May 2, 1939. J. EVANS 2,156,261

RESONANT CIRCUIT FOR ULTRA HIGH FREQUENCY AMPLIFIERS

Filed June 13, 1936 2 Sheets-Sheet 1

Fig. 1.

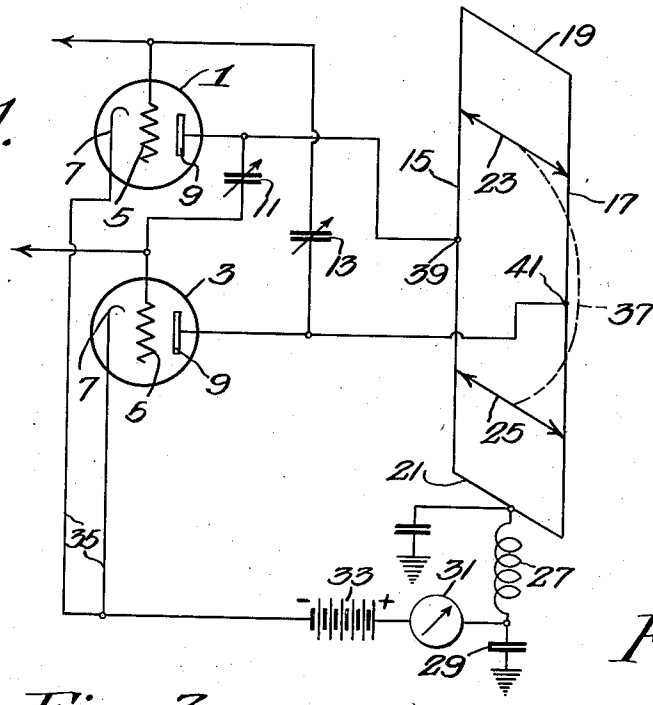



Fig. 4.

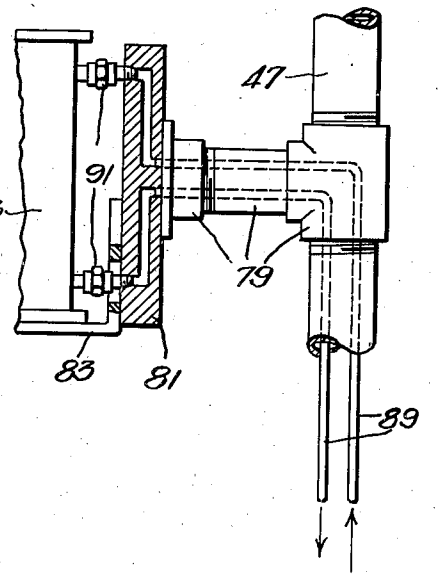
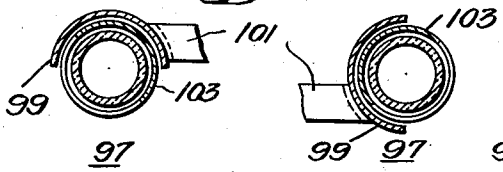



Fig. 3.




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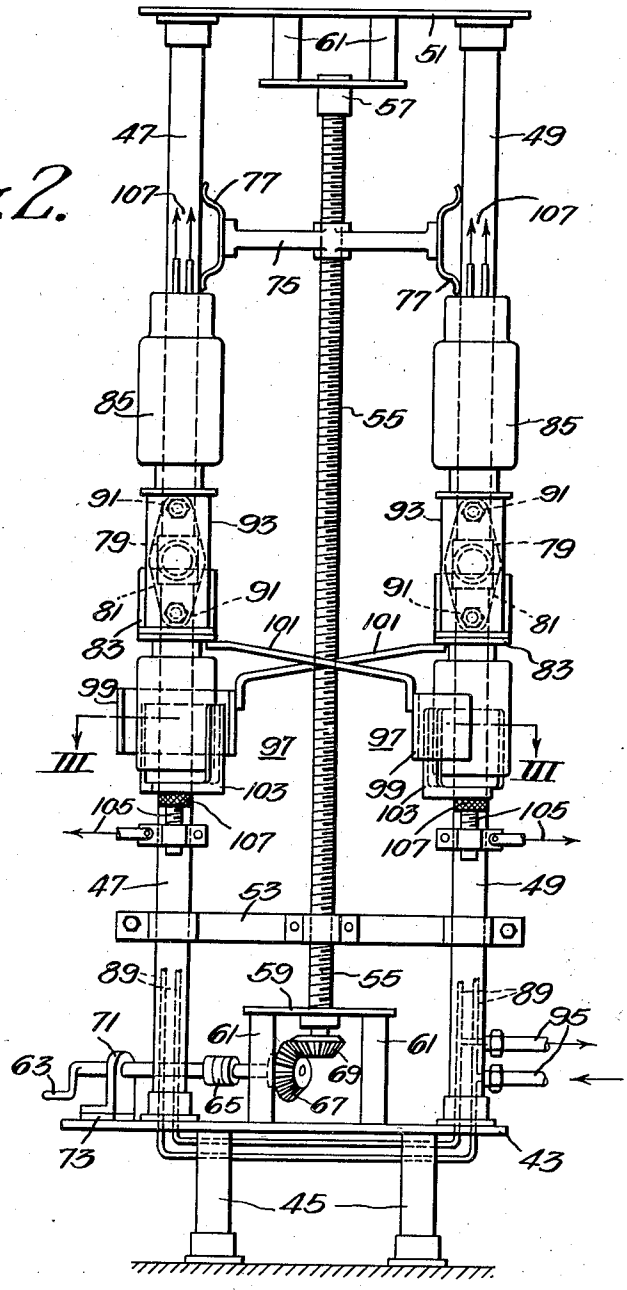
Attorney

