Aug. 9, 1938. J. EVANS 2,125,900

ULTRAHIGH FREQUENCY APPARATUS

Filed Nov. 25, 1936

Fig. 1.

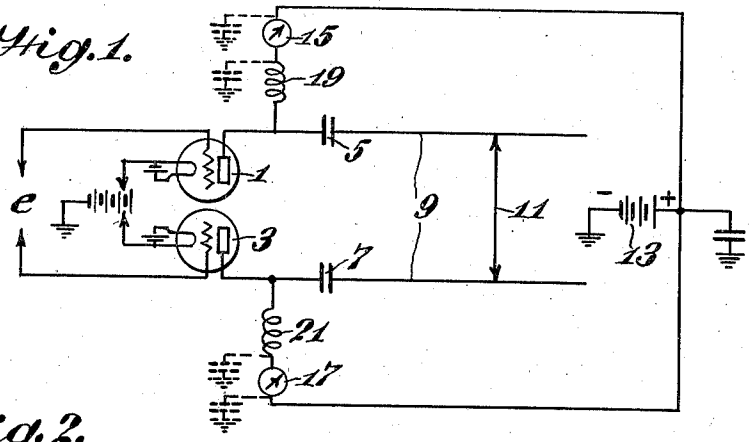


Fig. 2.

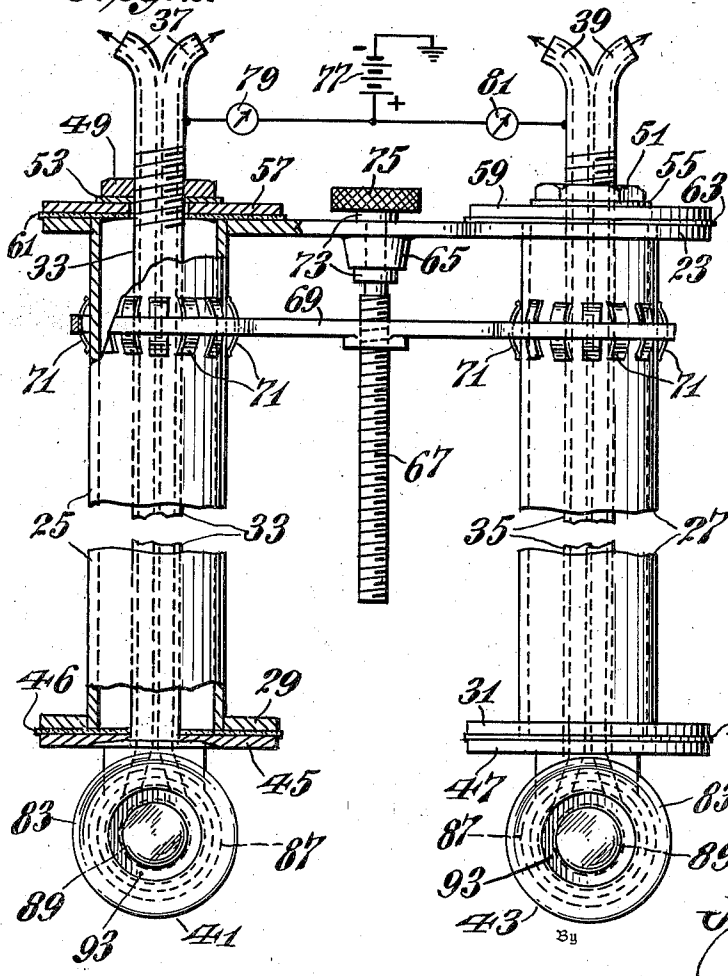


Fig. 3.

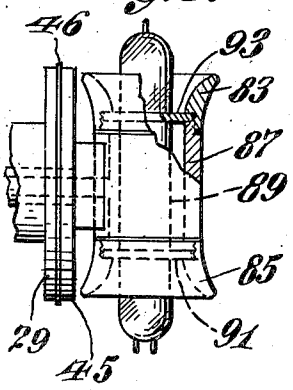
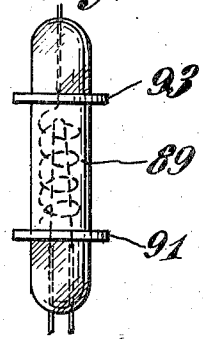


Fig. 4.



