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ELECTRON DISCHARGE DEVICE EMPLOYING CAVITY RESONATOR CIRCUITS

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Fig. 1.

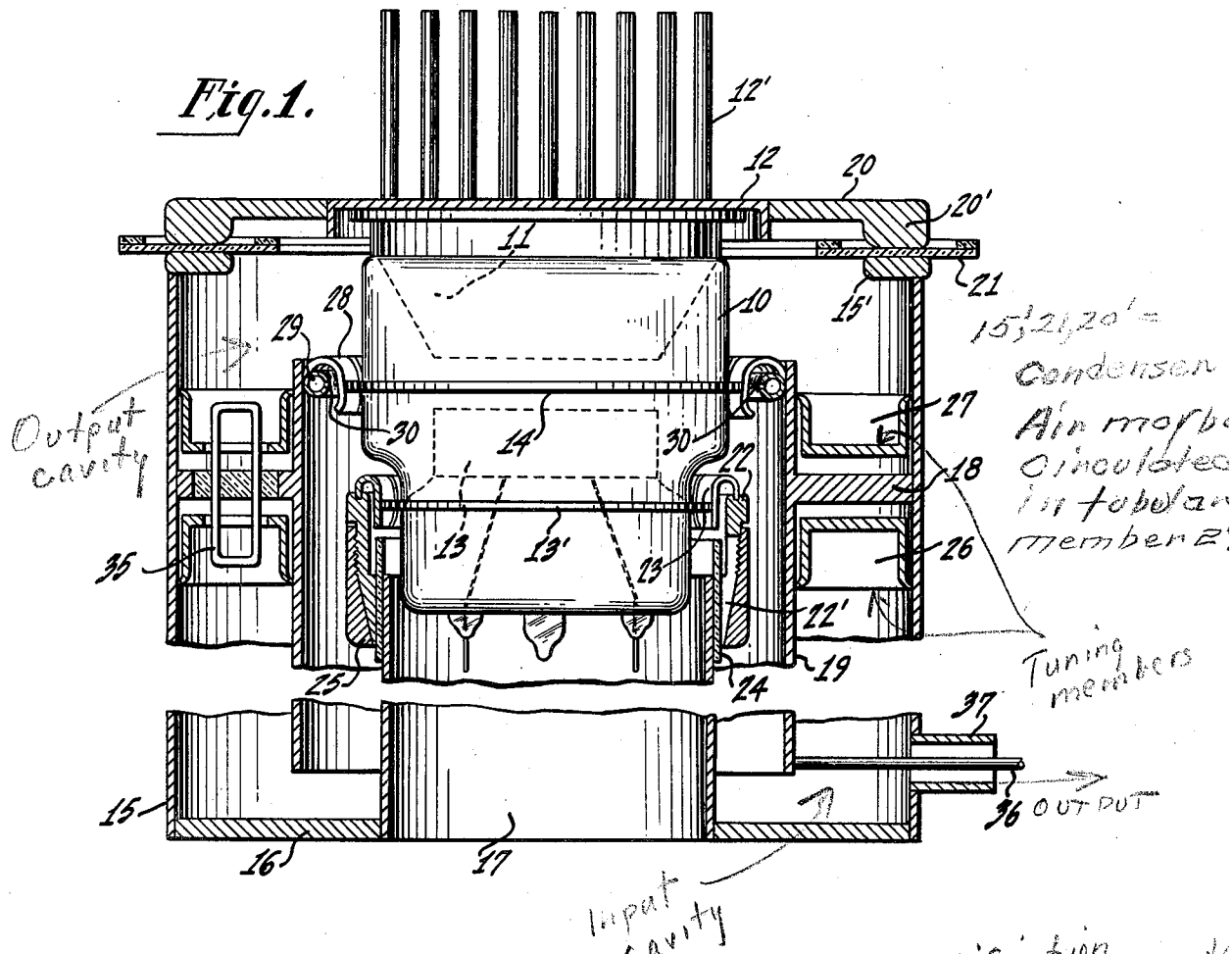
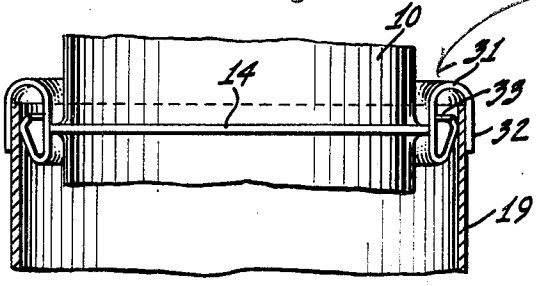


Fig. 2.



