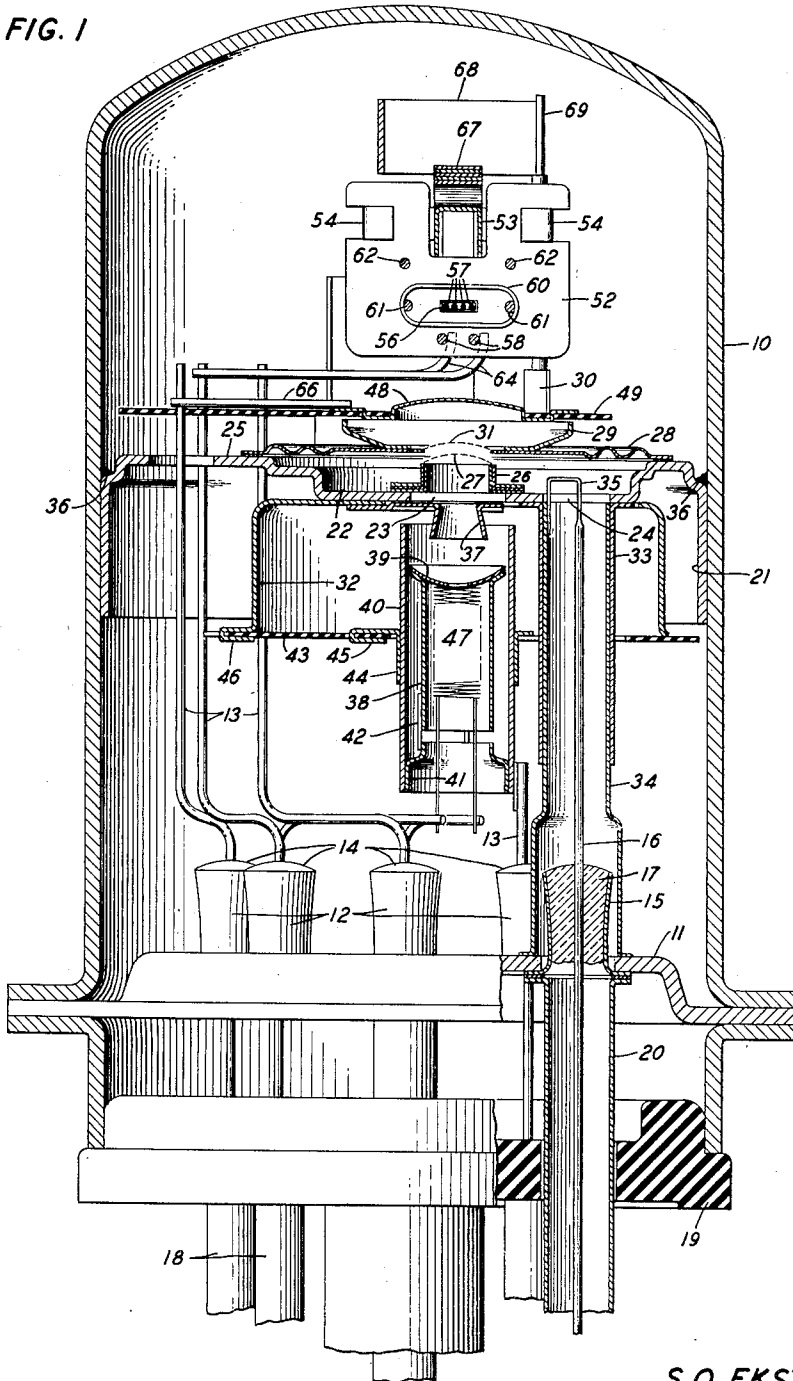


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FIG. 1



BY

Halter C. Kiesel

ATTORNEY

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ELECTRON DISCHARGE DEVICE INCLUDING
TUNABLE CAVITY RESONATOR

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FIG. 2