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2,125,900

ULTRAHIGH FREQUENCY APPARATUS

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Application November 25, 1936, Serial No. 112,653

8 Claims. (Cl. 179—171)

My invention relates to ultra high frequency apparatus, and more specifically to the output circuit of an ultra high frequency thermionic amplifier of the push-pull type.

Undesired distributed capacities may cause large losses in devices associated with ultra high frequency current amplification. As hereinafter used, the term ultra high frequency will include radio frequency currents having an oscillatory frequency of the order of thirty megacycles per second and upward. In a push-pull amplifier employed for television and like transmission, it is highly desirable to segregate the direct currents and the radio frequency currents. While direct and low radio frequency currents can be segregated without difficulty, at ultra high frequency precautions must be observed. The capacity of choke coils, meters and the like to ground may be neglected at low frequencies. At ultra high frequencies, these capacities are generally sources of loss which detract from the normal efficiency of the circuits. I propose to provide novel means for minimizing the stray capacities, and thereby improve the efficiency of ultra high frequency amplifiers.

One of the objects of my invention is to provide improved means for operating a push-pull, ultra high frequency amplifier.

Another object is to provide means for shunt feeding the anodes of a push-pull amplifier and utilizing the stray capacity effects.

A further object is to provide means, in a push-pull amplifier, for shielding the direct current anode leads within the tuned output circuit of the amplifier.

A still further object is to provide means for impressing direct currents on the anodes of a push-pull amplifier through water-cooling conduits, and providing means for tuning the output circuit which shields the direct current leads and determines the impedance characteristics of these leads.

Referring to the accompanying drawing, Figure 1 is a schematic circuit diagram of a push-pull amplifier with a shunt-fed anode circuit,

Figure 2 is a plan view, partly in section, of one embodiment of my invention,

Figure 3 is an elevational view of one of the thermionic tube holders of Figure 1, and

Figure 4 is an illustration of a water-cooled thermionic tube of the type employed in one embodiment of my invention.

Referring to Figure 1, a source of exciting voltage *e* is applied to the inputs of a pair of push-pull thermionic tubes 1, 3. The outputs of these tubes are connected through capacitors 5, 7 to a resonant circuit 9 which is tuned by a bridging conductor 11. The anode current source 13 is connected to the anode electrodes through ammeters 15, 17 and radio frequency chokes 19, 21.

The foregoing circuit is a push-pull shunt-fed amplifier, which is entirely satisfactory at relatively low radio frequencies. At ultra high frequencies the stray capacities from the chokes 19, 21 and ammeters 15, 17 to ground, represented by dotted lines, are objectionable. Furthermore, the proper impedance characteristics of choke coils over a range of ultra high frequencies are not always obtainable.

An improved means for connecting the output circuit of a push-pull amplifier is represented in Figure 2. On a metal base plate 23 are mounted a pair of hollow conductors 25, 27, which include flanges 29, 31 at their ends remote from the base 23. Within each of the hollow conductors 25, 27, and spaced from their inner walls, are mounted metal pipes 33, 35. These pipes 33, 35 are divided along their longitudinal axes to form water conduits 37, 39, which are connected to the anode supports 41, 43 and to flanges 45, 47. The flanges 45, 47, connected to the anode supports,are suitably insulated by mica spacers 46, 48, or the like from the conductor flanges 29, 31.

The ends of the water conduits, which pass through the base 23, may be threaded as shown and equipped with nuts 49, 51, washers 53, 55, and flanges 57, 59. The flanges 57, 59 are insulated from the base plate 23 by suitable mica washers 61, 63. The pipes 33, 35 and associated anode supports are fixed and spaced with respect to the hollow conductors 25, 27 by tightening the nuts 49, 51 which draw the base plate 23, conductors 25, 27, and the several flanges together. A bearing block 65, mounted on the base 23, supports the screw 67 which is threaded into a bridging member 69. Brushes 71, on the ends of the bridging member, contact the hollow conductors. Since the screw 67 is restrained from longitudinal movement by suitable collars 73, the control knob 75 may be rotated to move the bridging member to effectively tune the conductors 25, 27 connecting the anode supports 41, 43. The anode power source 77 is connected to ground, through ammeters 79, 81, and the pipes 33, 35 to the anode supports 41, 43. The water connection is made through rubber tubing to a source not shown.

