April 5, 1949. W. D. STRATTON 2,466,062

ELECTRON DISCHARGE DEVICE

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FIG. 1

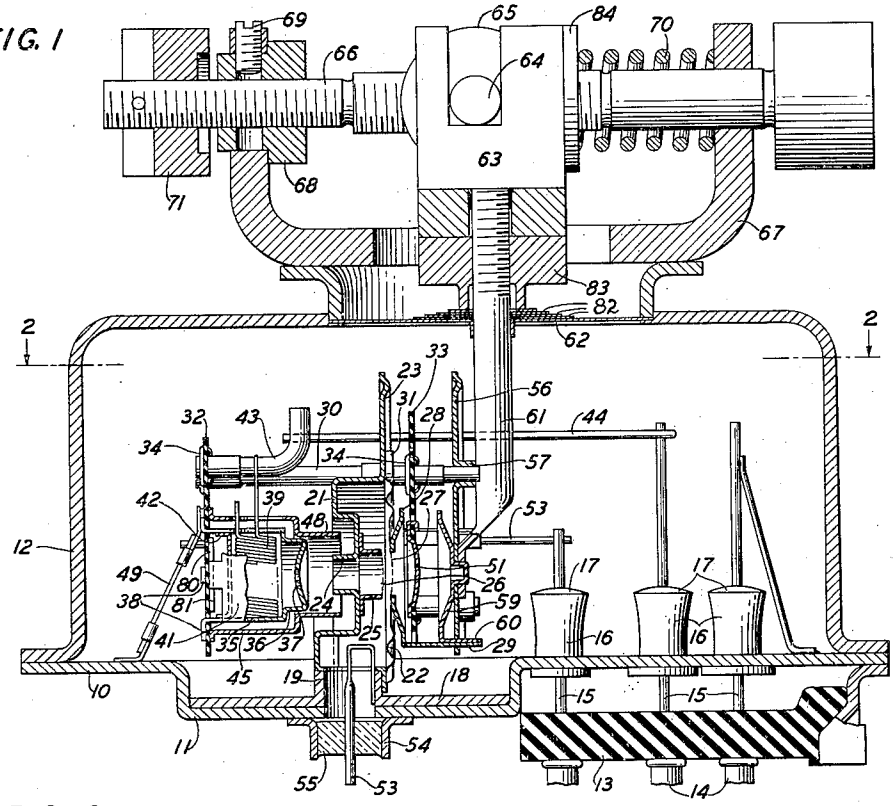