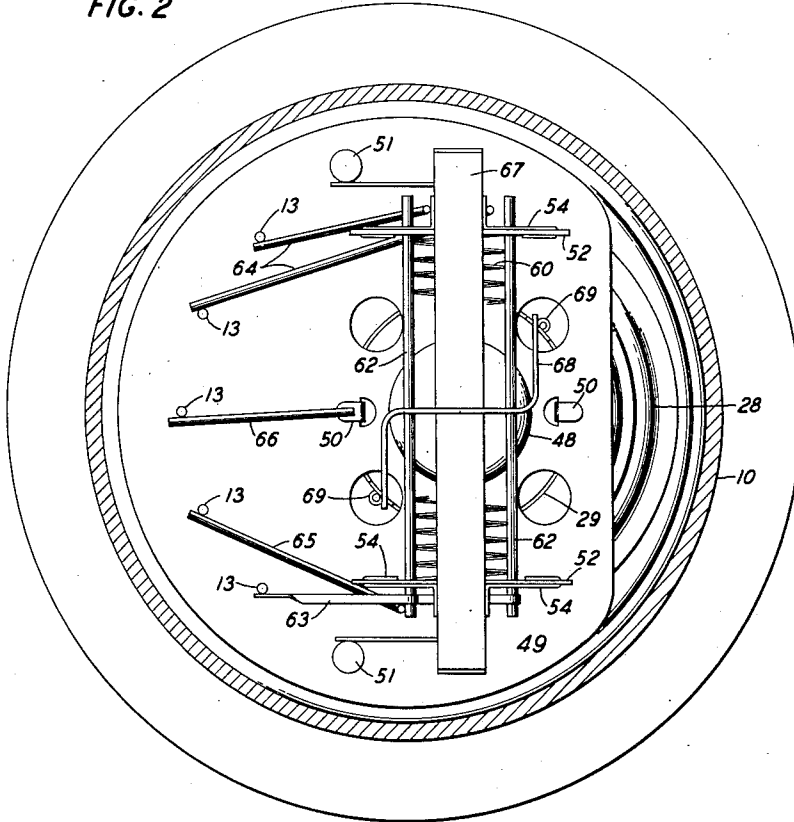
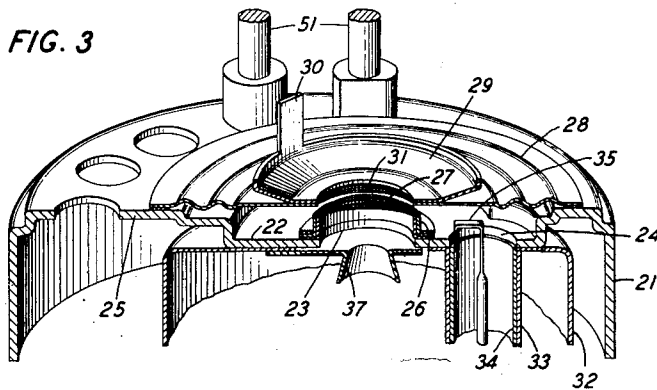


FIG. 3



INVENTORS: S. O. EKSTRAND
E. J. WALSH

BY

Walter C. Kiesel

ATTORNEY

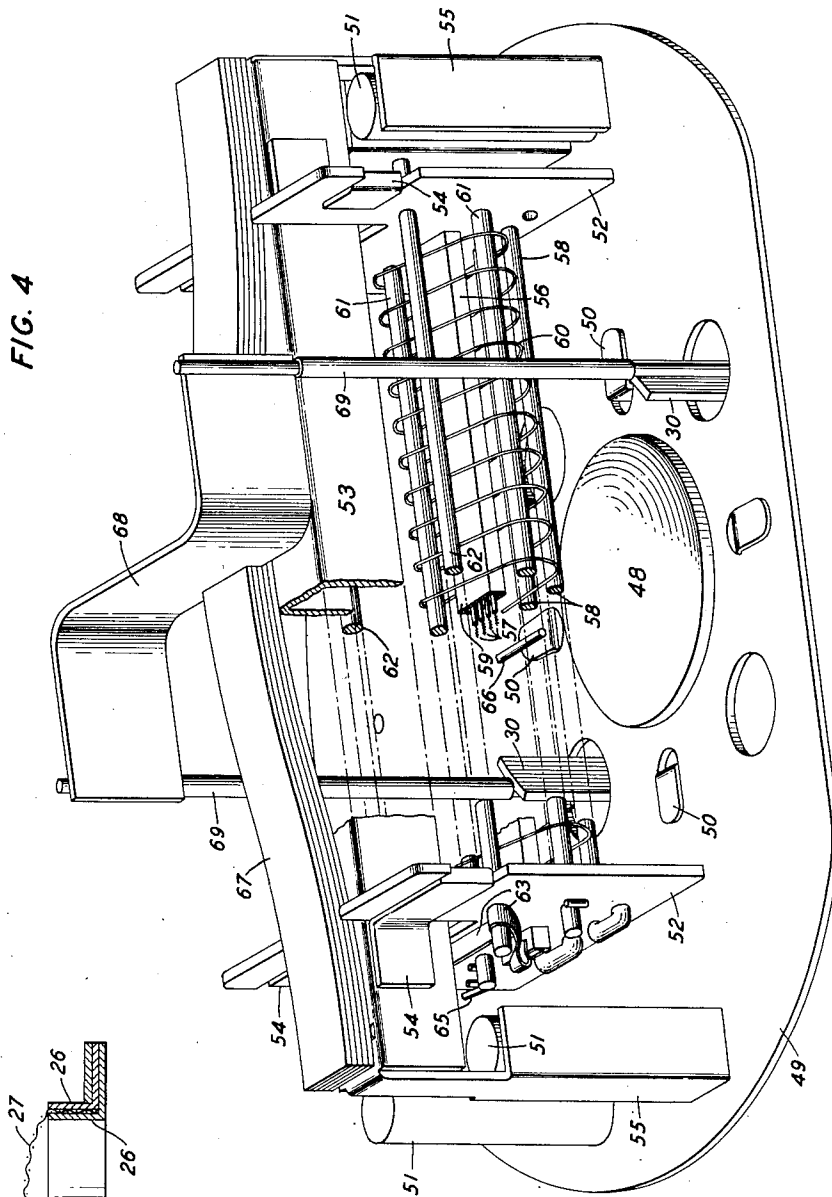
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INVENTORS: S. O. EKSTRAND
E. J. WALSH

