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ULTRA SHORT WAVE APPARATUS

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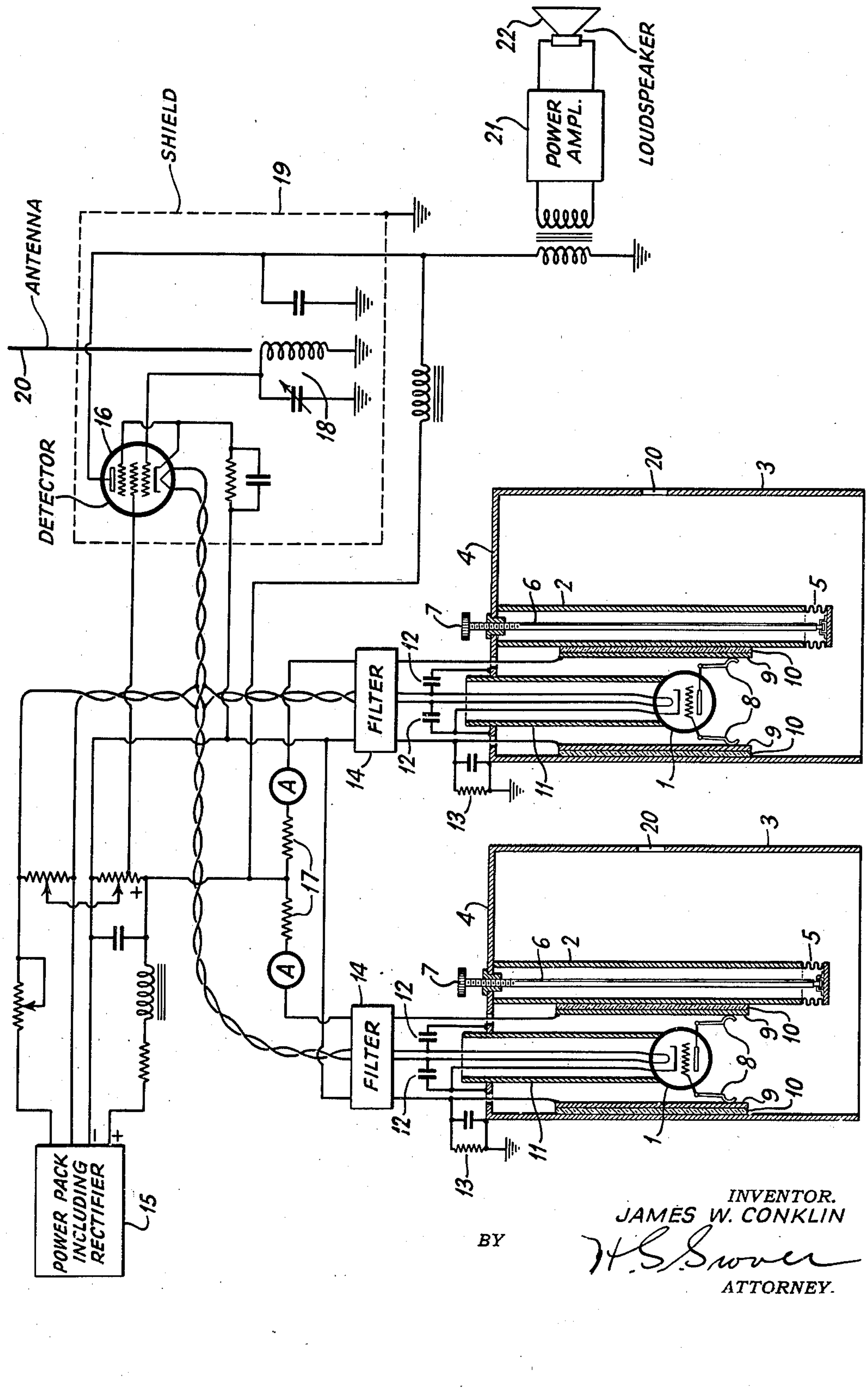

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ULTRA SHORT WAVE APPARATUS

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13 Claims. (Cl. 178—44)

The present invention relates to ultra short wave electron discharge device circuits, and particularly to resonant line controlled equipment.

