

March 5, 1946.

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2,396,167

ELECTRON DISCHARGE DEVICE

Filed July 28, 1943

2 Sheets-Sheet 1

Fig. 1.

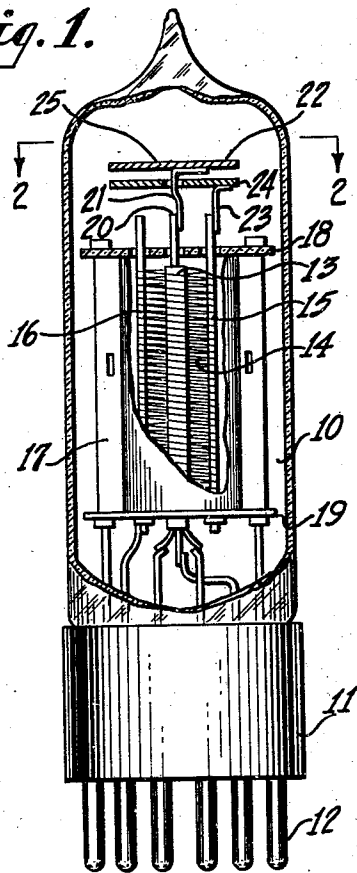


Fig. 3.

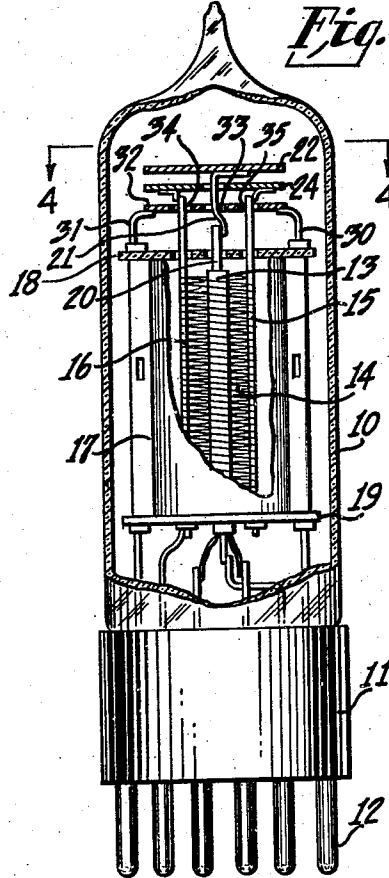
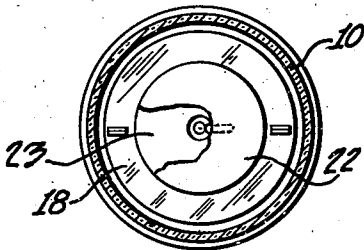


Fig. 2.

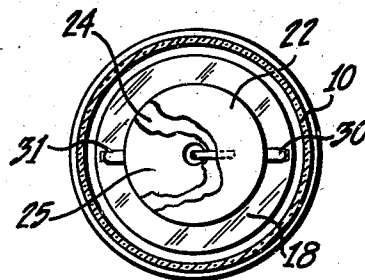


Fig. 4.

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Fig. 5.

