Dec. 21, 1943. P. D. ZOTTU 2,337,219

SHORT WAVE TUNED CIRCUIT ARRANGEMENT

Original Filed Jan. 21, 1937 2 Sheets-Sheet 1

Fig. 1

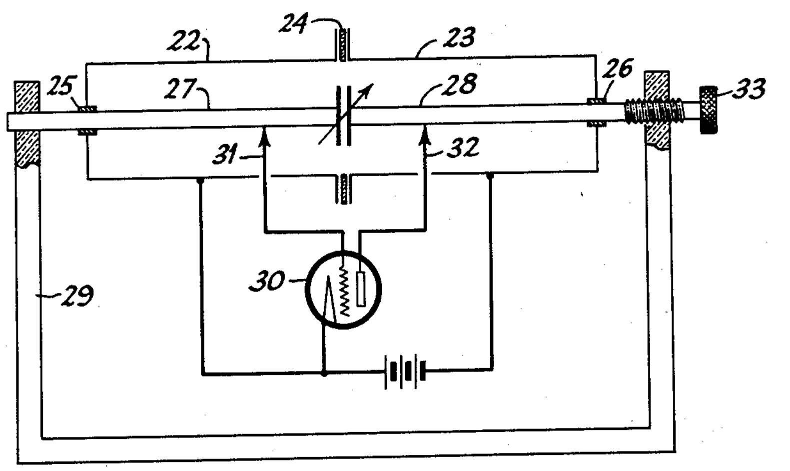

Fig. 2

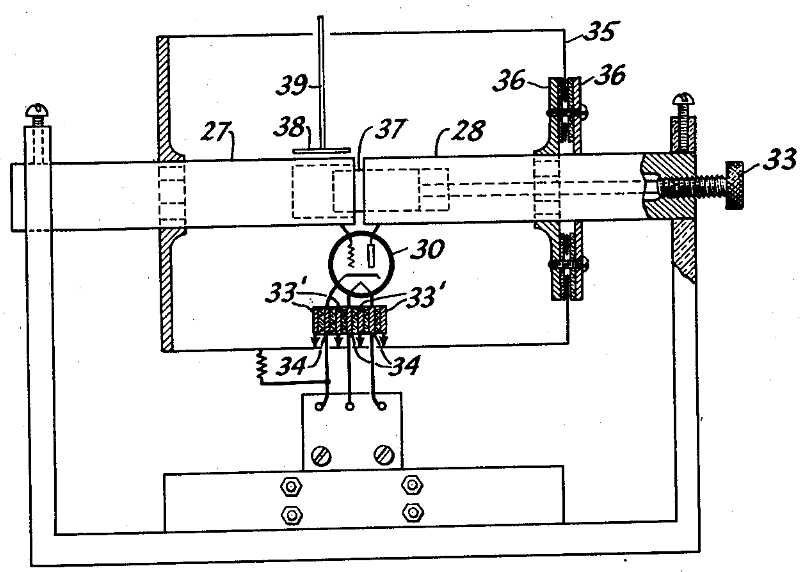

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Fig. 2a

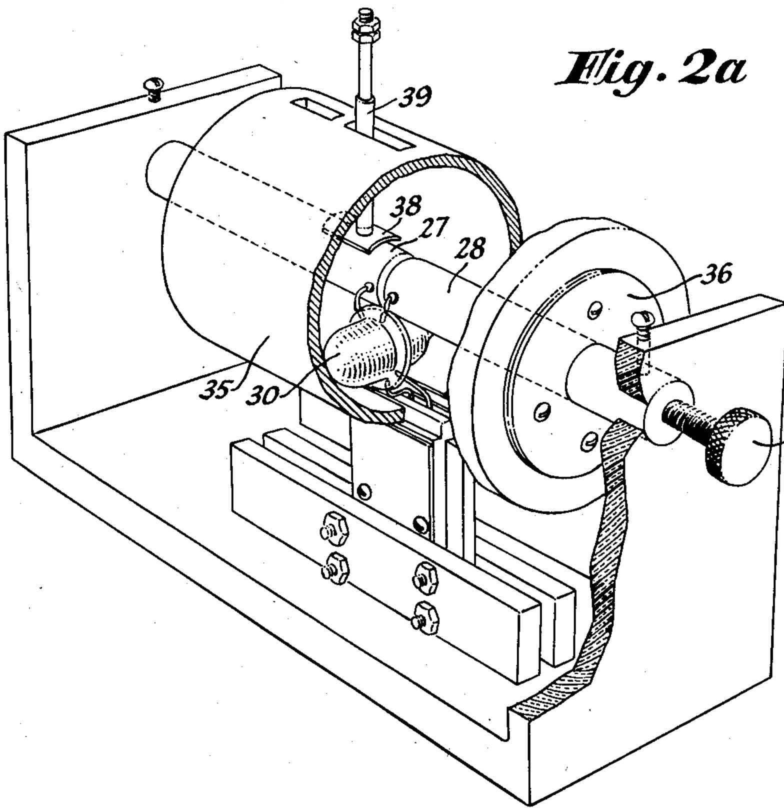
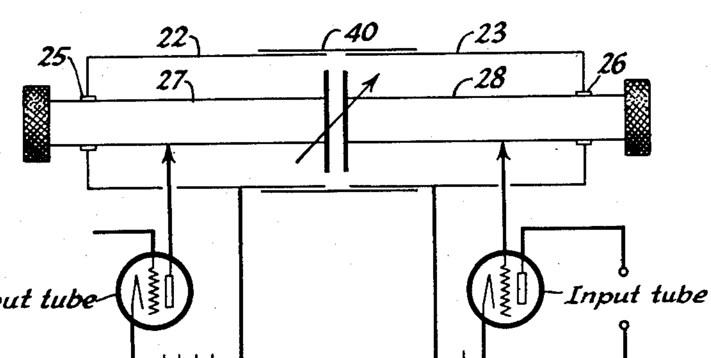


Fig. 3



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SHORT WAVE TUNED CIRCUIT ARRANGEMENT

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Original application January 21, 1937, Serial No. 121,498, now Patent No. 2,222,644, dated November 26, 1940. Divided and this application May 29, 1940, Serial No. 337,798

16 Claims. (Cl. 250—36)

This invention relates to ultra short wave radio circuits and is a division of my copending application, Serial No. 121,498, filed January 21, 1937, Patent No. 2,222,644, granted November 26, 1940. The primary object of the invention is to provide novel constructions of short wave resonator circuits and novel uses therefor, in associated electron discharge device arrangements.

In the accompanying drawings:

Fig. 1 shows, by way of example, one form of metallic resonator circuit used as a frequency controlling element of an oscillation generator;

Fig. 2 illustrates another form of construction of a short wave resonator used as the frequency control element of an electron discharge device oscillator wherein the oscillator per se is contained within the outer conductor of the line;

Fig. 2*a* is a perspective view of the circuit of Fig. 2, partly disassembled to illustrate the mechanical construction of the resonator and circuit; and

Fig. 3 illustrates the use of a short wave resonator as an impedance coupling element between two stages of a radio frequency amplifier.