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RESONANT CIRCUIT FOR ULTRA HIGH FREQUENCY AMPLIFIERS

Filed June 13, 1936 2 Sheets-Sheet 2

Fig. 2.




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# UNITED STATES PATENT OFFICE

2,156,261

## RESONANT CIRCUIT FOR ULTRA HIGH FREQUENCY AMPLIFIERS

John Evans, Oaklyn, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application June 13, 1936, Serial No. 85,019

2 Claims. (Cl. 179—171)

My invention relates to radio amplifiers; more specifically it relates to the output circuit of an amplifier stage of an ultra high frequency radio transmitter.

I am aware of the use of tuned output circuits in connection with amplifiers for radio transmitters. So called "long lines" or resonant lines have been used for this purpose. The present invention uses a novel arrangement of a resonant line, and thereby increases the operating efficiency, ease of adjustment, and simplicity of arrangement.

One of the objects of my invention is to improve the efficiency of a resonant line connected to the output circuit of an ultra high frequency amplifier.

Another object is to make a resonant line which is readily tunable and has means whereby the impedance of the terminals may be suitably varied.

Another object is to provide an electric discharge amplifier which includes a resonant line output circuit, with means for neutralizing the capacity coupling between input and output circuits of the discharge amplifier.

A further object is to employ water cooled thermionic tubes in an amplifier employing a resonant line and to install conduits for the water cooling within the resonant line conductors.

A still further object is to eliminate insulators from the high frequency field and substitute therefor portions of the conductor of a resonant line.

In the accompanying drawings which illustrate embodiments of my invention, Fig. 1 is a schematic diagram illustrating the output circuit of an amplifier,

Fig. 2 is an elevational view representing an embodiment of my invention,

Fig. 3 is a sectional view along the lines III—III of the neutralizing capacitors shown in Fig. 2, and

Fig. 4 represents, partly in a sectional view, some of the details of the water cooling conduits which convey water to the anodes of the thermionic amplifiers.

Referring to Fig. 1, a pair of thermionic amplifier tubes 1, 3, having grid 5, cathode 7, and anode-electrodes 9, are connected as follows: The grids 5 are connected to a preceding amplifier, oscillator, or other suitable source of high frequency energy which is not shown. The cathodes 7 may be energized by direct or alternating current in the conventional manner. I prefer to tune the cathode leads to establish potential nodal points at the cathodes; i. e., zero impedance between cathodes and ground. The grids 5 and anodes 9 are cross-connected by neutralizing capacitors 11, 13. The anodes 9 are connected to a pair of parallel conductors 15, 17, which have mutually cancelling fields.

The ends of these conductors may be connected by conductive members 19, 21. Intermediate these conductive members 19, 21 are arranged a pair of adjustable bridging conductors 23, 25. The lower conductive member 21 is serially connected through a radio frequency choke coil 27 and capacitor 29 to ground. The junction between the radio frequency choke 27 and capacitor 29 is connected to an ammeter 31. The remaining terminal of the ammeter is connected to the positive terminal of the anode power supply 33. The negative terminal of the power supply is connected to the cathode leads 35. The resonant circuit may be coupled to a work circuit by capacitive, inductive or conductive means not shown.

The operation is as follows: The neutralizing capacitors 11, 13 are adjusted to eliminate capacity coupling between the input and output circuits of the amplifier. This stabilizes the amplifier and prevents self-oscillation. The bridging members are adjusted so that each of the parallel conductors plus half of each bridging conductor is resonant to a half wave length of the high frequency currents to be amplified. The potential distribution in half the resonant circuit is approximately indicated by the dash line 37. A similar potential distribution line for the other half of the resonant circuit is not shown but may be assumed to exist in opposite phase. The amplifiers 1, 3 are in push-pull relation and therefore continue to supply energy to the output circuit in proper phase to maintain oscillations within the resonant circuit.