FIG. 2

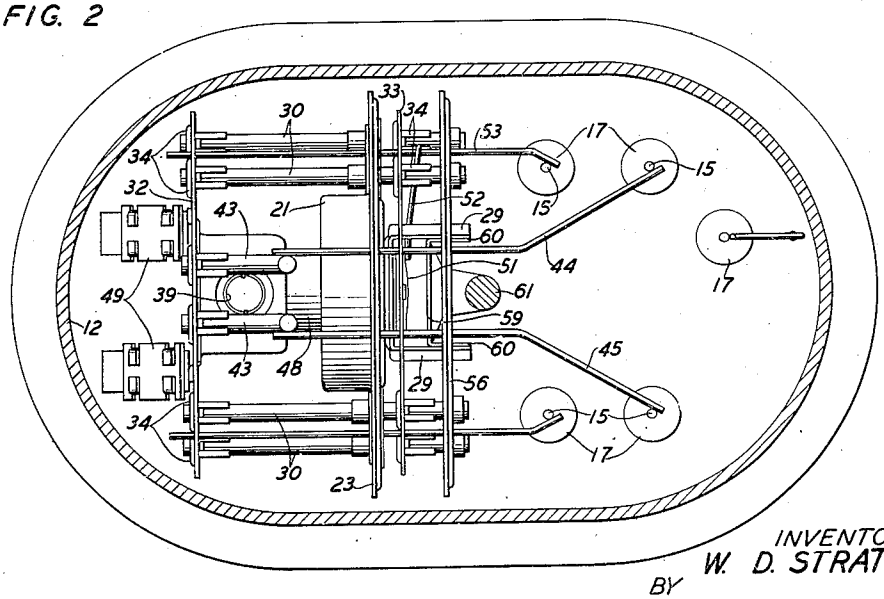

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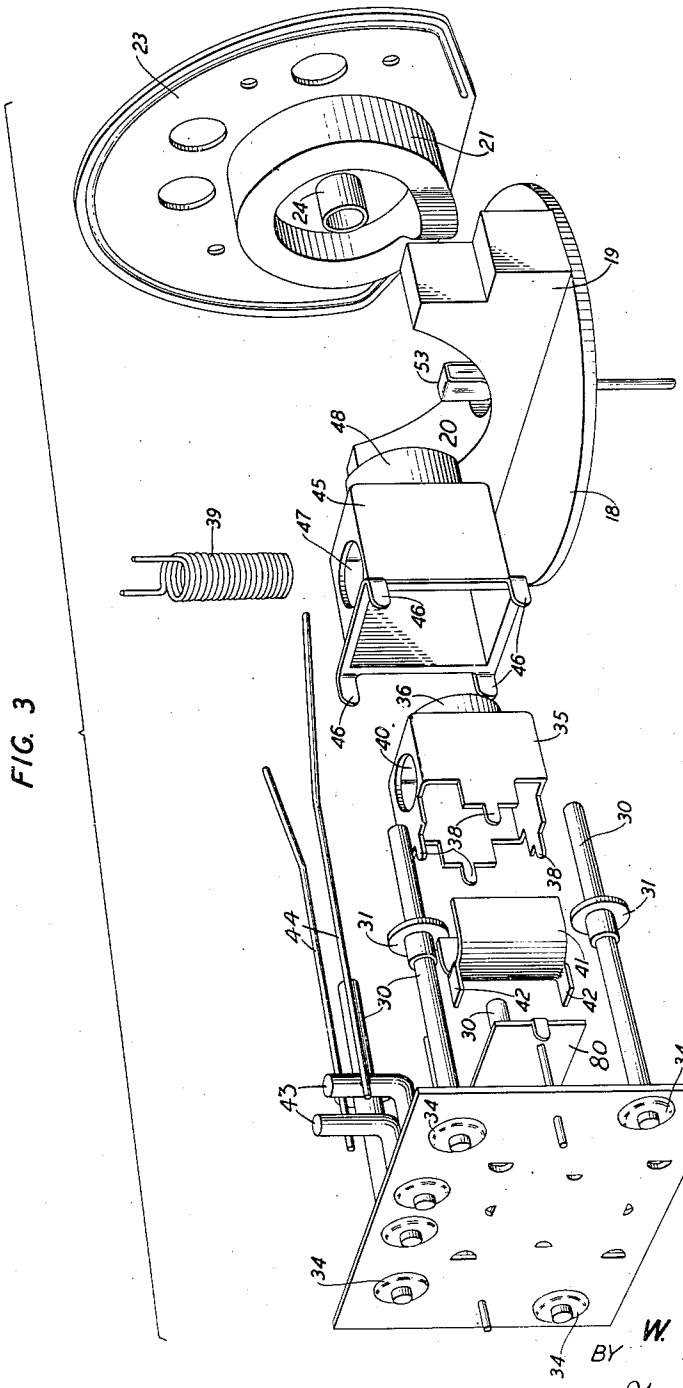
FIG. 3