BY

Walter C. Kiesel

ATTORNEY

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ELECTRON DISCHARGE DEVICE, INCLUDING
TUNABLE CAVITY RESONATOR

Sture O. Ekstrand, Bergenfield, and Edward J. Walsh, Tenafly, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application February 1, 1945, Serial No. 575,584

7 Claims. (Cl. 315-5)

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This invention relates to electron discharge devices and more particularly to such devices of the type disclosed in the applications Serial No. 575,587, filed February 1, 1945, of John R. Pierce, and Serial No. 575,585, filed February 1, 1945, of William G. Shepherd, including internal cavity resonators and thermal tuners therefor.

One general object of this invention is to improve the construction of electron discharge devices of the type above noted.

Another object of this invention is to facilitate the fabrication of such devices.

A further object of this invention is to realize accurate, uniform and predictable tuning of internal cavity resonators in electron discharge devices.

In one illustrative embodiment of this invention, an electron discharge device comprises an enclosing vessel having therein a cavity resonator, electrodes cooperatively associated with the resonator to constitute a reflex oscillator therewith, and a controllable thermally responsive element for tuning the cavity resonator. The tuning element comprises an electronic system, for example a triode, the expansion and contraction of the anode of which, due to temperature variations, is utilized to effect controlled alteration of the configuration of the resonator, thereby to adjust the natural frequency of the resonator to a desired value or to maintain it substantially constant at a preassigned value.

In accordance with one feature of this invention, the resonator and the tuner element are fabricated as individual unitary assemblies and the tuner assembly is supported as a unit from the resonator assembly.

In accordance with another feature of this invention, the resonator and tuner assemblies together with an electron gun and a repeller electrode are constructed as a unitary mount wherein, during the fabrication of the device, the resonator assembly and the tuner element are supported from a base member principally by an output conductor system, for example a guide or coaxial line, for the resonator.

In accordance with a further feature of this invention, the resonator assembly is provided with a peripheral cylindrical flange adapted to fit slidably within a cylindrical wall portion, for example of metal, of the enclosing vessel. The flange may be secured to this wall portion when the mount above noted is inserted into the vessel whereby, in the completed device, the resonator and the tuner element carried thereby are supported firmly and fixedly within the vessel by the

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flange. Further, the flange, being in intimate contact with the vessel wall assures substantial heat radiation from the resonator and thereby prevents deleterious heating of the resonator during the operation of the device.

