

Jan. 10, 1939.

P. D. ZOTTU

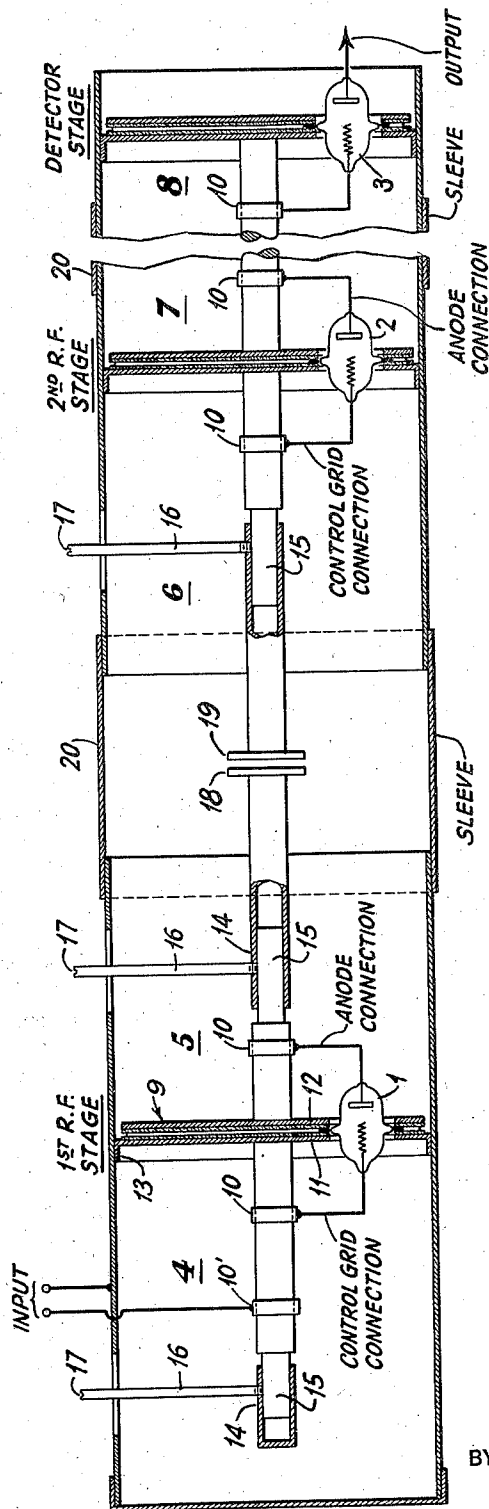
2,143,671

ULTRA SHORT WAVE CIRCUIT

Filed June 4, 1937

2 Sheets-Sheet 1

Fig. 1



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Fig. 2

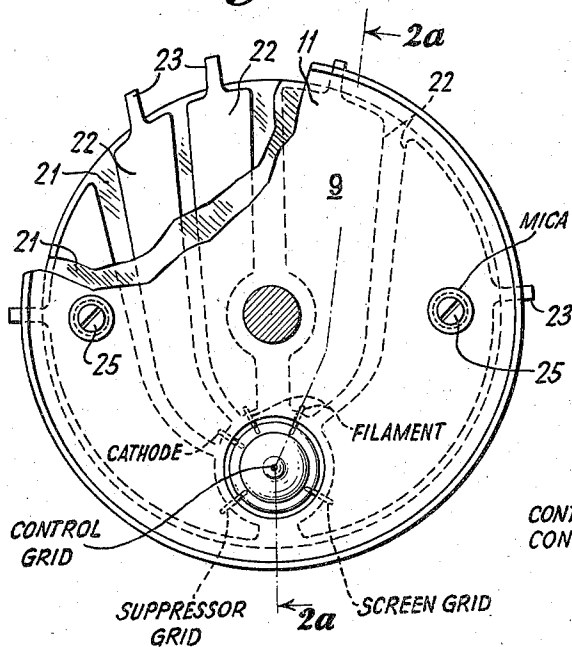


Fig. 2a

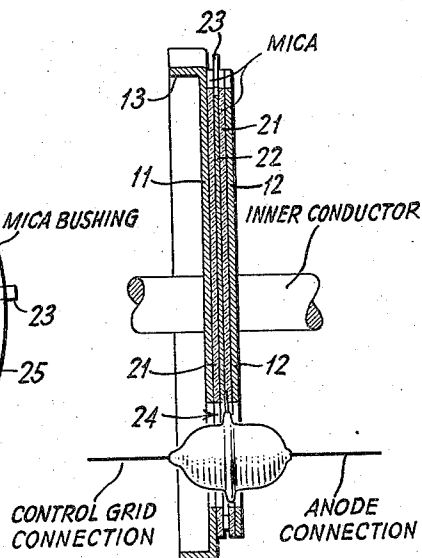
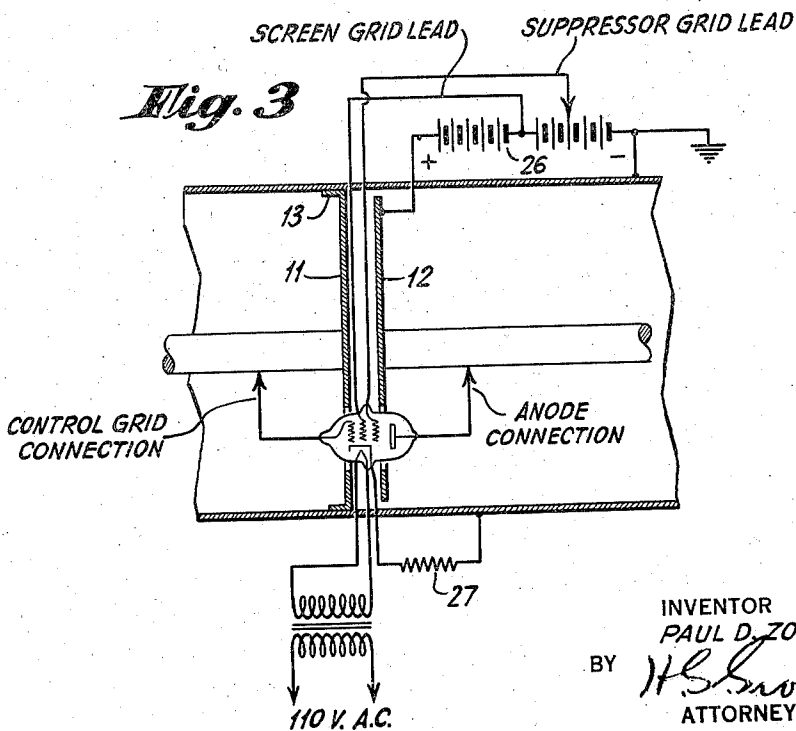


Fig. 3



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ULTRA SHORT WAVE CIRCUIT

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9 Claims. (Cl. 179—171)

The present invention relates to ultra short wave electron discharge device circuits, and particularly to multistage circuits.

An object of the invention is to provide a multistage ultra-short wave amplifier employing a plurality of interstage coupling impedances consisting of tuned concentric lines placed end to end in the same straight line.

Another object is to provide a completely shielded multistage electron discharge device amplifier circuit wherein the electron discharge device stages are located within the outer conductors of the tuned concentric lines used as coupling impedances between stages.

A further object is to provide a space conserving ultra short wave multistage receiver using tuned concentric lines as coupling impedances between stages, and wherein the leads between stages are of minimum length.

The advantages and features of the invention, together with other objects, will appear from a reading of the following description which is accompanied by drawings. It is to be distinctly understood, however, that these drawings are merely illustrative and do not define the limits of the invention.

In the drawings:

Fig. 1 illustrates very diagrammatically, a multistage ultra short wave receiving system employing tuned concentric lines as interstage coupling impedances. The concentric lines are shown, in part, in section, and the energy supply sources are omitted for the purpose of simplifying the drawing;

Fig. 2 is a detailed view of the electron discharge device support which also serves both as an end plate for associated tuned concentric lines and to bring out the connections from the stages to the external sources of energy;

Fig. 2a is a cross-sectional view of Fig. 2, along the line 2a—2a; and

Fig. 3 is a detailed view of one stage of the receiver showing, diagrammatically, the connections from the electrodes of the electron discharge device to the external sources of energy.