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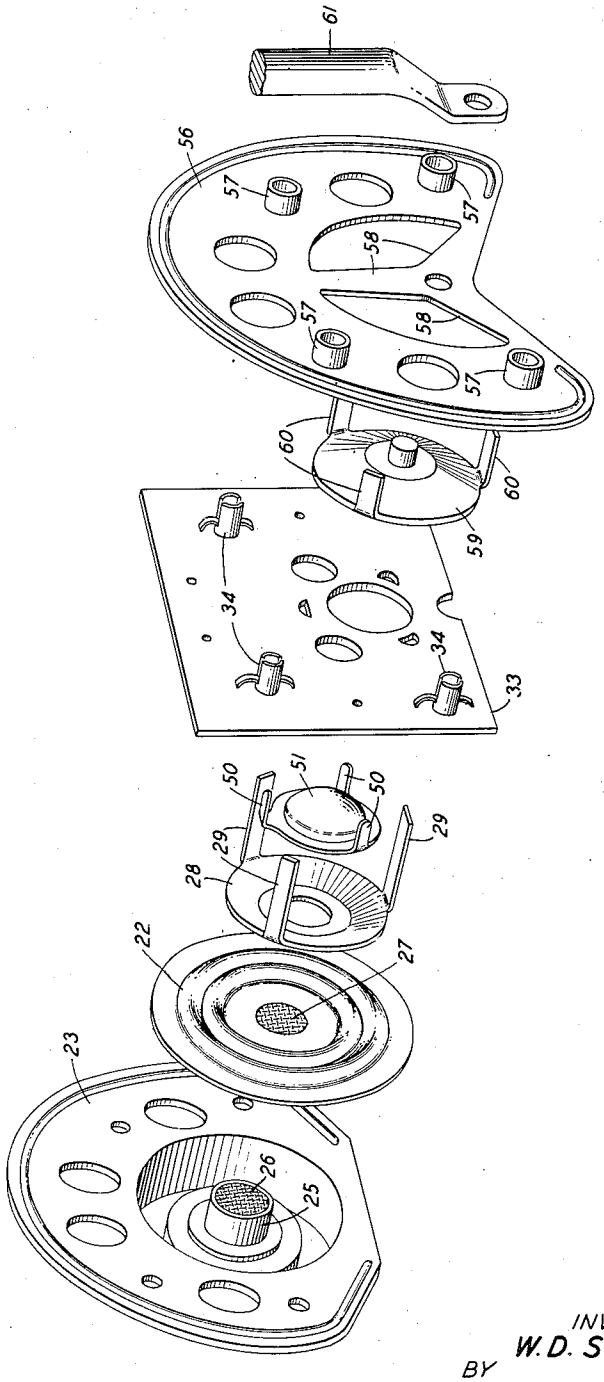

FIG. 4

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Patented Apr. 5, 1949

2,466,062

UNITED STATES PATENT OFFICE

2,466,062

ELECTRON DISCHARGE DEVICE

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Application June 28, 1946, Serial No. 679,966

8 Claims. (Cl. 250—27.5)

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This invention relates to electron discharge devices and more particularly to microwave oscillators of the reflex type and including an internal cavity resonator.

In microwave oscillators of the type above mentioned, it is desirable frequently that the resonator be tunable to adjust the operating frequency of the device. Tuning may be effected by altering the configuration of the resonator, as by flexing a wall portion thereof. Relatively large changes in frequency may be realized by small motion of the wall noted and conversely, even slight displacement of the wall may result in marked departure of the frequency from a desired value. Thus, it is highly desirable that the effect of the tuning mechanism employed upon the resonator frequency with variations in ambient temperature be small. Stated in another way, a desideratum is that once the resonator frequency has been adjusted to a desired value, it remain substantially fixed and unaffected by temperature effects upon the tuning mechanism.

In some applications of such oscillators, an auxiliary external cavity or wave guide may be associated with the internal cavity resonator in order to provide a high Q resonator system. Efficient coupling of the internal and auxiliary resonators requires that the line for associating the two be very short, advantageously of the order of one-half wavelength of the operating frequency.

Moreover, in microwave devices, the electrode and resonator dimensions and spacings necessarily are extremely small. Realization of accurate spacings within close tolerances obviously entails mechanical problems.

In accordance with one feature of this invention, in an electron discharge device having a tunable cavity resonator within the enclosing vessel of the device, the resonator and the tuning mechanism therefor are so constructed and arranged that the effects of temperature upon the setting of the frequency of the resonator are substantially minimized.