In accordance with still another feature of this invention, the resonator is provided with a flexible wall portion and the actuating element of the tuner is coupled to this wall portion in such manner that expansion and contraction of the anode of the electronic system of the tuner results in piston-like motion of the flexible wall portion, whereby an accurate and constant relationship between anode elongation and contraction and displacement of the flexible wall portion is realized.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is an elevational view mainly in section of an electron discharge device illustrative of one embodiment of this invention;

Fig. 2 is a plan view of the device illustrated in Fig. 1 with the top end of the enclosing vessel removed;

Fig. 3 is a perspective view in section showing details of the cavity resonator assembly included in the device illustrated in Fig. 1;

Fig. 4 is a perspective view of the thermionic tuner assembly included in the device illustrated in Fig. 1, portions of this assembly being broken away to show details thereof more clearly; and

Fig. 5 is a detail view in section of one of the grid assemblies of the device.

Referring now to the drawing, the electron discharge device therein illustrated comprises a highly evacuated enclosing vessel including a metallic, flanged cylindrical portion 13, the flange on which is sealed to a metallic base 11, as by welding or brazing. The base 11 has joined thereto a plurality of eyelets 12 to which a plurality of leading-in conductors 13 are sealed hermetically by vitreous beads 14, and has joined thereto also an eyelet 15 to which a conductor 16 is sealed hermetically by a vitreous bead 17. The conductors 13 are connected to terminal pins 18 carried by an insulating disc 19 mounted from the base 11; the conductor 16 constitutes a part of a coaxial line, the outer conductor 20 of which is defined in part by an elongated cylinder depending from the base 11.

Mounted within the enclosing vessel 10, 11 are a cavity resonator assembly, an electron gun and

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a thermionic tuner assembly. The resonator assembly, the construction of which is illustrated in detail in Fig. 3, comprises a metallic member having a cylindrical flange 21, adapted to fit slidably within the cylindrical portion 18 of the enclosing vessel and joined thereto by brazing material 36, the metallic member having also a dished portion 22 eccentric with respect to the flange 21 provided with a central aperture 23 and another aperture 24, and an intermediate portion 25. Mounted by the dished portion 22 and coaxial with the aperture 23 therein is a grid assembly, shown clearly in Fig. 5, comprising a pair of telescoped eyelets 26 between which the edge portion of a dished or concavo-convex grid 27 is clamped and secured as by brazing or welding.

Secured to the intermediate portion 25, as by welding, is a concentrically corrugated, centrally apertured, metallic diaphragm 28, which may also be radially slotted, which mounts a dished driving or coupling member 29 having thereon a number of tabs 30. The aperture in the diaphragm 28 is coaxial with the aperture 23 and has extending thereacross a concavo-convex grid 31.

The dished portion 22, diaphragm 28 and outer eyelet 26 bound a substantially toroidal cavity having therein a gap bounded by the grids 27 and 31. Because of the construction of the grid assembly 26, 27, it will be appreciated that the surfaces of this assembly forming portions of the boundary walls of the cavity are accurately controllable and fixed so that the cavity constants and, hence, the cavity frequency conform accurately to prescribed values. The resonant frequency of this cavity is dependent upon the position of the diaphragm 28 and is adjustable by flexing the diaphragm in the manner described hereinafter.

Supported from the dished portion 22 is a metallic cup-shaped member 32 having thereon a cylindrical sleeve 33 in which a metallic conductor 34 is telescopically fitted, the latter being supported from the base 11 and coaxial with the conductor 16. The inner end of the conductor 16 is reversely bent as shown at 35 and affixed to the sleeve 34 to define a coupling loop between the resonant cavity and the coaxial line 16, 20, 34. Also supported from the dished portion 22 and in axial alignment with the grids 27 and 31 is a frusto-conical member 37 which constitutes the end or nose electrode of an electron gun.

The electron gun includes a cathode member 38 having a concave electron emissive surface 39 coaxial with the electrode 37, and a cylindrical beam forming electrode 40 coaxial with the emissive surface and mechanically coupled to the cathode member 38 by a ring 41 and a plurality of wires or strips 42, only one of which is shown. The unit comprising the cathode member and beam forming electrode is supported from an insulating disc 43 by a flanged collar 44 locked to the disc by tabs 45, the disc being supported, in turn, by the member 32 to which it is locked by tabs 46. A heater filament 47 is disposed within the cathode member 38 and is supported, by extensions thereof, from two of the leading-in conductors 13. The emissive surface 39 and electrodes 37 and 40 are constructed and arranged, in ways known in the art, so that electrons emanating from the emissive surface are concentrated into a converging beam substantially focussed upon the gap between the grids 27 and 31.