Referring to Fig. 1 in more detail, there is shown a receiver comprising a suitable input circuit, for example an antenna (not shown) feeding two stages 1, 2 of radio frequency amplification, in turn feeding a detector 3 to whose output a suitable utilization circuit (not shown) is connected. Although only two stages of amplification have been shown, it will be understood, of course, that additional amplification stages can be added either before the detector or, where an intermediate amplifier is desired, after the detector. The tuned input and output circuits of the receiver are shown as consisting of concentric lines 4, 5, 6, 7 and 8, placed end to end in a

straight line, such concentric line comprising an outer conductor and an inner conductor.

Each stage consists of an evacuated electron discharge device, preferably of the small shoe button or acorn type, located within the outer conductors of its associated tuned input and output circuits, and mounted in a circular support 9 which is movable in position within and along the lengths of the outer conductors. Support 9 comprises two plates 11 and 12 separated for direct current by a suitable dielectric, such as mica, one of the plates having a continuous circular flange 13. The dielectric separating the plates of the support serves to isolate the direct current energy applied to the electrodes of the electron discharge device, in a manner which will become more apparent later. Each electron discharge device is supported at its center by support 9 which functions, so to speak, to divide the concentric lines into shielded compartments. The control grid and anode connections of each evacuated device extending from opposite ends of the envelope of the device are coupled to rings 10 which are in direct contact with the inner conductors of the concentric lines, as shown, and adjustable in position thereover. A similar adjustable ring 10' is provided for the input circuit. Movement of these rings over the inner conductors gives the proper impedance matching between circuits and also the desired degree of excitation for the electrodes of the devices. The other electrodes of the evacuated devices are brought out to sources of energy supply located outside the concentric lines by means of connections within the supports 9, in a manner described later in connection with Figs. 2 and 3.

The concentric lines form input and output tuned circuits and are each tuned to be electrically equal in length to approximately one-quarter of the operating wavelength, or some odd multiple thereof. The inner conductors of the adjacent lines, such as 4 and 5, or 7 and 8, are firmly fastened to the centers of the oppositely disposed metallic plates 11 and 12 of the supports 9, such that each plate of the support serves as an end plate for its directly associated concentric line. The electrical characteristics of the concentric line, as a tuned circuit, are now well known in the art and described in the literature, for example, in the article in Electrical Engineering, August, 1935, pages 852 to 857, by Clarence W. Hansell, in the Marconi Review (London), vol. 62, pages 14 to 24, and in my own copending applications, Serial No. 121,500, filed January 21, 1937, and Serial No. 121,498, filed January 21, 1937, for which reason it is not deemed necessary to go into detail concerning same.

In order to tune the concentric line circuits to the desired frequency, each inner conductor

of the tuned circuits is made adjustable in length. For this purpose, the inner conductor of each concentric line consists of an adjustable metallic sleeve 14 which snugly surrounds and is in direct contact with a plug member 15 of smaller diameter, both the sleeve and plug forming a continuous conductor. The sleeve 14, generally speaking, is merely an adjustable telescoping extension of the inner conductor. To achieve the desired adjustment in the length of the inner conductor, there is provided for each sleeve an insulator rod 16 which screws into the sleeve at one end and protrudes from the associated outer conductor at the other end, through a suitable slot in the outer conductor, in an ear or handle 17, whereby movement of the handle 17 in the slot over the length of the outer conductor causes movement of the sleeve 14 over the plug 15. To insure a firm contact between the sleeve and plug and to prevent movement between them after an adjustment, the screw at the bottom of the rod 16 is made long enough to engage the outer surface of the plug when the handle 17 is turned in the proper direction. At this time it should be noted that each support 9 can be relatively spaced from other such supports by sliding the outer conductors of the concentric lines within the cylinder 20. Inasmuch as the inner conductors are mechanically fastened to the support 9, and these in turn fastened to the outer conductors, movements of the outer conductors will vary the spacing between end plates 18, 19 and thus vary the capacitive coupling between stages. The spacing between plates 18 and 19 determines the degree of capacitive coupling between the two radio frequency amplifier stages. Metallic sleeve 20 snugly surrounds and directly connects together the adjacent ends of the outer conductors of the two tuned concentric lines 5 and 6 for an appreciable portion.

