

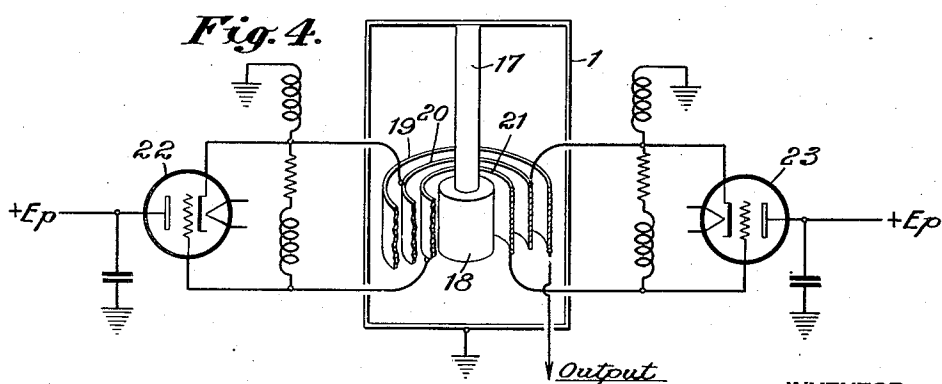
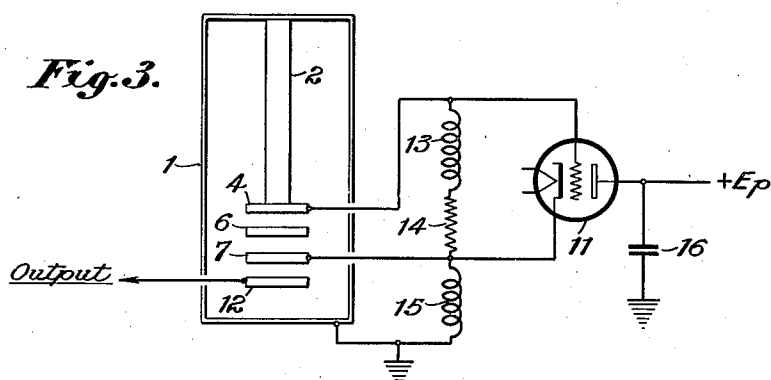
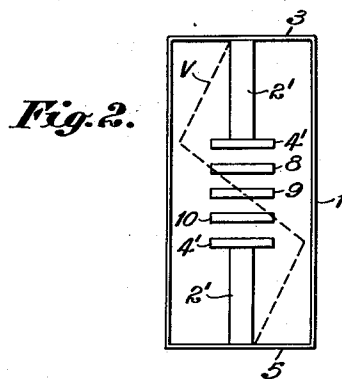
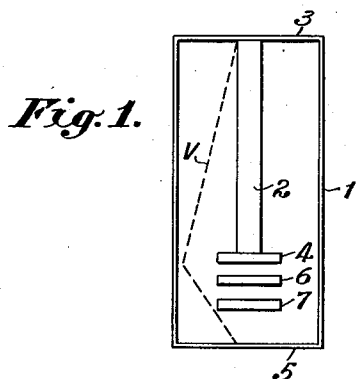
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CONCENTRIC RESONANT LINE AND CIRCUITS THEREFOR

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CONCENTRIC RESONANT LINE AND
CIRCUITS THEREFOR

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ber 19, 1940, Serial No. 357,448

11 Claims. (Cl. 250—36)

The present invention relates to improvements in tuned circuits, particularly concentric resonant lines, and to circuits therefor, and is a division of my application Serial No. 226,674, filed August 25, 1938, now United States Patent No. 2,245,597, granted June 17, 1941.

Tuned circuits in the form of concentric resonant lines are used particularly in connection with short and ultra short wave circuits. These lines are, because of their construction, non-radiating in character, and are characterized by low loss. Such tuned circuits, it is known, may be used in any one or more of the following capacities: As the frequency determining element of an oscillator; as an output tank circuit; as a tuned interstage coupling circuit; and as a filter. For a complete description of concentric resonant lines, reference is made to United States Patent No. 2,120,518, granted June 14, 1938, to John F. Dreyer, Jr.; United States Patents Nos. 2,108,895 and 2,077,800, granted February 22, 1938, and April 20, 1937, respectively, to Fred H. Kroger; and to the article by Clarence W. Hansell entitled "Resonant lines for frequency control," published August, 1935, in "Electrical Engineering," pages 852 to 856.

One of the objects of the present invention is to enable a multiplicity of voltage connections to be made to a resonant line without disturbing its balance or introducing multiple degrees of freedom.

Another object is to provide an improved concentric resonant line and vacuum tube circuit which has substantially one degree of freedom.

A further object is to provide an improved oscillation generator circuit having a concentric resonant line as a frequency controlling element therefor, wherein there is reduced the possible number of modes of oscillation (i. e., degrees of freedom).

