is an embossment.

Another method for increasing the coefficient of friction between the components of the vibration absorbing means is by the use of a permanent magnet. One manner in which this can be done is by the use of a vibration absorbing means similar to that shown in Fig. 3, with the exception that, in this embodiment, the mass must be a permanent magnet, the cup-shaped member must be made of a "soft" ferromagnetic material, and the cover is made of a non-magnetic material.

In the embodiment shown in Fig. 4, the mass 60 has an insert 61 of material that has been magnetiztd. In this embodiment the container 63 is made of a ferromagnetic material and the cover 62 is made of a non-magnetic material. In the embodiment shown in Fig. 5, the permanent magnet 64 is fixed outside the cup-shaped member 65 which is made of a non-magnetic material and the slug 66 is made of a ferromagnetic material.

The vibration damper shown in Fig. 4 may be advantageously used where space is limited. The vibration damper shown in Fig. 5 provides a great advantage due to the fact that a wide range of vibration damping may be achieved merely by changing the strength of the magnet 64. This can be easily accomplished since the magnet 64 is located outside the container.

Fig. 11 shows another embodiment in which a permanent magnet 71 is used as a means of increasing the coefficient of friction between the vibration absorbing members. In this embodiment planar ferromagnetic contact members 70 are attached to the side rods 23 at an appreciable distance above the top insulative spacer member by welding for example. The vibration absorbing means that is attached to the top insulative spacer member 25 is similar to the one described in connection with Figs. 8 and 9. The damping arms 72 extend adjacent to the planar contact member 70 and are pulled into the desired frictional contact with the damping arms 72 by a magnet fastened between the damping arms 72.

When proper potentials are applied to the electrodes, the tube operates according to conventional theory. It can be readily seen that the tube described has superior performance since one whole source of microphonism has been eliminated, namely, the microphonism due to the flexural deflection of the electrodes. To accomplish this result, a vibration damping means has been added to the free ends of the electrode support members, since a "loop" in the vibrating system always occurs at the free end. The frictional vibration damping means comprises one stationary member which is in frictional contact with a member in the vibrating system. The stationary member tends to remain at rest and the frictional contact with the member of the vibratory system results in energy being taken from the vibratory system and dissipated as heat at the frictional contact point.

While the present invention has been shown in a few

forms only, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications without departing from the spirit and scope thereof.

I claim as my invention:

1. An electron discharge tube comprising an envelope having an electrode assembly therein, said electrode assembly comprising a plurality of electrodes, one of said electrodes including an elongated support member, vibration damping means attached to one end of said elongated support member, said vibration damping means comprising a damping mass held in frictional contact with a container.

2. An electron discharge tube comprising an envelope having an electrode assembly therein, said electrode assembly comprising a plurality of electrodes, one of said electrodes including an elongated support member, a plurality of insulating spacer members provided to position said elongated support member within the electrode assembly, vibration damping means attached to said support member between one of said spacer members and the end of said support member, said vibration damping means comprising a damping mass held in frictional contact with a container.

3. An electron discharge tube comprising an envelope having an electrode assembly therein, said electrode assembly comprising a plurality of electrodes, one of said electrodes including an elongated support member, vibration damping means attached to one end of said elongated support member, said vibration damping means comprising a damping mass held in frictional contact within a container and spring biasing means associated with said mass for varying the friction between said mass and said container.

4. An electron discharge tube comprising an envelope having an electrode assembly therein, said electrode assembly comprising a plurality of electrodes, one of said electrodes including an elongated support member, vibration damping means attached to one of said elongated support members, said vibration damping means comprising a damping mass held in frictional contact with a container and magnetic means associated with said damping mass for varying the friction between said mass and said container.

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