More specifically, in accordance with one feature of this invention, the cavity resonator, which may be substantially toroidal, is provided with a flexible wall, a lever is coupled to this wall to effect displacement thereof and hence tuning of the resonator, and the lever is positioned relative to the resonator so that expansion and contraction of the lever with temperature variations is in the dimension substantially normal to the direction of displacement of the flexible wall requisite to alter the natural frequency of the resonator.

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In accordance with another feature of this invention, the internal cavity resonator is mounted with a peripheral wall portion thereof in immediate proximity to one wall of the enclosing vessel, whereby a coupling line of very short length may be provided between this resonator and an external resonator or wave guide.

More specifically, in accordance with another feature of the invention, the internal resonator of generally toroidal form is seated edgewise upon a saddle member secured to one wall of the enclosing vessel, the resonator, saddle member and wall being apertured for passage of a coupling loop.

In accordance with a further feature of this invention, the cavity resonator and the electrodes associated therewith are fabricated as a unitary assembly wherein the electrodes are mounted from the resonator in accurate and fixed relation therewith, which assembly is supported as a unit upon the saddle member noted heretofore.

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 in section of an electron discharge device illustrative of one embodiment of this invention;

Fig. 2 is a plan view taken along plane 2—2 of Fig. 1; and

Figs. 3 and 4 are exploded perspective views showing details of the cavity resonator, electrode and resonator tuner construction in the device illustrated in Fig. 1.

Referring now to the drawing, the electron discharge device comprises an evacuated, metal enclosing vessel generally oval in section as shown in Fig. 2 and including a base 10 having a circular recessed portion 11, and a flanged cup-shaped portion 12, the flange of which is sealed to the base 10, as by welding or brazing. Mounted from the base is an insulating disc 13 which carries a plurality of terminal pins or prongs 14. Leading-in conductors 15 are secured to the pins or prongs, extend through eyelets 16 on the base 10 and are sealed hermetically to the eyelets by vitreous beads 17.

Seated within the recess 11 is a support member which, as shown clearly in Fig. 3, comprises a disc 18 and a saddle shaped portion 19 having an arcuate seating surface 20. This member mounts a circular or toroidal cavity resonator

designated as a whole by 21, having centrally apertured, aligned juxtaposed walls one of which is defined by an annularly corrugated diaphragm 22 affixed at its peripheral portion to a flange 23. The other wall, the configuration of which is shown clearly in Fig. 1, comprises a central outwardly extending cylindrical portion 24 and has mounted thereon an inwardly extending cylindrical member 25 mounting a concavo-convex grid 26. The resonator is seated upon the surface 20, which conforms to the peripheral wall thereof. Opposite the grid 26 and conforming substantially thereto is a second grid 27, which is carried by the diaphragm 22. The diaphragm carries an annulus 28 having a plurality of parallel fingers or extensions 29 extending therefrom.

Supported by the flange 23 are a plurality, e. g. four, of mounting posts or supports 30, each of which extends through a corresponding aperture in the flange 23 and is provided with a collar 31 abutting one face of the flange. The several posts are locked to the flange as by forcing a portion of the material thereof against the other face of the flange. The mounting posts 30 support a pair of insulating plates 32 and 33 to which they are locked by eyelets 34. The insulating plate 32 mounts an electron gun coaxial with the grids 26 and 27. This electron gun comprises a cathode member including a portion 35 of square section and a cylindrical portion 36 having a concavo-convex end portion 37 the concave face of which is coated with an electron emissive material. The cathode member is locked to the plate 32 by a plurality of tabs 38 which extend through the plate and are bent over thereagainst. The cathode member has therein a heater filament 39, insertable through an aperture 40 in one wall of the portion 35, and a generally U-shaped heat reflecting shield 41 which is affixed to the portion 35 by tabs 42. The ends of the heater filament 39 are connected to bent studs 43 locked to the insulating plate 32 and connected electrically to two of the conductors 15 by suitable wires 44 which extend through apertures in the flange 23 and plate 33. A baffle or heat shield 89 locked to the plate 32 by tabs 81 is provided between the plate and the shield 41.