Briefly stated, the improved concentric resonant line of my invention comprises an inner and an outer concentric conductor suitably coupled together to provide a tuned circuit in generally known manner, with the addition of a plurality of separated metallic conductor plates sandwiched between the inner conductor and the outer conductor to provide condenser layers of different capacity. These condenser plates may have the form of discs located in the general line of extension of the inner conductor and whose planes are transverse of the longitudinal axis of the inner conductor, or they may be parallel to the longitudinal axis of the inner conductor.

One advantage of the improved concentric res-

onant line of the present invention is that the line can be terminated with disc or cylindrical condensers, thus providing extremely short and low reactance connections to the vacuum tube elements associated with the line. One way of accomplishing this is to widen the discs beyond the normal width of the inner conductor and to attach the electrode terminals of the associated vacuum tubes directly to these discs.

The principles underlying the present invention are explained in more detail in the following description which is accompanied by a drawing, wherein:

Figs. 1 and 2 show, in vertical cross-section, my improved concentric resonant line for use, respectively, with single ended and push-pull electron discharge device circuits;

Fig. 3 shows the improved concentric line of Fig. 1 used, by way of example only, as the frequency determining element of an associated single vacuum tube oscillator circuit; and

Fig. 4 shows another type of improved concentric resonant line, in accordance with the invention, wherein the condenser plates are in the form of parallel cylinders, instead of the discs of Figs. 1, 2 and 3.

Referring to Fig. 1, there is shown a concentric resonant line comprising an outer conductor 1 and an inner conductor 2 conductively connected together at one of their adjacent ends by an end plate 3. Inner conductor 2 is capacitively coupled at its other end to the outer conductor by virtue of a metallic plate 4 suitably spaced from end plate 5. In the space between plates 4 and 5 there are interposed separated metallic discs or plates 6 and 7, suitably mounted on insulating supports, not shown. It will thus be appreciated that the capacity between plates 4 and 5 is divided up into several series capacities by means of discs 6 and 7 sandwiched between 4 and 5.

The voltage distribution of the resonant line 1, 2 is indicated by the dotted line V, and from an inspection thereof it will be seen that the placing of discs 6 and 7 in the location shown will enable making connections thereto without introducing multiple degree of freedom, i. e., modes of oscillation. The reason for this is that the vacuum tube elements themselves are capacitive and that the connection between them and the condenser plates can be made extra short and therefore of negligible inductance. The thermionic electron discharge devices, together with the sandwiched capacity plates, then form a system which is essentially capacitive. The resonant line has thus only one degree of freedom.

Fig. 2 shows a concentric resonant line wherein the inner conductor is composed of two coaxial rods 2', 2', conductively connected to opposite end plates 3 and 5 and capacitively coupled together at their adjacent ends 4', 4'. Interposed between the adjacent ends 4', 4' of rods 2', 2' are metal discs 8, 9 and 10, suitably spaced apart and insulatingly mounted in a manner not shown. The voltage distribution of the concentric line of Fig. 2 is indicated by the dotted line V. It should be noted that the central disc 9 is at a voltage node or zero gradient point while the discs and rods on opposite sides thereof have voltages of opposite phase.

Fig. 3 shows a concentric resonant line of the type shown in Fig. 1 connected to a vacuum tube oscillator 11. The grid of the tube 11 is connected by way of example to plate 4, while the cathode of tube 11 is connected to plate 7. Output energy is obtained from plate 12. A positive polarizing potential for the anode of the oscillator 11 is derived from source +E_p, and suitable bias for the grid is obtained by virtue of the connection consisting of choke 13 and resistance 14 placed between grid and cathode. The cathode is connected to ground through a choke 15, and the anode connected to ground by means of the blocking and by-pass condenser 16.

The system of Fig. 3 can be likened to the well known Hartley circuit, wherein a tuned circuit, in this case the concentric line, is connected between the grid and anode of a vacuum tube whose cathode is connected to an intermediate point on the inductance of the tuned circuit. The anode end of the tuned circuit is here grounded for radio frequency energy.

Fig. 4 shows how metallic cylinders arranged in parallel can be employed instead of discs to obtain my improved concentric resonant line. The resonant line consists of an outer conductor 1 and an inner conductor 17. One end of the inner conductor 17 is shown enlarged at 18 to increase the capacity existing between the conductors of the line. A multiplicity of cylinders 19, 20 and 21 placed between the enlarged end 18 and the side walls of the outer conductor serve to subdivide the capacity therebetween into series condensers, in a manner similar to the arrangements of Figs. 1 and 2. A pair of electron discharge device oscillators 22 and 23 are shown connected in parallel relation to the concentric line, whereby said line functions to stabilize or control the frequency of oscillations produced by both vacuum tubes.

Although the improved concentric line of the invention has been shown employing discs and cylinders, it will be understood that these elements may take different forms and be located at different places between the inner and outer conductors, and that various modifications may be made both in the line and associated circuit arrangements without departing from the spirit and scope of the invention. For example, the condenser plates, as well as the plates capacitively coupled thereto, can be adjustably mounted to vary the spacing therebetween and between same and the inner conductor.