Fig. 2 illustrates a front view, and Fig. 2a a side cross-sectional view of the support 9 used for mounting an electron discharge device stage and for bringing out the connections from certain of the electrodes of the discharge device to the sources of energy located externally of the outer conductor of the tuned concentric line. The support 9 comprises a pair of circular spaced metallic outer plates 12 and 11, the latter of which has a continuous flange 13. Adjacent and between the plates 11 and 12 are located suitable insulating spacers, such as mica sheets 21, there being provided between these mica sheets smaller metallic plates 22 physically separated from one another, these in turn being connected to the electrodes of the evacuated electron discharge device. Smaller plates 22 are provided with terminals 23 extending past the circumferential edge of the support 9 for connection with the associated circuit elements. When the support is in position in the concentric line, the terminals 23 extend externally of the outer conductor through suitable slots in the outer conductor and are insulatingly positioned with respect thereto. A suitable off-center aperture 24 in the support 9 accommodates the electron discharge device. In practice, the entire composite support, when screwed together by screws 25, will be only slightly greater than one-eighth of an inch thick. The inner metallic plates are provided with holes to enable the screws 25 to pass therethrough for clamping the assembly together without conductively connecting the outer plates to the inner plates or to each other.

In Fig. 2 five of the smaller plates are illus-

trated in dotted lines, each of which plates are connected at one point adjacent aperture 24 to an electrode of the mounted electron discharge device, while at the outer periphery of the support 9 a connection is provided to a suitable terminal 23. At the center of each of the outer plates 11 and 12 of the support, the inner conductor of the associated concentric line is firmly attached thereto, as by welding, soldering or screwing. It will thus be apparent that each plate of the support 9 is isolated from a direct current standpoint from every plate in that support, although from an alternating current standpoint, each plate forms an armature of a condenser. Since the outer conductors of the tuned concentric lines are preferably maintained at ground or zero radio frequency potential, and the outer plate 11 of the support 9 is connected thereto through the flange 13, it will be seen that the connections to the terminals 23, 23 are by-passed to ground.

Fig. 3 illustrates, schematically, how the electrodes of an electron discharge device mounted in a support 9 are energized by suitable sources of potential located externally of the outer conductor of the concentric lines and connected to the terminals 23, 23 of the support. The anode of the evacuated device has a connection extending from one end of its envelope to the inner conductor of the output tuned concentric line circuit from which it obtains a positive potential, relative to the cathode, from source 26, by virtue of the connection through plate 12. The grid of the evacuated device has a connection extending from the opposite end of the envelope to the inner conductor of the input tuned concentric line circuit. Suitable grid bias is obtained by means of a resistor 27 which is connected at one end to the outer conductor and at its other end to the terminal 23 of that plate 22 which connects with the cathode. A suitable source of low voltage alternating current energy obtained from 110 volts alternating current supplies the filament terminals with heating energy, as shown. In similar manner, the screen grid and suppressor grid terminals are supplied with suitable potentials from source 26 whose negative terminal is connected to the outer conductors of the concentric line circuits. Although a pentode electron discharge device has been shown, it will be understood that any other type of device having a different number of electrodes may be employed.

One advantage of the present invention is that the stages are completely shielded, inasmuch as there is no radiation externally of the line. Another advantage lies in the conservation of space obtained by placing the electron discharge devices within the outer conductors of the concentric lines and arranging the lines as continuations of one another. A further advantage lies in the particular arrangement which minimizes the lengths of the lead connections to the electrodes of the devices.

Although only capacitive coupling has been described between stages, it is appreciated that inductive or conductive forms of coupling can be used instead. Furthermore the degree of capacity coupling can be varied by other well known electrostatic means in addition to the method described above; for example, an electrostatic grid may be interposed between end plates 18, 19 and thus the coupling change.

Although the invention has been described with particular reference to a receiver, it will be

understood that the principles thereof are not limited to a receiver but can be used in a transmitter and other circuits. It should also be understood that various modifications can be made in the arrangements illustrated and described without departing from the spirit and scope of the appended claims.

What is claimed is:

1. A multistage ultra high radio frequency amplifier with tuned concentric lines as coupling impedances between stages, each of said tuned concentric lines comprising an outer and a spaced inner conductor coupled together at one of their adjacent ends so as to form a closed oscillatory circuit, said lines being placed end to end with the outer conductors and the inner conductors, respectively, arranged as continuations of each other in the same line, the outer conductor of one line being a physical extension of and in direct contact with the outer conductor of the other line.