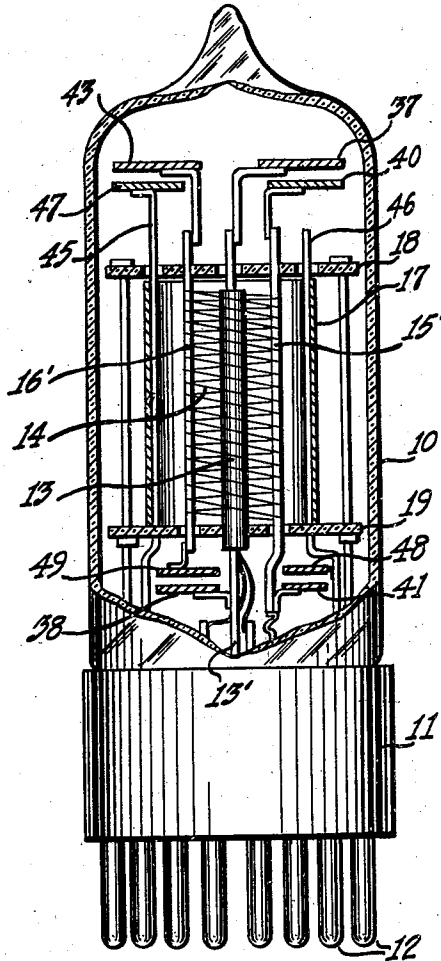
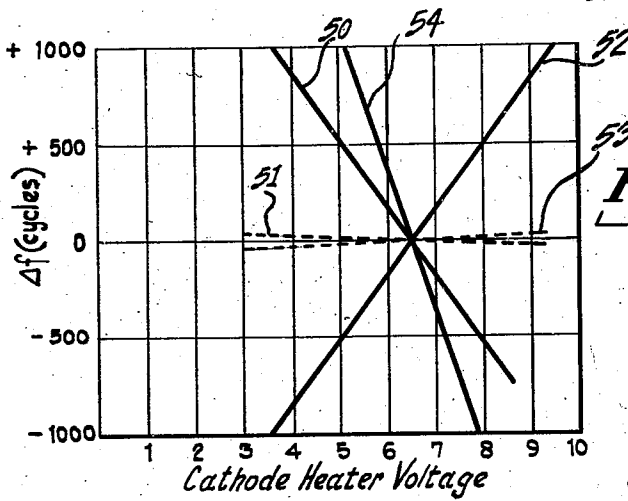


Fig. 6.

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ELECTRON DISCHARGE DEVICE

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9 Claims. (Cl. 250—27.5)

My invention relates to electron discharge devices and more particularly to such devices useful in oscillators.

During operation of an electron discharge device changes in temperature of the tube elements occur, particularly during the warm-up period. This results in changes in spacing between the various electrodes and thus also causes a change in the interelectrode capacities. Particularly when the device may be used in an oscillator, these capacity changes cause a shift in the frequency of operation of the oscillator, resulting in instability which may be quite pronounced at the higher frequencies.

In the past, efforts have been made to compensate for these changes due to thermal expansion and contraction of the tube elements by the use of bimetallic strips attached to the tube elements or adjacent the tube elements. However, all of these arrangements are subject to the fault that a considerable time lag exists between the increase or decrease of the interelectrode capacity resulting from the change in temperature of the tube elements when the power dissipated by the tube elements varies and the following capacity compensation.

It is, therefore, a principal object of my invention to provide an electron discharge device of improved design particularly useful as an oscillator.

Another object of my invention is to provide an electron discharge device which has stable operating characteristics under varying operating temperature conditions.

More specifically it is an object of my invention to provide such a device in which the interelectrode capacity changes due to thermal expansion and contraction of the electrode elements are automatically compensated for within the device.

It is a further object of my invention to provide such a device in which automatic compensation is provided and in which the time lag is eliminated or substantially eliminated.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawings in which Figure 1 is a side view with parts broken away, showing details of construction of one form of an electron discharge device made according to my invention, Figure 2 is a section taken along the line 2—2 of Figure 1, Figure 3 shows a modification of an electron discharge device made accord-

ing to my invention with parts broken away showing details of construction, Figure 4 is a section taken along the line 4—4 of Figure 3, Figure 5 is a still further modification of an electron discharge device made according to my invention, and Figure 6 is a graph showing change in frequency with respect to change in electrode spacings of different types of tubes including those made according to my invention.

In Figure 1 an electron discharge device made according to my invention includes the usual evacuated envelope 10, base 11 and base pins 12. The mount assembly includes the indirectly heated cathode 13 surrounded by grid 14 having side rods 15 and 16, and the anode 17, these electrodes being mounted between insulating spacer members 18 and 19.

In accordance with my invention I mount at the upper end of the cathode 13 a rod-like extension and support wire 20, which could be an extension of the cathode sleeve, and a further extension 21 supporting one condenser plate 22. Attached to the side rod 15 of the grid is an extension and support wire 23 supporting the condenser plate 24 having an aperture 25 through which the support wire 21 extends. The cathode, grid and anode are all fixed to the bottom mica 19 but the cathode and grid are free to move relative to the upper mica plate 18 due to the loose fit between the cathode extension 20 and the side rods 15 and 16 of the grid.