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ELECTRON DISCHARGE DEVICE EMPLOYING CAVITY RESONATOR CIRCUITS

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13 Claims. (Cl. 315—39)

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My invention relates to electron discharge devices and associated circuits useful at ultra high frequencies and more particularly to circuits of the cavity resonator type.

In one form of ultra high frequency apparatus an electron discharge device having a plurality of electrodes is provided with ring-like contacts and supports for said electrodes, which supports extend through the envelope for engagement with appropriate cavity resonator circuits, for example, of the coaxial line type, the resonators being provided with spring-like contact fingers which engage the ring contacts of the electrodes for coupling the circuits between the various electrodes.

In order to provide an adequate tuning range of the resonators it is preferable to make the grid cathode circuit electrically three-quarters of a wavelength long. Physically, however, such a resonator becomes undesirably long. This introduces the further difficulty in that when the apparatus is utilized as an oscillator it is necessary to use long feedback coupling lines for coupling the output and input circuits so that the apparatus will function as an oscillator. Again in this type of apparatus voltage breakdown between the cavity wall and output coupling loop in the plate tank resonator, particularly where the resonator is small, becomes quite possible.

Contact between the ends of the resonators and the ring contacts of the electrodes is usually made by means of a resonator supported ring having a plurality of spring fingers, the free ends of which engage the electrode contact to provide the necessary electrical and mechanical contact. In this type of spring contact, insuring proper stiffness becomes a problem and the spring contacts have a tendency to cave in at the center where they usually engage the ring contact of the electrode. It is at the ring contact of the electrode that heating problems are introduced, particularly at the grid ring, and cooling becomes a problem.

In this type of apparatus it is customary to use grounded grid operation which requires that the cathode contacts and the anode contacts be capacitively coupled to the resonator walls so that different D.-C. potentials may be applied to the cathode, the grid and the anode. It is, therefore, desirable to have some simple means for providing capacity coupling but at the same time assures positive support of the spring contacts.

It is, therefore, an object of my invention to provide an electron discharge device and associated circuit of improved design and suitable for use at ultra high frequencies.

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It is another object of my invention to provide such an apparatus utilizing cavity resonators but in which resonators of desirable size may be employed.

A further object of my invention is to provide such an apparatus in which the feedback loop may be simplified and reduced in size.

A further object of my invention is to provide apparatus of the type described having improved contact means for coupling the resonator to the electrodes of the electron discharge device.

A further object of my invention is to provide such an apparatus employing improved by-passing condensers supporting spring contact fingers.

A still further object of my invention is to provide such a device having means for cooling the spring contact fingers and the tube contacts associated therewith.

A still further object of my invention is to provide an output coupling system which will eliminate or avoid voltage breakdown between the cavity walls and the output coupling loop.

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 drawing in which Figure 1 is a longitudinal section of an electron discharge device and associated circuit made according to my invention and Figure 2 shows a modification of a detail of Figure 1, and shows an improved type of contact spring.

In Figure 1 is shown an electron discharge device and associated circuit made according to my invention. The electron discharge device includes an envelope 10 having at one end the anode 11 provided with the cap ring contact 12 supporting radiating fins 12'. At the other end of the envelope is mounted cathode 13 supported from a cathode contact ring 13' which extends and is sealed through the envelope 10. Intermediate the anode and cathode is the flat grid having grid contact ring 14 sealed through the envelope of the wall of the tube.