The anode supports (see Figure 3) are provided with end portions 83, 85, which are screwed to the main portion 87 of the anode support. The anodes 89 (see Figure 4) are provided with shoul-

ders 91, 93. The anode electrodes 89 are clamped between the end portions 83, 85. Gaskets, not shown, may be used to make these connections water-tight. The space between the anode shoulders 91, 93 becomes the water jacket which is connected to the conduits 37 to complete the circulating path for the cooling medium.

In the operation of the foregoing circuit, the bridging conductor 69 is adjusted until the hollow conductors 25, 27 are tuned to substantially a quarter-wave length. The sum of the quarter-wave sections is a half-wave line which is, at its center, at ground potential with respect to ultra high frequency currents. The mica insulation 46, 48 and the flanges 29, 45 and 31, 47 form capacities of sufficient magnitude to offer very low reactance to the ultra high frequency currents flowing from the anode electrodes 89 and anode supports 41, 43 into the resonant line. The pipes 33, 35, which are spaced from the walls of the hollow conductors 25, 27, are so closely coupled to these conductors that they partake of the resonant characteristics of each. Each conductor, as previously explained, is tuned to a quarter-wave length; therefore the pipes within the conductors become quarter-wave sections which are insulated with respect to direct currents, and grounded with respect to radio frequency currents by the capacity between the flanges 57, 59 and the base plate 23.

Thus the pipes 33, 35, being tuned to a quarter-wave length, become very effective chokes for the shunt-feed anode circuit. These chokes are completely shielded within the hollow conductors. The stray capacities become coupling and by-pass capacities which, instead of contributing to the losses of the device, become a component part of the circuits.

I claim as my invention:

1. An amplifier comprising a pair of thermionic tubes having anode and cathode electrodes, a pair of hollow conductors coupled to said anodes by capacity coupling, said conductors forming a resonant quarter-wave line as viewed from said anodes to ground, water conduits located within said hollow conductors and conductively connected to said anodes, an anode current source, and means connecting said source between said conduits and said cathode electrodes.

2. An amplifier comprising a pair of thermionic tubes having anode and cathode electrodes, a pair of hollow conductors capacitively coupled to the anodes of said tubes, means for adjusting said conductors to form a quarter-wave length resonant circuit as viewed from said anodes to ground, water conduits located within said hollow conductors and conductively connected to said anodes, an anode current source, and means connecting said source between said conduits and the cathode electrodes of said tubes.

3. A push-pull amplifier comprising a pair of thermionic tubes having anode and cathode electrodes, a pair of hollow conductors mounted in parallel relationship and capacitively coupled to said anodes, a bridging conductor connecting said conductors, water conduits located within said hollow conductors and connected to said anodes, means for insulating said conduits from said hollow conductors, a source of anode current, and means connecting said source between said conduits and said cathodes.

4. A push-pull amplifier comprising a pair of water-cooled vacuum tubes having grid, cathode and anode electrodes, a pair of hollow conductors capacitively coupled to said anodes and arranged to form a resonant line, means arranged within said hollow conductors for applying direct currents to the anodes and arranged to form a radio frequency choke at the operating frequency of said amplifier, and means for insulating said first-mentioned means from said hollow conductors.

5. In a device of the character of claim 4, means for reading the direct currents flowing to each of said anodes.

6. In an ultra high frequency amplifier, a pair of thermionic tubes having cathode, grid and anode electrodes, a pair of hollow conductors capacitively coupled to said anodes and arranged as a resonant line, means positioned within said hollow conductors and insulated therefrom for applying direct currents to said anodes, and means coupling said hollow conductors and said first mentioned means so that said first mentioned means partakes of the resonant characteristics of said hollow conductors and offers high impedance to ultra high frequency currents in said resonant line.

7. In a device of the character described in claim 6, further characterized in that said thermionic tubes have fluid-cooled anodes, and said first mentioned means is a conduit for said fluid.

8. In a device of the character described, a base plate, a pair of hollow conductors mounted on said base plate, a bridging conductor supported between said conductors, a conductive fluid conduit mounted on said base plate and positioned within said hollow conductors, anode supports mounted on said conduits and capacitively coupled to said hollow conductors, and means for adjusting said bridging member to resonate said conductors and said conduits.

JOHN EVANS.