2. A multistage ultra high radio frequency amplifier with tuned variable length concentric lines as coupling impedances between stages, each of said tuned concentric lines comprising an outer and a spaced inner conductor coupled together at one of their adjacent ends so as to form a closed oscillatory circuit, said lines being placed end to end with the outer conductors and the inner conductors, respectively, arranged as continuations of each other in the same line, the outer conductor of one line being a physical extension of and in direct contact with the outer conductor of the other line.

3. A multistage ultra high radio frequency amplifier with tuned concentric lines as coupling impedances between stages, each of said tuned concentric lines comprising an outer and a spaced inner conductor coupled together at one of their adjacent ends so as to form a closed oscillatory circuit, said lines being placed end to end with the outer conductors and the inner conductors, respectively, arranged as continuations of each other in the same line, the outer conductor of one line being a physical extension of and in direct contact with the outer conductor of the other line, said stages being located within the outer conductors of said lines, whereby the wiring from said lines to the various electron discharge device elements is reduced to a minimum.

4. In a multistage ultra high frequency amplifier, at least one of said stages having input and output circuits in the form of concentric lines placed end to end in the same straight line, the outer conductor of one line being a physical extension of and in direct contact with the outer conductor of the other line, a partition within the outer conductors of said concentric lines shielding one line from the other, said partition forming a support for the electron discharge device of said stage, whereby the wiring from the inner conductors of said concentric lines to the elements of said stage is reduced to a minimum.

5. In a multistage ultra high frequency amplifier with each stage having an input electrode and an output electrode, the combination of tuned concentric lines placed end to end in the same straight line as interstage coupling impedances consisting in each stage of a concentric line comprising an outer grounded conductor and an inner concentric conductor, tuning means associated with each inner conductor and movable along its length to increase the length

thereof, and means for supporting each electron discharge device within the outer conductor of its associated concentric line, whereby the wiring from said lines to each of said input and output electrodes is reduced to a minimum.

6. A multistage ultra high radio frequency amplifier with tuned concentric lines as coupling impedances between stages, each of said tuned concentric lines comprising an outer and a spaced inner conductor coupled together at one of their adjacent ends so as to form a closed oscillatory circuit, said lines being placed end to end with the outer conductors and the inner conductors, respectively, arranged as continuations of each other in the same line, the outer conductor of one line being a physical extension of and in direct contact with the outer conductor of the other line, and tuning means associated with each inner conductor and movable along at least a portion of its length.

7. In an ultra high radio frequency circuit, an electron discharge device having an input circuit and an output circuit each in the form of a tuned concentric line, said concentric lines being placed end to end in the same straight line, the outer conductor of one line being a physical extension of and in direct contact with the outer conductor of the other line, a partition located within the outer conductors of and between said lines for dividing said lines into two shielded compartments, said partition forming a support for said electron discharge device.

8. In an ultra high radio frequency circuit, an electron discharge device having an input circuit and an output circuit each in the form of a tuned concentric line, said concentric lines being placed end to end in the same straight line, the outer conductor of one line being a physical extension of and in direct contact with the outer conductor of the other line, a partition located within the outer conductors of and between said lines for dividing said lines into two shielded compartments, said partition forming a support for said electron discharge device, said electron discharge device being mounted on said support within said outer conductors, whereby the wiring from said lines to the elements of said device is reduced to a minimum.

9. In an ultra high radio frequency circuit, an electron discharge device having an input circuit and an output circuit each in the form of a tuned concentric line, said concentric lines being placed end to end in the same straight line, the outer conductor of one line being a physical extension of and in direct contact with the outer conductor of the other line, a partition located within the outer conductors of and between said lines for dividing said lines into two compartments, said partition forming a support for said electron discharge device, another electron discharge device having similarly arranged input and output circuits and being similarly supported, the concentric line circuits of both devices being arranged in the same straight line, the output circuit outer conductor of said first device being a continuation of the input circuit outer conductor of said second device, the output circuit inner conductor of said first device being capacitively coupled to and in the same straight line as the input circuit inner conductor of said second device.

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