What is claimed is:

1. A high frequency oscillatory circuit comprising concentric inner and outer conductors suitably connected to form a tuned oscillatory circuit, and terminals for said oscillatory circuit comprising a plurality of parallel electrically conducting metallic surfaces interposed between and adjacent to only a relatively small portion of said

inner and outer conductors, said metallic surfaces being insulated from but capacitively coupled to each other and insulated at all points from said inner and outer conductors and constituting with said inner and outer conductors a single oscillatory circuit.

2. A high frequency circuit comprising concentric inner and outer conductors suitably connected to form a tuned oscillatory circuit, and a plurality of parallel metallic discs placed at one end of the inner conductor, transversely of the length thereof, and interposed between the inner and outer conductors, an end plate bridging the adjacent end of the outer conductor and arranged parallel to said discs, said discs being insulated from but capacitively coupled to each other and insulated at all points from said inner and outer conductors, whereby they provide terminal connections for an associated circuit.

3. A high frequency circuit in accordance with claim 1, characterized in this that said metallic surfaces are cylinders arranged parallel to said inner conductor along a portion of the length thereof and located between the inner and outer conductors.

4. The combination with a high frequency oscillatory circuit comprising concentric inner and outer conductors suitably connected to form a tuned oscillatory circuit, and terminals for said oscillatory circuit comprising a plurality of parallel conducting condenser electrodes interposed between and adjacent to only a small portion of said inner and outer conductors, said condenser electrodes being insulated at all points from each other and from said inner and outer conductors, of an electron discharge device circuit connected to certain of said condenser electrodes, and a utilization circuit coupled to at least one of said other condenser electrodes.

5. A tuned high frequency circuit comprising a pair of concentric metallic conductors conductively coupled together at one of their adjacent ends, the inner conductor having a portion of larger diameter at the other end to increase the capacitance existing between said conductors, and terminals for said tuned circuit comprising a plurality of concentric metallic cylinders surrounding said portion of larger diameter and located in the space between the inner and outer conductors, said cylinders being insulated from each other and from said conductors.

6. An oscillation generator circuit comprising an electron discharge device having anode, cathode and grid electrodes, a tuned frequency controlling circuit comprising a pair of concentric conductors directly connected together at one of their adjacent ends and capacitively coupled together by virtue of the spacing between them at their other ends, a plurality of spaced condenser plates interposed between and adjacent to only a small portion of said inner and outer conductors, said plates being insulated from each other and from said conductors, a connection from said grid to said inner conductor, a connection from said cathode to one of said plates, a low impedance connection for radio frequency energy from said anode to said outer conductor, and a connection from another of said plates to an output circuit.

7. An oscillation generator circuit comprising an electron discharge device having anode, cathode and grid electrodes, a tuned frequency controlling circuit comprising a pair of concentric conductors directly connected together at one of their adjacent ends and capacitively coupled together by virtue of the spacing between them

at their other ends, a plurality of spaced condenser electrodes interposed between and adjacent to only a relatively small portion of said inner and outer conductors, said condenser electrodes being insulated from each other and from said conductors, a connection from said grid to one of said condenser electrodes, a connection from said cathode to another one of said condenser electrodes, a low impedance connection for radio frequency energy from said anode to said outer conductor, and a connection from still another one of said condenser electrodes to a utilization circuit.

8. A high frequency circuit comprising an outer conductor and a concentric inner conductor, an element of low impedance to the operating frequency connecting said outer conductor at one end to the adjacent end of said inner conductor, a metallic plate at the other end of said outer conductor, and means capacitively coupling said metallic plate to the nearest end of said inner conductor, said means including a plurality of parallel conducting plates located between said metallic plate and the nearest end of said inner conductor, said plurality of plates being insulated from each other and from said inner and outer conductors, whereby they provide terminal connections for an associated circuit.

9. A high frequency circuit comprising an outer conductor and a concentric inner conductor, an element of low impedance to the operating frequency connecting said outer conductor at one end to the adjacent end of said inner conductor, a metallic plate at the other end of said outer conductor, and means capacitively coupling said metallic plate to the nearest end of said inner

conductor, said means including a plurality of parallel conducting plates located between said metallic plate and the nearest end of said inner conductor, said plurality of plates being insulated from each other and from said inner and outer conductors and having their planes arranged transversely to the lengths of said concentric conductors, whereby they provide terminal connections for an associated circuit.

10. A high frequency circuit comprising an outer conductor and a concentric inner conductor, an element of low impedance to the operating frequency connecting said outer conductor at one end to the adjacent end of said inner conductor, a metallic plate at the other end of said outer conductor, said other end of said inner conductor being spaced from said metallic plate and said outer conductor to form a capacity effect, and a plurality of parallel electrodes located between said last end of said inner conductor and said plate, said electrodes being insulated from each other and from said inner and outer conductors, whereby they form terminal connections for an associated circuit.

11. A high frequency oscillatory circuit comprising concentric inner and outer conductors suitably connected to form a tuned oscillatory circuit, and terminals for said oscillatory circuit comprising a plurality of parallel electrically conducting metallic surfaces interposed between and having lengths appreciably smaller than said inner and outer conductors, said metallic surfaces being insulated from but capacitively coupled to each other and insulated at all points from said inner and outer conductors.

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