Fig. 1 illustrates the use of a novel form of a tuned oscillatory circuit used as a frequency controlling and feed back arrangement between the input and output electrodes of an electron discharge device oscillator. In this case, the oscillatory circuit is in the form of a concentric line and comprises an outer conductor formed of two sections **22** and **23** which are capacitively coupled together through an insulating ring **24**, both sections being slidable over the inner conductor over electrically conducting bearings **25** and **26**. The inner conductor also consists of two sections **27** and **28** which extend in the same straight line, the adjacent ends of rods **27** and **28** of the inner conductor being capacitively coupled together while the other ends are fastened to a suitable support comprising an insulated U-shaped element **29**. The oscillation generator arrangement, shown by way of example as a triode **30**, has its control electrode connected over a sliding joint to one of the elements **27** while its output anode electrode is similarly connected to the other element **28** of the inner conductor, the filament being connected on one side to section **22** and on the other side through a suitable polarizing battery to the other section **23**. It will thus be observed that the control and anode electrodes of the oscillator **30** are suitably insulated from one another for direct current potential, although the entire assembly of concentric circuits **22, 23, 27, 28** form a single tank circuit. The proper value of excitation may be obtained by adjusting the position of the lead **31** over the length of rod **27**, while the proper impedance presented to the output circuit of the electron discharge device **30** can be obtained by slidably adjusting the lead **32** over the length of the rod **28**.