An object of the present invention is to provide an improved mechanical design for an electron discharge device associated with a resonant line circuit in which the lengths of the connections from the electron discharge device to the resonant line are minimized, and made adjustable over the length of the resonant line.

Another object is to provide an improved mounting for an electron discharge device associated with a coaxial line resonator in which the discharge device is positioned between the conductors of the resonator, and means are provided for adjusting the position of the discharge device.

A further object is to provide an audio frequency generator composed of a pair of ultra high frequency stabilized oscillators whose outputs are combined in a detector unit to provide an audio beat signal.

A feature of the invention lies in the use of a coaxial or concentric line resonator having an electron discharge device mounted between the conductors of the resonator with leads of minimum length arranged for connection to the most suitable points on the resonator. A further features resides in the manner of mounting the electron discharge device on a movable tubular support, there being slidable spring contacts associated with certain electrodes of the discharge device for connection with the conductors of the concentric line resonator.

Other objects and features will appear from a reading of the following description given in conjunction with a drawing whose single figure illustrates a beat frequency generator composed of a pair of coaxial resonant line controlled oscillators beating together to form an audio beat signal.

Referring more particularly to the drawing, there are shown two identical ultra high frequency oscillator circuits, each comprising an evacuated electron discharge device 1 positioned between conductors 2, 3 of a concentric line resonator employed for stabilizing the frequency of the oscillator. The line resonator is a high Q line (low loss) having an outer conductor 3 and an inner conductor 2, both connected together at one end by a metallic end plate 4. Attached to the free end of each inner conductor 2 is a corrugated metallic bellows 5 mechanically linked to a low temperature coefficient "Invar" rod 6 for maintaining the overall length of the inner conductor 2 substantially constant against temperature variations. Slight adjustments in overall length of the inner conductor can be made by movement of the knurled screw 7. This type of concentric resonant line has an effective electrical length of one-quarter wave at the operating frequency, and is now known in the art, reference being made to United States Patent No. 2,108,895, granted February 22, 1938, to Fred H. Kroger and United States Patent No. 2,103,515, granted December 28, 1937, to James W. Conklin et al.

The vacuum tube 1 of each oscillator circuit is mounted between the inner and outer conductors of the resonant line 2, 3 and has its anode and grid directly connected by slidable flexible spring contacts 8 to metallic bars or plates 9, in turn insulatingly mounted on the conductors of the line resonator by virtue of insulating spacers 10, as shown. The vacuum tube is preferably of the small acorn type, such as the RCA Type 955 Acorn triode, and is supported at one end of a slidable copper tube 11 positioned half way between the inner and outer conductors of the line resonator. The cathode and filament leads extend through the interior of the tubing 11 and are brought out at the short-circuited end of the resonant line. The cathode is grounded to the supporting tube 11 and end plate 4, as shown, while the filament leads are by-passed to ground for radio frequency currents through condensers 12, 12. The grid and anode electrodes of the vacuum tube 1 are suitably polarized by connections which extend to the bars or plates 9, the grid electrode obtaining its bias by way of grid lead 13 while the anode electrode obtains a positive polarizing potential through the filter 14. It should be observed that the leads between the grid and anode electrodes of the vacuum tubes and the conductors of the resonant lines are of minimum length and hence of minimum inductance. The copper tubing 11 which suports the vacuum tube 1 is slidable through end plate 4 and thus can move the vacuum tube and associated leads and flexible contact springs to any desired suitable location over the length of bars 9. If the vacuum tube is connected near end plate 4, maximum frequency stability will be obtained but the circuit load on the electron discharge device will be maximum, and may be sufficient to prevent the vacuum tube from oscillating. Therefore, the actual adjustment is a compromise between reliable vacuum tube performance and maximum frequency stability.

Each oscillator can be compared to a Hartley circuit wherein the grid and anode are connected to opposite ends of an inductance coil through condensers, and the cathode to the center of the inductance coil.

Filters 14 are of the three section type and are designed to substantially prevent radio frequency energy in the oscillator circuits from entering the power supply circuit 15 and the detector unit 16 over the connections extending thereto. The filters reduce radio frequency currents in the leads external of the line resonator to prevent as far as possible all undesired coupling between the two oscillator units. A pair of resistors 17 in series with the anode leads serve to reduce the voltage on the anodes of the vacuum tubes and also protect the vacuum tubes in case of tube failure.