Coupled between the cathode and grid and between the grid and the anode are cavity resonators for providing the input and output circuits. The cavity resonator structure includes an outer tubular member 15 and an inner tubular member 17 connected together and closed at one end by means of the apertured conducting disc 16. Intermediate the ends of the outer tubular member

15 is transverse partition 18 supporting an inner concentric tubular member 19, which extends toward the disc 16 but is out of contact therewith so that the space between the outer tubular member 15 and member 19 and the space between member 17 and partition 18 communicate with each other to provide in effect a folded coaxial line resonator. The partition 18 separates the input and output resonators, the output resonator being completed by means of the closure member 20 contacting the anode ring 12 but insulated from the tubular member 15 by means of the insulating ring 21, preferably of mica. The grid-cathode resonator is elongated and the inner member 17 serves as a reentrant portion coupled to the cathode, the member 19 serving as a partition between the outer wall formed by member 15 and the wall of the reentrant portion 17.

The enlarged flat ring 15' serves as a plate of a condenser, the other plate of which is formed by the enlarged portion 20' of the closure member 20. The resonators may be independently tuned by means of the ring-like tuning elements 26 and 27 which may be moved longitudinally for this purpose in any convenient manner, for example, by insulating rods not shown.

Inasmuch as the apparatus is to be operated as a grounded grid oscillator, the cathode cannot be connected directly to the resonator but must be capacity coupled thereto. A collar 22 having a plurality of slots 22' on its lower end is provided with a plurality of spring fingers 23 of U-shape, the inner free ends contacting the cathode ring 13'. Mounted inside of the split collar 22 is a mica sleeve 24 for insulatingly supporting the collar 22. Mounted on the outside of the split collar 22 is the ring 25 which has screw engagement therewith and which moves longitudinally thereof when rotated. The ring 25 and collar 22 have inclined surfaces as shown, which cause the lower end of the split collar 22 to be forced more tightly into engagement with the mica sleeve 24 and the inner tubular member 17 when the ring 25 is rotated to telescope the members together in the manner of a chuck. This provides an easily assembled cathode condenser.

At the upper end of the tubular member 19 are mounted a plurality of spring fingers 28 having adjacent thereto the tubular member 29 provided with a plurality of apertures 30. Air under pressure may be supplied to this ring to be directed on to the spring fingers contacting the grid ring 14, thereby maintaining these fingers cool.

The use of a simple coupling loop is possible because of the phase reversal of the current in the three-quarter wave input circuit and the shielding of the input line which brings the reverse field of the input line in proximity to the plate tank. This feedback loop 35 may be insulatingly mounted in the partition 18 and extends into the input and output resonators for feeding energy from the output resonator into the input resonator to cause the apparatus to function as an oscillator.

The ends of the input resonator are coupled to the grid ring and cathode ring in the tubular member 19 and in effect increase the electrical length of the resonator so that the three-quarter wavelength resonator occupies half the space it would normally occupy were it extended in the conventional manner into a coaxial line.

The output is taken from the grid cathode line by means of the coaxial output line including the inner conductor 36 and the outer conductor

37, the conductor 36 being coupled at a voltage node.

In Figure 2 I show a modification of the spring contact fingers of Fig. 1. In this arrangement the contact fingers 31, which may be U-shaped ribbons, have one of their legs 32 secured to the outside of the tubular member 19. The inner leg contacting the grid ring 14 is extended and bent back upon itself between the two legs of the U as shown at 33. This inner free end 33 contacts the inner surface of the tubular member 19. The spring contact fingers 31 of Fig. 2 may be substituted for either the fingers 23 or the fingers 28 in Fig. 1. When the electron discharge device is received within the resonator, the free ends of contact fingers 31 are depressed and deformation of the spring fingers by the ring is such as to increase the pressure on the contact. There is little tendency for the spring to cave in at the center and good contact is assured. This also permits the spring to have proper stiffness at the supported end and also permits adjustment of the spring to have proper stiffness at the free end.