At ultra high frequencies where the lengths of the leads **31** and **32** are desired to be at a minimum and fixed, the excitation of the grid can be varied not by moving the conductor **31** but by moving the entire outer conductor, consisting of **22, 23** and **24**, over the length of inner conductor elements **27** and **28**. The bearings **25** and **26** which permit the conductive connection between the outside cylinder and the inner conductor enable such a movement to be made without disturbing the connections to the electrodes of the electron discharge device. In this case, of course, the leads from the filament of tube **30** to both cylindrical elements **22** and **23** of the outer conductor should be of sufficient length to enable such an adjustment without breaking the connections to the outer conductor of the tuned circuit. The capacity between the two metallic rods **27** and **28** of the inner conductor can be varied in any suitable fashion, such as by adjusting one of the rods **27** or **28** or both with respect to one another from a point external of the tuned concentric circuit, such as by handle or knob **33** which is mechanically linked to the rod **28**.

Where desired, the radio frequency filament return leads need not be fixedly fastened to the outer conductor but may be arranged in sliding contact fashion so that the electron discharge device and lead connections remain fixed while the outer conductor slides over the inner conductor. Such an arrangement is shown in Figs. 2 and 2*a* which now show the electron discharge device **30** located within the outer conductor, the grid and anode being permanently connected to suitable points on the two rods **27** and **28** of the inner conductor. The tube **30** in this figure is of the indirectly heated type, each leg of the filament and heater being by-passed to the outer conductor which may be at ground or zero radio frequency potential, by means of condensers comprising suitably spaced and insulated connections **33'** and **34** which, although fixed with respect to one another, permit the outer conductor of the tuned concentric line to make a wiping contact over the lengths of the two outer connections **33'**. This will be more apparent from an inspection of Fig. 2*a*, which shows the construction of Fig. 2 somewhat disassembled. The tuned concentric line of Fig. 2 also differs from that of Fig. 1 by having the isolating condenser of the outer conductor (indicated generally as 24 in Fig. 1) at one of the extreme ends of the line. In Fig. 2, this isolating condenser merely consists of end plate 35 fastened to the outer conductor but separated by means of mica spacers from a pair of flanges 36 which are in intimate contact with the rod 28 of the inner conductor. Instead of using bearings, such as 25 and 26 shown in Fig. 1, there are provided at each end of the line circuit of Fig. 2 suitable sliding fits which enable the outer conductor to be varied as a unit over the metallic rods 27 and 28 comprising the inner conductor, in the same fashion as the outer conductor of Fig. 1 is variable over its inner conductor. These sliding fits comprise, in a preferred embodiment, tight cylindrical metallic shields which are slit longitudinally at several points in their periphery for the purpose of providing a firm springy contact with the rods 27 and 28 constituting the inner conductor.

Variation of the capacity between rods 27 and 28 is here obtained by variation in the projecting length of a plug 37 which is movable in suitably cut-out apertures in the inner conductors 27 and 28, as shown, and movable in response to variation of knob 33.

Energy may be taken from the tuned concentric line of Figs. 2 and 2*a* by means of a suitable sleeve 38 which contacts with either rod 27 or 28 and is movable over their lengths by virtue of a metallic rod 39 which extends out from the outer conductor through a slit running along the axes of the inner and outer conductors. Rod 39 is, of course, insulated from the outer conductor as it passes through the slit, either by means of an insulating material or by means of the air space between the rod 39 and outer conductor.

When it is desired to obtain a greater output from the tuned concentric line circuits of Figs. 1 and 2 than is possible by the use of a single electron discharge device, there may be employed a plurality of electron discharge devices placed around the tuned line circuit in identically the same manner as shown in either Figs. 1 or 2. In the case of Fig. 2, of course, the electron discharge devices would be located in the interior of the tuned circuit and, preferably, symmetrically disposed around the inner surface of the outer conductor with respect to the inner conductor.