The detector unit 16 is an RCA Type 954 Acorn pentode operating as a biased detector tube and contains a simple parallel tuned circuit 18. This detector unit is completely enclosed in a metallic shield 19 shown in dotted lines. An antenna rod 20, a portion of which extends outside of the shield 19, is employed to couple the tuned circuit 18 to the two oscillator circuits, and this is achieved by virtue of leakage radiation from the resonators. Where the filters 14 prevent any leakage from the oscillators, then holes 20 may be provided in the outer conductors of the resonator, in order to obtain sufficient external field to operate the detector unit 16.

The two oscillators 1, 1 and the detector unit are connected by means of shielded plug-in cables to the common power supply 15 to provide the necessary voltages for the vacuum tube electrodes. This power supply circuit is of the conventional type which may be plugged into a 110 volt, 60 cycle supply.

The output of detector unit 16 serves to excite a power amplifier circuit 21 and associated loud speaker 22.

In operation, the two oscillators are adjusted by means of screws 7 to produce slightly different frequencies so as to produce an audio frequency beat note in the detector unit. The direct current in the anode circuit of the detector will be very small or zero until the radio frequency potential is applied to the control grid, after which the current flows in the detector approximately proportional to the amplitude of the radio frequency current.

In one embodiment successfully tried out in practice, the oscillators functioned at a frequency of about 300 megacycles, although it will be appreciated that there would be less load on the vacuum tubes and higher frequency stability at lower frequencies.

What is claimed is:

1. The combination with a tuned circuit in the form of a coaxial line resonator having an outer conductor and a coaxial inner conductor, of a multi-electrode electron discharge device located between the conductors of said resonator, a connection coupling one electrode of said device to the inner surface of said outer conductor and a connection coupling another electrode of said device to the inner conductor, whereby the wiring between said electrodes and said resonator are reduced to a minimum, and means for adjusting the position of said device and associated connections over a portion of the length of said line resonator.

2. In combination, a tuned circuit in the form of a coaxial line resonator having an outer conductor and a coaxial inner conductor, a metallic plate coupling said conductors together at substantially one end, a metallic hollow tubular conductor passing through said plate and positioned half-way between said outer and inner conductors, said tubular conductor being movable through said plate in the direction of the length of said conductors, a multi-electrode electron discharge device located within said resonator and mounted on one end of said tubular conductor and movable therewith, and connections coupling certain electrodes of said device to the conductors of said resonator in the interior thereof.

3. In combination, a tuned circuit in the form of a coaxial line resonator having an outer conductor and a coaxial inner conductor, a metallic plate coupling said conductors together at substantially one end, a metallic hollow tubular conductor passing through said plate and positioned half-way between said outer and inner conductors, said tubular conductor being movable through said plate in the direction of the length of said conductors, a multi-electrode electron discharge device located within said resonator and mounted on one end of said tubular conductor and movable therewith, and connections including flexible contact springs coupling certain electrodes of said device to the conductors of said resonator in the interior thereof.

4. In combination, a tuned circuit in the form of a coaxial line resonator having an outer conductor and a coaxial inner conductor, a metallic plate insulatingly positioned on the interior surface of said outer conductor, and a metallic plate insulatingly positioned on said inner conductor, both of said plates facing each other and extending over at least a small portion of the length of said resonator, an electron discharge device located in the space between said plates, a connection from one electrode of said device to one of said plates, and a connection from another electrode of said device to the other of said plates, whereby the wiring between said electrodes and the conductors of said resonator are a minimum.

5. In combination, a tuned circuit in the form of a coaxial line resonator having an outer conductor and a coaxial inner conductor, a metallic plate insulatingly positioned on the interior surface of said outer conductor, and a metallic plate insulatingly positioned on said inner conductor, both of said plates facing each other and extending over at least a small portion of the length of said resonator, an electron discharge device located in the space between said plates, a connection from one electrode of said device to one of said plates, and a connection from another electrode of said device to the other of said plates, whereby the wiring between said electrodes and the conductors of said resonator are a minimum, and a metallic tube extending parallel to said conductors of said resonator and in the interior of said resonator and supporting at one end said device.

