331-98

SEARCH ROOM

7m/144

X1396

June 7, 1949. E. FUBINI ET AL 2,472,204

HIGH-FREQUENCY CONCENTRIC LINE OSCILLATOR

Filed March 1, 1946

FIG. 1

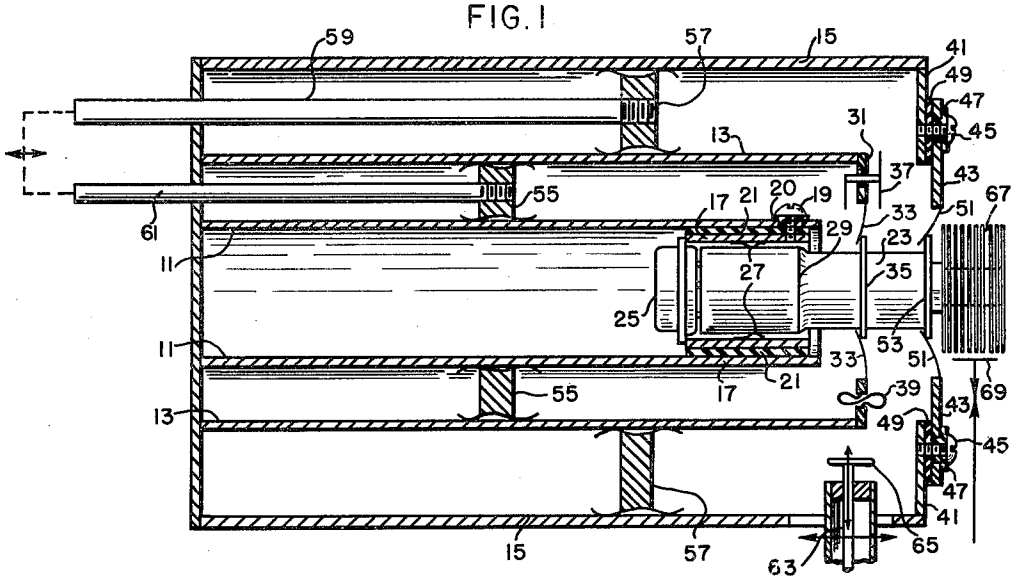
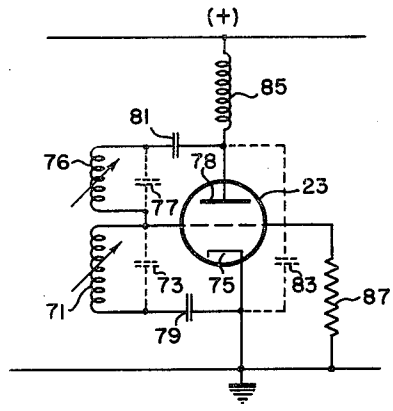


FIG. 2



INVENTORS.
EUGENE FUBINI
HEGAR C. KRIEGEL
BY JOHN G. STEPHENSON
William D. Hall
ATTORNEY

SEARCH ROOM

Patented June 7, 1949 2,472,204

UNITED STATES PATENT OFFICE

2,472,204

HIGH-FREQUENCY CONCENTRIC LINE OSCILLATOR

Eugene Fubini, New York, N. Y., Hegar C. Kriegel, Houston, Tex., and John G. Stephenson, Mineola, N. Y., assignors to the United States of America as represented by the Secretary of War

Application March 1, 1946, Serial No. 651,310

4 Claims. (Cl. 250—36)

1

This invention relates in general to electrical generators and more particularly to high-frequency oscillators.

It is sometimes desirable in high-frequency oscillators to use radio-frequency transmission lines or resonant cavities for the tuning circuits instead of conventional inductance-capacitance circuits. This invention relates to an oscillator which uses resonant cavities of the so called concentric type and it is an object, therefore, of this invention to provide a high-frequency oscillator, which utilizes resonant cavities for its tuning circuits, said cavities being constructed in a concentric manner.

It is a further object of this invention to provide a high-frequency oscillator with a plurality of resonant cavities tunable by a single control.

It is a still further object of this invention to provide a high-frequency oscillator tunable over a relatively wide frequency range.

In general, this invention contemplates the use of three concentric hollow cylinders which form two coaxial cavities, the latter being used as resonant circuits. This oscillator is particularly adapted for use with the lighthouse type of vacuum tubes. The tube is mounted in the smaller cylinder, and the outer cavity is the resonant circuit between grid and plate. The inner cavity forms a resonant circuit between cathode and grid. Means are provided for tuning both cavities simultaneously. Coupling between the two cavities is accomplished by both magnetic and electrostatic coupling means.

Other objects, features and advantages of this invention will suggest themselves to those skilled in the art and will become apparent from the following description of the invention taken in connection with the accompanying drawing, in which:

Fig. 1 is a cross-sectional view of the oscillator; and

Fig. 2 is an equivalent schematic circuit diagram of the invention.