Opposite the grid 31 and axially aligned there-

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with is a cup-shaped repeller electrode 48 which is affixed to an insulating plate 49 by locking tabs 50, the plate 49 being supported from the intermediate portion 25 and in preassigned space relation to the grid 31 by a plurality of studs 51, for example four, secured to the portion 25. The insulating plate 49 and the studs 51 mount also a thermionic tuner assembly, shown in detail in Fig. 4.

This assembly comprises a pair of parallel insulating plates 52 seated upon the plate 49 and held in spaced relation by a channeled anode 53 to which they are locked by metallic strips 54. The anode 53 is provided with extensions 55 which are affixed, as by welding, to respective studs 51. Supported by the insulating plates 52 in alignment with the anode 53 is a hollow flattened cathode member 56 enclosing a heater element 57, for example a W-shaped filament coated with insulating material, the ends of the filament being connected to wires or rods 58 which extend between the plates 52 and are connected to certain of the lead-in wires 13. The surfaces 59 of the cathode member toward the anode 53 has thereon a coating of electron emissive material.

The cathode is encompassed by a flattened helical grid 60 carried by a pair of wires or posts 61 which extend between the plates 52 and are suitably fixed therein. Between the grid and anode are a pair of rods or wires 62 which are tied electrically to the cathode 56 by a strip 63 and constitute a focussing or suppressor electrode.

The anode 53 is connected electrically to the cavity resonator by way of the studs 51 and the cathode 56 and electrodes 62 are connected in common to one of the leading-in conductors 13 by the strip 63 as illustrated in Fig. 2. As shown clearly in this figure, the rods or wires 58, to which the ends of the heater 57 are connected as noted heretofore, are connected to respective conductors 13 by the wires 64 and the grid 60 is connected to another of the conductors 13 by a tie wire 65. The repeller electrode 48 is associated electrically with another conductor 13 by a tie wire 66 affixed to one of the tabs 50.

Associated with the anode 53 is a laminated bow member 67 the ends of which are affixed as by welding, to the anode at points in alignment with the studs 51 to which the anode extensions 55 are secured. The bow member 67 has welded thereto a rigid cross-piece 68 which mounts a pair of rigid parallel rods 69 fixed thereto and to the tabs 30 in the drawing member 29.

The anode 53 and bow member 67 are constructed of materials having widely different temperature coefficients of expansion and contraction. In one illustrative construction, the anode may be of a material, such as stainless steel, having a high temperature coefficient and the bow member may be of a material, such as an alloy of iron, cobalt and nickel known as "Kovar," having a low temperature coefficient. As is apparent, longitudinal expansion and contraction of the anode, which action may be relatively free due to the flexibility of the unfixed portion of the extensions 55, results in bowing of the member 67 to a lesser or greater extent, whereby the cross-piece 68 is moved in the direction at right angles to the longitudinal axis of the anode. Motion of the cross-piece 68 is communicated to the driver member 29 by the rods 69 and thence to the diaphragm 28. Flexure of the latter results in alteration of the dimensions of the resonant

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cavity, and consequently, in the resonant frequency of the cavity.

The length of the anode at any time is determined by the anode temperature and this in turn is determined by the bombardment thereof by electrons from the cathode 56. The anode current is controlled by the potential of the grid 60. Thus, by controlling this potential, the resonant frequency of the cavity resonator may be adjusted or maintained substantially fixed at a prescribed value despite variations in the configuration of the cavity due to temperature effects.

It will be appreciated that because of the amplification of motion realized from the anode and bow member combination, sensitive control of the resonant frequency of the cavity is attained. Further, because motion of the rods 69 is essentially linear, and, therefore, piston-like motion of the diaphragm 28 obtains, accurate relationship between potential of the control grid 60 and resonant frequency is achieved.

It will be appreciated further that the tuner and resonator may be fabricated readily as individual assemblies which may then be associated by affixing the anode extensions 55 to the respective studs 51 and securing the rods 69 to the cross-piece 68 and tabs 30. When the assemblies have been associated and before the rods 69 are affixed to the cross-piece 68, the diaphragm 28 is flexed by adjustment of the position of the rods, as by a differential screw in a suitable fixture, to tune the cavity resonator to a preassigned frequency. The rods are then secured to the cross-piece while held in the adjusted position. Thus, the diaphragm is fixed initially, accurately at such position that during operation of the device it can be flexed to vary the natural frequency of the cavity over a desired prescribed range. The resulting assembly, supported from the base 11 by the conductors 13 and 34, principally by the latter, is inserted into the vessel portion 10, the flange 21 fitting slidably within this portion as noted heretofore, and carrying thereon a ring of brazing material. The flange on the portion 10 is then sealed to the base 11 and heat is applied to braze the flange 21 to the vessel wall. Thus, in the completed device the electron gun, resonator and tuner are securely mounted by the flange 21 and the latter, being in intimate engagement with the vessel wall, facilitates radiation of heat from the resonator and prevents excessive heating thereof.