If now the temperature of the grid electrode increases so as to cause expansion both radially and longitudinally, the grid will move away from the cathode surface thereby decreasing the cathode-grid capacity. However, due to the longitudinal expansion of the grid, the plate 24 is moved closer to the plate 22 thereby increasing the capacity between these two plates. The capacity of the plates is in parallel with the grid-cathode capacity and hence compensates for the decrease in interelectrode capacity. Thus there is automatic and instant compensation for variations in interelectrode capacity. It may be necessary under some conditions to have the grid side rods and the mesh of different metals to insure uniform heating and expansion of the grid as a whole.

On the other hand if the cathode expands radially and longitudinally due to temperature changes, the grid-cathode capacity increases due to the cathode surface moving closer to the grid. But the cathode expands longitudinally, moving plate 22 away from plate 24, thus decreasing the capacity and compensating for the increase in

grid-cathode capacity. The compensation is always instantaneous in this case.

In the modification shown in Figure 3 like numerals indicate like elements as in Figure 1. In this form, however, anode side rods 30 and 31 support at their upper end a condenser plate 32 provided with apertures 33, 34 and 35 through which the grid side rods 15 and 16 extend and the extension 21 on the cathode. In this case it may in general be best to use grid side rods having a different coefficient of expansion from that of the mesh wire. The use of metals having a specific coefficient of expansion may sometimes be necessary for the cathode and plate also.

The operation with respect to the cathode and grid in Figure 3 is identical to the operation that occurs in the form of my invention shown in Figure 1. Additional compensation is provided, however, by the addition of the anode-condenser plate. Assuming that the grid expands due to changes in temperature so that the grid moves closer to the anode, the capacity between the grid and anode changes and increases. However, due to the longitudinal expansion of the grid, the grid-condenser plate 24 is moved away from the anode-condenser plate 32, decreasing the capacity between the plates and thereby compensating for the change in spacing between the grid and anode. With the arrangement shown in Figure 3 automatic compensation is provided between any two electrodes which move toward or from each other in a radial direction due to temperature changes independently of or simultaneously with the changes in dimensions of any of the other electrodes due to temperature changes.

In the form of my invention shown in Figure 5 a different arrangement of the electrode elements and condenser plate elements is provided. Here again like numerals indicate like parts shown in Figures 1 and 2. This design may be made to work regardless of the coefficient of expansion of the different parts but mechanically is more complicated than that shown in Figure 3.

A cathode 13 is provided with an upper extension supporting condenser plate 37 and has mounted in its lower end and supported by the cathode extension 13' the condenser plate 38. The grid side rods support several plates including plates 40, 41, 43, 49 mounted on extensions on the grid side rods 15' and 16'. The anode side rods 45 and 46 support the condenser plates 47 and 48. In the arrangement shown the grid is fixed to the top mica but free to expand longitudinally downward. The anode and cathode are fixed to the lower mica and free to expand longitudinally upward.

In this arrangement, as in the arrangement shown in Figures 2 and 3, compensation between different electrodes where only one electrode may expand at a time will still be compensated for independently of any other elements. For example, if the cathode 13 becomes heated and expands radially and longitudinally the condenser plate 37 moves away from the condenser plate 48 of the grid to compensate for the decrease in the grid-cathode spacing. On the other hand, if the grid expands, compensation is provided for by means of the plates 38 and 49. That is, if the grid expands radially and longitudinally the spacing between it and the cathode increases reducing the interelectrode capacity. However, plates 38 and 49 move closer to each other, increasing their capacity and thus compensating for the cathode-grid capacity change. Inasmuch as the grid moves closer to the anode, the grid-anode

capacity increases. However, plates 41 and 48 move away from each other and automatically compensate for the increase in anode-grid capacity.

If on the other hand the plate expands, due to some temperature change, its diameter increases causing it to move away from the grid and cathode, decreasing the anode-grid capacity. Since the anode expands longitudinally, however, the plates 47 and 43 are brought closer to each other, increasing the capacity therebetween and compensating for the decrease in the anode-grid capacity. Thus, all independent variations of the different electrodes are automatically compensated for.

In tubes which have actually been constructed incorporating my invention, it has been possible to substantially completely compensate for inter-electrode capacity changes.