The cathode member 35, 36 is encompassed by a beam forming electrode having a square portion 45 secured to the plate 32 by tabs 46 and provided with an aperture 47 in alignment with the aperture 40, and having a cylindrical portion 48 coaxial with the cathode portion 36 and the cylindrical portion 24 of the resonator structure. The concavo-convex portion 37 of the cathode, the beam forming electrode 45, 48 and the cylindrical member 24 are constructed and arranged so that electrons emanating from the coated face of the cathode portion 37 are concentrated into a converging beam substantially focussed upon the gap between the grids 26 and 27.

A pair of struts 49 may be provided to brace the insulating disc 32 from the base 10.

Rigidly mounted on the insulating plate 33, as by locking tabs 50, is a dished repeller electrode 51, which is connected electrically to one of the conductors 15 by a tie wire 52 connected in turn to a suitable wire 53 fitted in apertures in the insulating plates 32 and 33.

The saddle shaped mount 19 and cavity resonator 21 are provided with aligned apertures through which a coupling conductor 53 having its inner end bent as shown in Figs. 1 and 3, extends, the conductor 53 being hermetically sealed to an eyelet 54 upon the base 10 by a vitreous mass 55. The conductor 53 may project into an external cavity or wave guide of high Q to which an output line is coupled, or may be coupled directly to a load circuit. Because of the mounting of the resonator and electrode assembly in the saddle 19 and with its longitudinal axis parallel to the base 10, the conductor 53 may be made very short, for example of substantially one-half wavelength of the operating frequency, whereby a highly efficient coupling between the internal cavity resonator 21 and the external resonator or guide is realized.

The electron gun, cavity resonator and repeller electrode constitute a unitary assembly which can be fabricated expeditiously as a unit and mounted, also as a unit, by brazing the resonator to the saddle shaped mount 19.

In order to enable tuning of the resonator 21, means are provided for displacing the diaphragm 22 to alter the configuration of the resonator and, hence, its resonant frequency. The tuning mechanism comprises a frame or spider 56 having integral sockets 57 for receiving the posts 30 and to which these posts are fixed, the frame or spider 56 having also resilient fingers 58 extending from a central portion to which a rigid driving or coupling member 59 is secured. The driving member 59 is provided with parallel fingers or extensions 60 to each of which a respective finger 29 is affixed, and is actuated by a lever 61 secured thereto and to the central portion noted. The lever extends substantially normal to the base 10 and is mounted rockably by a diaphragm 62 closing an aperture in the cup-shaped portion 12 of the enclosing vessel and having a plurality of spring washers 82 seated thereon.

The lever 61 is rockable to flex the diaphragm 22 in the direction normal to its plane by a differential screw arrangement which enables very fine tuning of the cavity resonator. Specifically, the lever is threaded into a nut 83 and secured, as by soldering, to a head-piece 63 having slots, only one of which is shown, for receiving pins 64 extending from a nut member 65. The latter is threaded upon a tuning screw 66 which is carried by a U-shaped support 67 and is threaded into an insert 68 in the support and locked in place by a set screw 69. A helical spring 70 bearing against a washer 84 engaging the head-piece 63 may be provided to substantially eliminate blacklash and to maintain the driving force on the nut member 65 substantially constant. Also, a stop 71 is provided on the screw 66 to limit the permissible travel thereof.

It will be noted that the axis of major expansion and contraction of the lever 61 with temperature changes is substantially normal to the direction of displacement of the diaphragm 22 to tune the resonator 21, so that variations in the natural frequency of the resonator with such expansion and contraction are minimized. Further, it will be appreciated that the distance between the diaphragm 22 and the fulcrum for the lever, in the direction parallel to the axis of the resonator and electrode assembly, is quite small, so that relative motion between the diaphragm and fulcrum with expansion and contraction of the vessel 12 with temperature changes also is minimized.