Fig. 3 illustrates a tuned concentric line of a type very similar to that shown in Fig. 1 as an impedance coupling element between two stages of an amplifier. It should be noted that whereas the circuit of Fig. 1 shows this line as a frequency controlling and feed back path for an oscillation generator, the line of Fig. 3 is an impedance coupling element between the output electrodes of one stage and the input electrodes of another stage. In this last figure, the output electrodes of one stage are connected to one rod and one outer cylinder of the inner and outer conductors of the line, respectively, while the input electrodes of the other stage are connected to the other rod and the other cylinder of the inner and outer conductors of the line, respectively. Here again, although the outer conductor is shown slit in the center in the same manner shown in Fig. 1, if desired the outer conductor may consist of a single cylinder which is insulated from the inner conductor at one end, as shown in Fig. 2, the essential requirement being that the outer conductor be insulated from at least one of the rods of the inner conductor at some point in its length. For mechanical simplicity, the cylinders 22 and 23 of the outer conductor are here shown capacitively coupled together through a spaced concentric metallic cylinder 40, instead of by means of flanges as shown in Fig. 1.

It is to be distinctly understood that the invention is not limited to the precise arrangements shown and described, since various modifications may be made without departing from the spirit and scope thereof.

What is claimed is:

1. An impedance coupling element between an input and an output circuit, comprising a pair of concentric lines placed end to end, each line of said pair having an inner and an outer conductor coupled together at the end remote from the other line, means for capacitively coupling said inner conductors together, and means for capacitively coupling said outer conductors together, whereby said pair of concentric lines taken together form an electrical resonator, said input circuit being coupled to one of said lines, and said output circuit being coupled to the other of said lines.

2. A tuned circuit comprising a concentric line having straight inner and outer conductors coupled together, said inner and outer conductors being each physically separated into two portions, which two portions are capacitively coupled together at their adjacent ends, the two portions of the outer conductor being movable as a unit over the outer surface of said inner conductor.

3. A tuned circuit comprising a concentric line having inner and outer coupled conductors, said inner and outer conductors being each physically separated into two portions, which two portions are capacitively coupled together at their adjacent ends, the other ends of said outer conductor portions being in conductive contact with different portions of the inner conductor and slidably movable thereover.

4. A tuned circuit comprising a concentric line having inner and outer coupled conductors, said inner conductor being separated into two coaxially arranged portions whose adjacent ends are capacitively coupled together, means for varying the capacity of said two portions, means for coupling said outer conductor to said two portions, said means being slidable over the lengths of said two portions.

5. The combination with a circuit as defined in claim 4, of an input circuit coupled between one portion of the inner conductor and said outer conductor, and an output circuit coupled between the other portions of said inner conductor and outer conductor.

6. The combination with a circuit as defined in claim 4, of an input circuit coupled between one portion of said inner conductor and said outer conductor, and an output circuit coupled between the other portion of said inner conductor and said outer conductor, the connections from said input and output circuits to said portions being adjustable over the lengths thereof.

7. In combination, an ultra high frequency tuned oscillatory circuit in the form of a metallic surface of revolution, said surface of revolution being divided into two similarly constructed and symmetrically located cylindrically shaped parts capacitively coupled together at their adjacent

edges by spaced flanges, a lumped capacitor located in the interior and substantially in the center of said surface of revolution and having different plates directly connected from a direct current standpoint to opposite points on said two parts by inductance in the form of rods.

8. In combination, an ultra high frequency tuned oscillatory circuit in the form of a metallic surface of revolution, said surface of revolution being divided into two similarly constructed and symmetrically located cylindrically shaped parts capacitively coupled together at their adjacent edges by spaced flanges, a lumped capacitor located in the interior and substantially in the center of said surface of revolution and having different plates directly connected from a direct current standpoint to opposite points on said two parts by inductance in the form of rods, said rods being arranged in the same straight line and positioned along the axis of said surface, said lumped capacitor comprising a plurality of spaced metallic plates located between the adjacent ends of said rods.