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, grid and anode, and a cavity resonator coupled between said grid and cathode, said resonator comprising an elongated hollow conducting member, said elongated hollow conducting member being coupled to said cathode and said grid at spaced apart portions of said hollow conducting member, and a conducting partition within said elongated hollow conducting member and extending from the portion of said elongated hollow conducting member coupled to said grid toward but out of contact with a wall portion of said elongated hollow conducting member intermediate said spaced apart portions, whereby the effective electrical length of said elongated hollow conducting member is increased.

2. An electron discharge device having a cathode, grid and an anode, cavity resonators coupled between said grid and cathode and between said grid and anode, the cavity resonator coupled between said grid and cathode comprising an elongated hollow conducting member having a reentrant portion, said hollow conducting member being coupled to said grid and the free end of said reentrant portion being coupled to said cathode, and a conducting partition positioned intermediate the wall of said hollow conducting member and the wall of said reentrant portion and extending from the portion of said hollow conducting member coupled to said grid toward the wall of said hollow conducting member adjacent said reentrant portion but out of contact therewith, whereby the electrical length of the cavity resonator coupled between said grid and cathode is increased.

3. An electron discharge device having a cathode, grid and anode, cavity resonators coupled between said cathode and grid and betwen said grid and said anode, the resonator coupled

between said grid and cathode including inner and outer concentric tubular members, adjacent ends of said tubular members at one end being closed by a conducting member and an intermediate tubular member, the other end of the inner tubular member of said tubular members being coupled to said cathode, said grid being coupled to a portion of the outer tubular member of said tubular members spaced from said closed end extending from said grid toward the closed ends of said tubular members but out of contact therewith, whereby the effective length of the resonator coupled between said cathode and grid is increased.

4. An electron discharge device having a cathode, grid and anode, said grid and cathode being provided with ring contacts, cavity resonators coupled between said cathode and grid and between said grid and said anode, the resonator coupled between said grid and cathode including coaxial tubular members, adjacent ends of one end of said coaxial tubular members being closed by a conducting member, the other end of one of said tubular members being coupled to said cathode, said grid being coupled to the other of said tubular members adjacent said cathode and an intermediate tubular member extending from said grid toward the closed ends of said tubular members but out of contact therewith, whereby the effective length of the resonator coupled between said cathode and grid is increased.

5. An electron discharge device having a cathode, grid and anode, a cavity resonator coupled between said cathode and grid, said resonator including an elongated hollow conducting member having a reentrant portion, one end of the reentrant portion being coupled to said cathode and said grid being coupled to the hollow conducting member adjacent said cathode, and a tubular conducting member extending from the portion of said hollow conducting member coupled to said grid intermediate the wall of said hollow conducting member and the wall of the reentrant portion and toward but out of contact with the wall of said hollow conducting member adjacent said reentrant portion, whereby the effective length of said resonator is increased, and a coupling line connected to said intermediate tubular member adjacent the end remote from the grid, said coupling line extending to the exterior of said hollow conducting member.

6. An electron discharge device having a cathode, grid and anode, cavity resonators coupled between said cathode and grid and between said grid and said anode, the resonator coupled between said grid and cathode including coaxial tubular members, adjacent ends at one end of said tubular members being closed by a conducting member, the other end of one of said tubular members being coupled to said cathode, said grid being coupled to the other tubular member adjacent said cathode, and an intermediate tubular member extending from said grid toward the closed ends of said tubular members but out of contact therewith, whereby the effective length of said resonator is increased, and a coupling line connected to the end of said intermediate tubular member adjacent the closed end of said first tubular members and extending through the wall of the resonator coupled between said cathode and said grid.

7. An electron discharge device having a cathode, grid and anode, cavity resonators coupled between said cathode and grid and between said

grid and said anode, the resonator coupled between said grid and cathode including coaxial tubular members, adjacent ends at one end of said tubular members being closed by a conducting member, the other end of one of said tubular members being coupled to said cathode, said grid being coupled to the other tubular member adjacent said cathode, and an intermediate tubular member extending from said grid toward the closed ends of said tubular members but out of contact therewith, whereby the effective length of said resonator is increased, and a coupling line connected to the end of said intermediate tubular member adjacent the closed end of said first tubular members and extending through the wall of the resonator coupled between said cathode and said grid, and a coupling loop extending betwen the resonators for coupling said resonators together.