Reference is made of the application Serial No. 679,967, filed June 28, 1946, of William G.

Shepherd wherein a related invention is disclosed.

Although a specific embodiment of the 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 an evacuated enclosing vessel, a unitary assembly within said vessel including a cavity resonator having a pair of juxtaposed walls, a plurality of supports separate from said vessel mounted on said resonator and extending beyond said walls, an electron gun opposite one of said walls, an electrode opposite the other of said walls and insulating means mounting said gun and electrode from said supports, and a support member seated upon an inner wall portion of said vessel and mounting said unitary assembly, said resonator being seated upon said support member.

2. An electron discharge device comprising an evacuated enclosing vessel, a unitary assembly within said vessel including a cavity resonator having a pair of juxtaposed walls, a plurality of parallel posts mounted on said resonator and extending beyond said walls, an electron gun opposite one of said walls, an electrode opposite the other of said walls, an insulating plate separate from said vessel supported by said posts and mounting said electron gun and a second insulating plate separate from said vessel, supported by said posts and mounting said electrode, and a support member mounting said assembly within said vessel, said support member being seated upon an inner wall portion of said vessel and said resonator being seated upon said support member.

3. An electron discharge device comprising an evacuated enclosing vessel, a substantially toroidal cavity resonator within said vessel, a saddle member upon one wall of said vessel and having an arcuate surface conforming to a peripheral wall portion of said resonator, said wall portion being seated upon said surface, exciting means coupled to said resonator, and coupling means for said resonator extending through said wall and wall portion.

4. An electron discharge device comprising an evacuated enclosing vessel, a cavity resonator within and enclosed by said vessel and having a pair of juxtaposed apertured walls and having also an arcuate peripheral wall portion, a support member seated upon one wall of said vessel and having a seating surface conforming to and engaging said peripheral wall portion, an electron gun opposite one of said apertured walls, and an electrode opposite the other of said wall portions, said gun and said electrode being mounted separately from said resonator.

5. A microwave reflex type oscillator comprising an evacuated enclosing vessel having a base, a substantially toroidal cavity resonator within said vessel and having its axis substantially parallel to said base, a saddle member seated on said base and having an arcuate seating surface for accomodating and conforming to a peripheral wall portion of said resonator, an electron gun and a repeller electrode each separately mounted from said resonator independently of said vessel, and a coupling loop extending through said base and wall portion.

6. An electron discharge device comprising an enclosing vessel having a pair of substantially parallel walls one of which includes a diaphragm, a cavity resonator supported on the other of said walls and having a flexible wall portion substantially normal to said parallel walls, exciting means and tuning means each coupled to said resonator, said tuning means comprising a lever mounted on said diaphragm, extending therethrough and substantially parallel to said flexible wall portion, means coupling the inner end of said lever to said wall portion and means external to said vessel and supported thereon for rocking said lever.

7. An electron discharge device in accordance with claim 6 wherein said coupling means comprises a frame member fixed with respect to said resonator, resilient fingers extending from said frame member and coupled to the inner end of said lever, and a rigid coupling between said fingers and said flexible wall portion.

8. An electron discharge device comprising an enclosing vessel having a pair of substantially parallel walls one of which includes a diaphragm, a cavity resonator supported on the other of said walls and having a flexible wall portion substantially normal to said parallel walls, and exciting means and tuning means each coupled to said resonator, said tuning means comprising a lever mounted on said diaphragm, extending therethrough and substantially parallel to said flexible wall portion, a coupling member affixed to said flexible wall portion and having a plurality of extensions extending normal thereto, a member having a rigid outer frame portion fixedly supported from said resonator and having also a plurality of resilient fingers extending inwardly from said frame portion and substantially parallel to said flexible wall portion, and a second coupling member coupled to said resilient fingers and having extensions affixed to said first extensions, said lever having its inner end secured to said resilient fingers.

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