Since the high frequency potential at the lower end of the parallel conductors is substantially zero, no high frequency currents tend to flow to ground. Insulation is only provided for the direct current supply. The foregoing arrangement eliminates the losses caused by the use of insulators in ultra high frequency electric fields. In the particular diagram of Fig. 1 the anode terminal connections 39, 41 are midway between the bridging conductors. These connections 39, 41 represent the maximum impedance of the resonant circuit. The impedance at the terminal connections 39, 41 may be varied by altering the relative position of the connections and

the bridging members. As the distance between the anode terminal connections and the nearer bridging member decreases, the impedance between the anode connections decreases. The distance from the anode connections to the other bridging member is increased to maintain the same resonant frequency. The impedance of the resonant circuit, represented between the connections 39, 41, may match, or be more or less than the anode circuit impedance as required.

One embodiment of the apparatus which has proven very efficient is illustrated in Figs. 2, 3 and 4. In these figures similar reference numerals will indicate similar parts. Referring to Fig. 2, a base member 43 is insulated from ground by suitable insulated supports 45. A pair of hollow parallel conductive members 47, 49 are mounted on the base. The tops of these parallel conductors are positioned by a connecting member 51.

A lower conductive bridging member 53 is clamped adjacent the base and may be adjusted with respect thereto. A non-ferrous screw 55, preferably centrally located with respect to the hollow conductors, is mounted on bearings 57, 59. These bearings may be insulated by members 61 from the base 43 and top connecting member 51. The screw 55 may be turned by a crank 63 which is connected through the insulated coupling 65 and bevel gears 67, 69, or the like, to the screw. The bearing 71 for the crank is preferably insulated by a suitable block 73. An upper conductive bridging member 75 is adapted to be moved by the screw 55. The ends of the upper bridge member 75 are provided with brushes 77 which make low loss contacts with the hollow conductors 47, 49.

Suitable fittings 79, intermediate the upper and lower bridging members, are attached to the hollow conductors to support a pair of cored blocks 81. Angular members 83, attached to the cored blocks 81, support a pair of water cooled thermionic tubes 85. The water cooling conduit comprises pipes 89 which extend through the hollow conductors 47, 49 to fittings in the cored block. Unions 91 are used between the cored block and the water cooled anode 93. The hollow conductors 47, 49 may be used as one of the water conduits. The pipes 89 terminate in rubber hose 95 which is connected to a water supply not shown. Because of the very low radio frequency potential between the hose connection and ground, the hose is not subject to deterioration.

Neutralizing capacitors 97 are cross-connected between the grid and anode electrodes. These capacitors may be made by a pair of semi-cylindrical outer armatures 99 which are fixedly supported from the anodes by braces 101. Opposing or inner armatures 103 are rotatably mounted on the grid leads 105. The inner armatures 103 may be of semi-cylindrical form but of lesser diameter than the outer armatures to provide an air dielectric between the inner and outer armatures. A vernier adjustment of the inner armatures is secured by raising or lowering the knurled nuts 107 on which the inner armatures are supported. After adjustment, the rotatable armatures may be locked in position.

The grid leads 105 are connected to a high frequency source which is to be amplified. These connections are preferably made to a push-pull amplifier or the like. The cathode leads are represented by arrows 107. These leads may be tuned as described in my Patent No. 2,113,340, which issued April 5, 1938, on application filed September 21, 1935, and entitled Ultra high frequency oscillators.

Thus I have described a resonant output circuit for an ultra high frequency amplifier. The output circuit is characterized by its low losses, short connecting leads, elimination of insulation from the high frequency field, ease of neutralization, and impedance adjustment to match the associated circuits. The operation of the apparatus emphasizes the efficiency and frequency range which is higher than heretofore considered practical with thermionic amplifiers of the type described.

I claim as my invention:

1. An amplifier output circuit for ultra high frequencies including, in combination, a pair of thermionic tubes having grid, a grid lead, cathode and water-cooled anode electrodes, a pair of parallel conductors, means connecting said anode electrodes to said conductors, bridging members connecting said conductors and positioned on either side of said anode connections, means at ground potential for simultaneously adjusting said bridging members, cross-connected neutralizing capacitors supported from said anodes and said grid leads comprising inner and outer semi-cylindrical plates, one of which is rotatable about its axis to provide a coarse capacity adjustment, and independently movable axially to provide a vernier adjustment, and means extending within said parallel conductors and said anode connections for water cooling said anodes.

2. A device of the character of claim 1 being further characterized by having tuned cathode leads whereby the impedance between said cathodes and ground is made substantially zero.

JOHN EVANS.