8. An electron discharge device having a cathode, grid and anode, said cathode and grid having ring contacts, and cavity resonators coupled between said grid and cathode and between said grid and anode and comprising an outer tubular member and an inner tubular member, one end of said inner tubular member being capacity coupled to the cathode ring, said tubular members being concentric, the adjacent ends of said tubular members remote from the cathode ring being closed by a conducting member, and a closure member for the other end of said outer tubular member and coupled to said anode, and an intermediate tubular member positioned between and concentric with said inner and outer tubular members and contacting said grid ring, said intermediate tubular members extending toward the closed ends of said inner and outer tubular members and a transverse partition extending between said outer tubular member and said intermediate tubular member adjacent the grid contact.

9. An electron discharge device having a cathode, grid and anode, said cathode and grid having ring contacts, and cavity resonators coupled between said grid and cathode and between said grid and anode and comprising an outer tubular member and an inner tubular member, one end of said inner tubular member being capacity coupled to the cathode ring, said tubular members being concentric, the adjacent ends of said tubular members remote from the cathode ring being closed by a conducting member, and a closure member for the other end of said outer tubular member and coupled to said anode, and an intermediate tubular member positioned between and concentric with said inner and outer tubular members and contacting said grid ring, said intermediate tubular member extending toward the closed ends of said inner and outer tubular members, a transverse partition extending between said outer tubular member and said intermediate tubular member adjacent the grid contact, and an output coupling means including a coaxial line the inner conductor of which is connected to the end of said intermediate tubular member at its end remote from said grid ring and extending through said outer tubular member.

10. An electron discharge device having a plurality of electrodes, one of said electrodes having a ring contact and a cavity resonator coupled to said electron discharge device and including a tubular member, one end of which is provided with a plurality of U-shaped spring contact fingers, one leg of which is secured to said tubular member and the other leg of which contacts said ring contact, the leg contacting said spring con-

tact being extended and folded back upon itself and constructed and arranged to serve as spring stop when the leg contacting said ring contact is forced outwardly on contact with said ring contact.

11. An electron discharge device having a plurality of electrodes, one of said electrodes being provided with a ring contact, a cavity resonator coupled to said electron discharge device and including a tubular member, one end of said tubular member being provided with a plurality of inwardly directed ribbon-like spring fingers of U-shape, the outer leg of each of said spring fingers being secured to said tubular member, the inner leg of each of said spring fingers contacting said ring contact, said contacting leg being extended and folded back upon itself, the folded back portion contacting the inner surface of the tubular member and serving as a spring stop when said spring fingers are in contact with said ring contact.

12. An electron discharge device having a plurality of electrodes, one of said electrodes having a ring contact and a cavity resonator coupled to said electron discharge device and including a tubular member, an insulating sleeve mounted on one end of said tubular member, a conducting collar mounted on said insulating sleeve and supporting a plurality of spring finger contacts at one end, and means for securing said conducting collar on said insulating sleeve comprising resilent fingers on the other end of said conducting collar and means engagiing said resilient fingers for increasing the pressure of said resilient fingers on said insulating sleeve and said

tubular member upon relative longitudinal movement of said means and said resilient fingers.

13. An electron discharge device having a plurality of electrodes, one of said electrodes having a ring contact and a cavity resonator coupled to said electron discharge device and including a tubular member, an insulating sleeve mounted on one end of said tubular member, a conducting collar mounted on said insulating sleeve and supporting a plurality of spring finger contacts at one end, said conducting collar being slotted at its other end to provide a plurality of resilient fingers, and a ring engaging said conducting collar for longitudinal movement relative thereto upon rotation of said ring, said ring being adapted to increase the pressure of said resilient fingers on said insulating sleeve and said tubular member upon relative longitudinal movement of said ring and said conducting collar.

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