Although a specific embodiment of this invention has been shown and described, it will be understood that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising a cavity resonator having a diaphragm portion, means included with the device for exciting said resonator, an insulating plate overlying said diaphragm portion, means mounting said plate from said resonator, an electrode system supported on said plate and including a thermally sensitive anode extending substantially parallel to said diaphragm portion, and coupling means between said anode and said diaphragm portion for displacing said portion proportionately to changes in the length of said anode with temperature variations.

2. An electron discharge device comprising a cavity resonator having a flexible wall portion, means included with the device for exciting said resonator, and a unitary tuner element supported

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by said resonator, said element comprising an elongated electrode having a high temperature coefficient of expansion and contraction and extending substantially parallel to said flexible wall portion, a bow member having a low temperature coefficient of expansion and contraction, extending substantially parallel to said electrode, a cross-piece mounted on said bow member, coupling links connecting said cross-piece to said flexible wall portion and means for controlling the temperature of said electrode.

3. An electron discharge device comprising a cavity resonator having a diaphragm portion, a driving member coupled to said portion, means included with the device for exciting said resonator, an insulating plate supported from said resonator and overlying said diaphragm portion, an electrode system mounted from and overlying said plate and including a cathode and an elongated anode extending substantially parallel to said diaphragm portion, said anode having a high temperature coefficient of expansion and contraction, a bow member having a low temperature coefficient of expansion and contraction and having its ends affixed to said anode adjacent the ends thereof, and means comprising a pair of parallel, rigid rods extending substantially normal to said diaphragm portion, coupling said bow member to said driving member.

4. An electron discharge device comprising a rigid metallic disc having a circular recessed portion, means including a diaphragm overlying said recessed portion defining a cavity resonator therewith, means included with the device for exciting said resonator, a plurality of rigid studs carried by said disc, an insulating plate mounted on said studs and overlying said diaphragm, an elongated anode substantially parallel to said diaphragm, overlying said plate and having its ends flexibly connected to two of said studs, a cathode opposite said anode, insulating spacer means seated on said plate and positioning said cathode relative to said anode, said anode having a high temperature coefficient of expansion and contraction, a bowed strip member overlying said anode and having its ends affixed thereto, said strip member having a low temperature coefficient of expansion and contraction, a rigid member extending transversely with respect to said strip member and fixed to the central portion thereof, a pair of parallel rods depending from said rigid member and substantially normal to said diaphragm, and a driving member connected to said diaphragm and said rods.

5. An electron discharge device comprising a base, a cavity resonator having a pair of juxtaposed apertured walls, a rigid coupling line supporting said resonator from said base, an insulating plate opposite one of said walls, means supporting said plate from said resonator, an electron gun mounted by said plate, a second insulating plate opposite the other of said walls and supported by said resonator, a repeller electrode supported by said second insulating plate, and a thermionic tuner for said resonator mounted on said second plate.

6. An electron discharge device comprising an enclosing vessel having a cylindrical metallic portion and a unitary mount positioned in said cylindrical portion, said mount comprising a metallic disc having a cylindrical flange adapted to fit slidably within said cylindrical portion, said disc having also a recessed portion, means including a metallic member overlying said recessed portion defining a cavity resonator therewith and elec-

trode means for exciting said resonator supported therefrom.

7. An electron discharge device comprising an enclosing vessel having a cylindrical metallic portion and a unitary mount positioned in said cylindrical portion, said mount comprising a metallic disc having a cylindrical flange adapted to fit slidably within said cylindrical portion, metallic members cooperating with said disc defining a cavity resonator therewith, a pair of insulating members on opposite sides of said resonator and supported therefrom, an electron gun supported by one of said insulating members and thermionic tuner means for said resonator mounted on the other of said insulating members.

STURE O. EKSTRAND.
EDWARD J. WALSH.

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