In Figure 6 I show the graphs representing tests on a tube with compensation applied as in Figure 1, and show the results in frequency drift in five megacycle oscillators produced by cathode and grid expansion due to variations in cathode heater voltage. The solid line curve 50 shows the result of an under-compensated tube while the curve 52 shows the result of an over-compensated tube. The curves represent the change in frequency with respect to change in cathode heater voltage and hence temperature changes of the electrode elements. Curve 54 represents the characteristic of a conventional uncompensated tube. The dotted curves 51 and 53 represent the limits of error within which measurements could be made to show clearly the exact compensation possible with proper compensation afforded by the construction shown in Figure 1. All curves except 54 are based on actual data taken on a tube made according to my invention as described in Figure 1.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is:

1. An electron discharge device having a cathode, a grid and an anode, said cathode, grid and anode being relatively movable longitudinally in response to temperature changes, and a condenser plate mounted on said cathode, and another condenser plate mounted on said grid, said plates having relative movement with respect to each other upon relative longitudinal movement of the cathode and grid in response to temperature changes in said cathode and grid.

2. An electron discharge device having a cathode, a grid and an anode, said cathode, grid and anode being relatively movable longitudinally in response to temperature changes, a first condenser plate mounted on one end of and connected to said cathode, and a second condenser plate registering with said first condenser plate and mounted on said grid adjacent the first plate, said plates having relative movement with respect to each other upon relative longitudinal movement of said cathode and grid in response to temperature changes in said cathode and grid.

3. An electron discharge device having a

cathode electrode, grid electrode and anode electrode, said cathode, grid and anode electrodes being relatively movable longitudinally in response to temperature changes, and a condenser plate mounted on one of the electrodes, and a second condenser plate mounted on another of said electrodes, said condenser plates having relative movement with respect to each other upon relative longitudinal movement in response to temperature changes of the electrodes supporting said condenser plates.

4. An electron discharge device having a cathode electrode, grid electrode and an anode electrode coaxial with each other, said electrodes having relative longitudinal movement in response to temperature changes, a first condenser plate mounted on one end of one of said electrodes, and a second condenser plate mounted on one end of another of said electrodes and adjacent the first condenser plate whereby said condenser plates may have relative movement with respect to each other to vary the capacity therebetween upon relative longitudinal movement in response to temperature changes of the electrodes supporting said condenser plates to compensate for changes in interelectrode capacities.

5. An electron discharge device having a cathode, grid and anode coaxial with each other, said cathode, grid and anode having relative longitudinal movement in response to temperature changes, a first condenser plate mounted on one end of said grid, and a second condenser plate mounted on one end of said anode and adjacent the first condenser plate whereby said condenser plates may have relative movement with respect to each other upon relative longitudinal movement in response to temperature changes of said grid and anode.

6. An electron discharge device having a cathode electrode, grid electrode and anode electrode coaxial with each other, said electrodes having relative longitudinal movement in response to temperature changes, a condenser plate mounted on one end of each of said electrodes and adjacent each other in spaced registering relationship, whereby said condenser plates may have relative movement with respect to each other upon relative longitudinal movement in response to temperature changes of said electrodes.

7. An electron discharge device including a linear indirectly heated cathode, a grid surrounding said cathode, and an anode surrounding said cathode and grid, said cathode, grid and anode being fixed at one end and free to move longitudinally at the other end upon expansion and contraction in response to temperature changes, a condenser plate mounted at the free end of said cathode and a second condenser plate mounted at the free end of said grid, said condenser plates registering with each other and having relative longitudinal movement in response to the relative longitudinal movement of said cathode and grid due to thermal expansion and contraction of said cathode and grid in response to temperature changes.

8. An electron discharge device having a linear indirectly heated cathode electrode, a grid electrode having a side rod and surrounding said cathode, and an anode electrode surrounding said cathode and grid, a condenser plate mounted at one end of said cathode, a condenser plate mounted at each end of said grid side rod, and a condenser plate connected to one end of said anode, each condenser plate registering with a plate on one of the other electrodes and having relative longitudinal movement with respect to each other upon relative expansion and contraction longitudinally of said cathode, grid and anode electrodes.

9. An electron discharge device having a linear indirectly heated cathode, a grid having side rods surrounding said cathode, and an anode surrounding said cathode and grid, the cathode, grid and anode being fixed at one end against longitudinal movement and free to move longitudinally at the other end in response to expansion and contraction due to temperature changes, a condenser plate carried by the free end of the cathode, a second condenser plate registering with the first condenser plate and carried by said side rods at the free end of said grid, and a third condenser plate carried by the free end of said anode, said condenser plates being spaced in registering relationship and having relative longitudinal movement with respect to each other upon expansion and contraction of the cathode, grid and anode.

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