9. In combination, an ultra high frequency tuned oscillatory circuit in the form of a metallic surface of revolution, said surface of revolution being divided into two similarly constructed and symmetrically located parts capacitively coupled together at their adjacent edges by spaced flanges, a lumped capacitor located in the interior and substantially in the center of said surface of revolution and having different plates directly connected from a direct current standpoint to opposite points on said two parts by inductance in the form of rods.

10. In combination, an ultra high frequency tuned oscillatory circuit in the form of a metallic surface of revolution, said surface of revolution being divided into two similarly constructed and symmetrically located parts capacitively coupled together at their adjacent edges by spaced flanges, a lumped capacitor located in the interior and substantially in the center of said surface of revolution and having different plates directly connected from a direct current standpoint to opposite points on said two parts by inductance in the form of rods, said rods being arranged in the same straight line and positioned along the axis of said surface, said lumped capacitor comprising a plurality of spaced metallic plates located between the adjacent ends of said rods.

11. In combination, an ultra high frequency tuned oscillatory circuit in the form of a metallic surface of revolution, said surface of revolution being divided into two similarly constructed and symmetrically located parts capacitively coupled together at their adjacent edges by spaced flanges, a lumped capacitor located in the interior and substantially in the center of said surface of revolution and having different plates directly connected from a direct current standpoint to opposite points on said two parts by inductance in the form of rods, means for coupling said surface of revolution to said rods, said means being slidable over said rods.

12. In combination, an ultra high frequency tuned oscillatory circuit in the form of a metallic surface of revolution, said surface of revolution being divided into two similarly constructed and symmetrically located parts capacitively coupled together at their adjacent edges, a lumped capacitor located in the interior and substantially in the center of said surface of revolution and having different plates directly connected from a direct current standpoint to opposite points on said two parts by inductance in the form of rods, an electron discharge device having an anode, a cathode and a control electrode, connections from said anode and control electrode to different ones of said rods, and a connection from said cathode to said surface of revolution.

13. In combination, an ultra high frequency tuned oscillatory circuit in the form of a metallic surface of revolution, said surface of revolution being divided into two similarly constructed and symmetrically located parts capacitively coupled together at their adjacent edges, a lumped capacitor located in the interior and substantially in the center of said surface of revolution and having different plates directly connected from a direct current standpoint to opposite points on said two parts by inductance in the form of rods, said rods being arranged in the same straight line and positioned along the axis of said surface, said lumped capacitor comprising a plurality of spaced metallic plates located between the adjacent ends of said rods, an electron discharge device having an anode, a cathode and a control electrode, connections from said anode and control electrode to different ones of said rods, and a connection from said cathode to said surface of revolution.

14. In combination, a tuned circuit comprising a concentric line having inner and outer coupled conductors, said inner and outer conductors being each physically separated into two portions, which two portions are capacitively coupled together at their adjacent ends, the other ends of said outer conductor portions being coupled with different portions of the inner conductor, an electron discharge device having an anode, a cathode and a control electrode, connections from said anode and control electrode to different portions of said inner conductor and a connection from said cathode to said outer conductor.

15. In combination, a tuned circuit comprising a concentric line having inner and outer coupled conductors, said inner and outer conductors being each physically separated into two portions, which two portions are capacitively coupled together at their adjacent ends, the other ends of said outer conductor portions being coupled with different portions of the inner conductor, an electron discharge device having an anode, a cathode and a control electrode, connections from said anode and control electrode to different portions of one of said conductors of said tuned circuit, and a connection from said cathode to the other conductor of said tuned circuit.

16. An ultra-high frequency device, comprising a coaxial line having inner and outer members short circuited at both ends, said inner conductor being open intermediate its ends, capacitive loading means interposed in said inner conductor where said inner conductor is open, an anode connected to said inner conductor at one side of the point where said inner conductor is open, a grid connected to the inner conductor at the other side of said point and positioned to cooperate with said anode, an emissive cathode positioned to cooperate with said grid and said anode to form a triode, the impedances of said triode being matched to the impedances of said coaxial line at the point where said cathode, grid and anode are respectively connected.

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