6. In combination, a tuned circuit in the form of a coaxial line resonator having an outer conductor and a coaxial inner conductor, a metallic plate insulatingly positioned on the interior surface of said outer conductor, and a metallic plate insulatingly positioned on said inner conductor, both of said plates facing each other and extending over at least a small portion of the length of said resonator, an electron discharge device located in the space between said plates, a connection including a flexible contact spring from one electrode of said device to one of said plates, and a connection including a flexible contact spring from another electrode of said device to the other of said plates, whereby the wiring be-

tween said electrodes and the conductors of said resonator are a minimum, and a metallic tube extending parallel to said conductors in the interior of said resonator and supporting at one end said device, said metallic tube being movable lengthwise for adjusting the position of said device and associated electrode connections over the lengths of said plate.

7. The combination with a tuned circuit in the form of a coaxial line resonator having an outer conductor and a coaxial inner conductor, of a multi-electrode electron discharge device located between the conductors of said resonator, a connection including a flexible contact spring coupling one electrode of said device to the inner surface of said outer conductor and a connection also including a flexible contact spring coupling another electrode of said device to the inner conductor, whereby the wiring between said electrodes and said resonator are reduced to a minimum, and means for adjusting the position of said device and contact springs over a portion of the length of said line resonator.

8. Apparatus in accordance with claim 5, characterized in this that said electron discharge device has a cathode and a heater, and there are connections for said cathode and heater which extend within the metallic tube supporting said electron device.

9. In combination, a resonant circuit having a pair of conductive surfaces separated solely by space, a metallic plate insulatingly positioned on one of said pair of surfaces, and a metallic plate insulatingly positioned on the other of said pair of surfaces, both of said plates facing each other, an electron discharge device located in the space between said plates and having a cathode and a pair of cold electrodes, a connection from one of said cold electrodes to one of said plates, and a connection from the other cold electrode to the other of said plates, whereby the wiring between said electrodes and the pair of surfaces of said resonant circuit are a minimum, a hollow tubular conductor entering the space between said conductive surfaces, and a connection from said cathode extending through the interior of said hollow tubular conductor externally of said resonant circuit.

10. In combination, a resonant circuit having a pair of conductive surfaces separated solely by space, a metallic plate insulatingly positioned on one of said pair of surfaces to form a condenser, and a metallic plate insulatingly positioned on the other of said pair of surfaces to form a condenser, both of said plates facing each other, an electron discharge device located in the space between said plates and having a cathode and a pair of cold electrodes, a connection from one of said cold electrodes to one of said plates, and a connection from the other cold electrode to the other of said plates, whereby the wiring between said electrodes and the pair of surfaces of said resonant circuit are a minimum, a hollow tubular conductor entering the space between said conductive surfaces, and heater leads for said cathode extending through the interior of said hollow tubular conductor to a source of heater energy located externally of said resonant circuit.

11. In combination, a resonant circuit having a pair of conductive surfaces separated solely by space, a metallic plate insulatingly positioned on one of said pair of surfaces, and a metallic plate insulatingly positioned on the other of said pair of surfaces, both of said plates facing each other, an electron discharge device located in the space between said plates, a connection from one electrode of said device to one of said plates, and a connection from another electrode of said device to the other of said plates, whereby the wiring between said electrodes and the pair of surfaces of said resonant circuit are a minimum, a hollow tubular conductor entering the space between said conductive surfaces, and a connection from a third electrode of said device extending through the interior of said hollow tubular conductor externally of said resonant circuit.

12. Apparatus in accordance with claim 9, characterized in this that said tubular conductor is metal.

13. In combination, a resonant circuit having a pair of conductive surfaces separated solely by space, a metallic plate insulatingly positioned on one of said pair of surfaces, and a metallic plate insulatingly positioned on the other of said pair of surfaces, both of said plates facing each other, an electron discharge device located in the space between said plates and having a cathode and a pair of cold electrodes, a connection from one of said cold electrodes to one of said plates, and a connection from the other cold electrode to the other of said plates, whereby the wiring between said electrodes and the pair of surfaces of said resonant circuit are substantially a minimum, and means coupling said cathode to a point of fixed radio frequency potential.

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