Referring now more particularly to Fig. 1, metallic hollow cylinders 11, 13, and 15 are constructed and arranged concentrically as shown. Another hollow metallic cylinder 17 is attached inside the cylinder 11 by means of one or more screws 19 or other appropriate fastening means. A washer or bushing 20 of insulating material

2

electrically insulates the screw 19 from cylinder 11. A dielectric material 21 is interposed between the cylinders 11 and 17. A vacuum tube 23 of the lighthouse type is placed in the cylinder 17, as shown, being held in place by tube socket 25, which is connected to cylinder 17 in any conventional manner. An annular spring clip 27 is connected inside the cylinder 17 and electrically connects the cathode shell 29 of lighthouse tube 23 to cylinder 17. A metallic circular plate 31 having spring metal fingers 33 electrically connects the grid connection 35 of the lighthouse tube 23 to the cylinder 13. Electrostatic coupling probes 37 and magnetic coupling loops 39 are used to couple energy between the two cavities. An annular metallic plate 41 is connected to the cylinder 15. Annular metallic plate 43 is connected to plate 41 by screws 45. Insulating washers 47 electrically insulate the screws 45 from plate 43. A dielectric material 49 is interposed between plates 41 and 43. Plate 43 has spring metallic fingers 51 similar to plate 31 which electrically connect the plate connection 53 to plate 43. Annular pistons 55 and 57 electrically short the inner and outer cavities. Rods 59 and 61 are used to move pistons 55 and 57 back and forth in a longitudinal direction. Well known mechanical coupling means between rods 59 and 61 are provided whereby the pistons 55 and 57 may be moved simultaneously. Means also are provided whereby the position of one rod may be changed independently of the other rod. In practice, the rods and supports are threaded whereby when rotated the rods will move in a longitudinal direction. Also, the rods are geared together so that both pistons move simultaneously. Movement of one piston only is accomplished by unmeshing the gears. Coaxial transmission line 63 is inserted into the outer cavity with its center conductor terminating in an electrostatic probe 65. Means are provided for moving the line 63 in an axial direction and the probe 65 in a radial direction. The anode cooling fins 67 and the metal plate 69 form a capacitor, and means are provided for adjusting the distance between them. In practice, a metal cover plate (not shown) is fastened over the tube end of the oscillator.

The oscillator described above can be represented by its equivalent circuit shown in Fig. 2. The inner coaxial cavity along with the cathode-

grid capacitance of lighthouse tube **23** and other inherent capacitances can be represented by the tuned circuit consisting of inductance **71** and the capacitor **73** connected between the grid **74** and the cathode **75** of lighthouse tube **23**.

The outer coaxial cavity and the grid-plate capacitance of lighthouse tube **23** and other inherent capacitances may be represented by the tuned circuit of inductance **76** and capacitor **77** connected between grid **74** and anode or plate **78**. The capacitor formed by cylinders **11** and **17** and dielectric **21**, as shown in Fig. 1, can be represented by capacitor **79**. The capacitor formed by plates **41** and **43** and dielectric **49** can be represented by capacitor **81**. Cathode-plate capacitance and other stray capacitances are represented by capacitor **83**. The plate **78** is connected through an inductance **85** to a source of positive potential (not shown). The cathode **75** is connected to ground. The grid **74** is returned to ground through resistor **87**. The capacitor formed by fins **67** and plate **69** is not shown in Fig. 2 but will be explained later. Actually, the grid of the oscillator shown in Fig. 1 is grounded, but for clarity the cathode is shown grounded in Fig. 2.

It can be seen that the circuit of Fig. 2 can be considered as a form of a Colpitts oscillator. Since the theory of this general type of oscillator is well known in the art, no explanation will be given as to its theory of operation.

In operation, the frequency of the oscillator is controlled by the positions of the pistons **55** and **57**. Oscillation is possible in several different modes and the tuning range is thereby increased. The fundamental mode of operation is such that both the grid-plate and cathode-grid pistons are adjusted in such a manner that the coaxial cavities are substantially one-quarter wavelength long. By readjusting the relative positions of the pistons other modes of operation may be obtained.

It was found that by shifting the grid-cathode plunger slightly when in the one-quarter wavelength mode, the mode will be changed to the three-quarter wavelength mode. Mode separation was made adequate by choosing the product CZ_0 for the grid-plate, line to differ as much as possible from $C'Z'_0$ for the grid-cathode line where

C is the grid-plate capacitance
Z_0 is the characteristic impedance of the grid-plate line
C′ is the grid-cathode capacitance
Z'_0 is the characteristic impedance of the grid cathode line

The combined electrostatic and magnetic feedback will then enable operation in both the one-quarter wavelength mode and in the three-quarter wavelength mode without making any changes other than shifting the grid-cathode plunger.

At a certain frequency within the tuning range of the oscillator, the cooling fins **67** become resonant, causing a serious drop in the power output at that particular frequency. In order to eliminate this difficulty, the trimmer capacitor formed by the fins **67** and the plate **69** is adjusted whereby the resonant frequency of the fins **67** is shifted in phase sufficiently that substantially full power output may be obtained.

For preferred operation of the oscillator, it is desirable to provide feedback between the outer and the inner cavities. To accomplish this feedback properly over the entire tuning range, a plurality of magnetic coupling loops and electrostatic coupling probes are constructed in the plate **31**.

Output power is taken from the oscillator at coaxial transmission line **63** by means of probe **65**. Means are provided for moving the line **63** and probe **65** in an axial direction, and for moving the probe in a radial direction whereby optimum coupling may be obtained over the entire range.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as set forth in the appended claims and we claim all such changes and modifications as fall fairly within the spirit and scope of the invention.

We claim:

1. In an oscillation generator, first, second and third hollow metallic cylinders, said second cylinder being larger than said first cylinder, and said third cylinder being larger than said second cylinder, means positioning said cylinders in a concentric manner, a lighthouse type vacuum tube, a first dielectric means, means coupling the cathode of said vacuum tube to said first cylinder through said first dielectric means, means connecting the second cylinder to the grid of said vacuum tube, a second dielectric means, means coupling said third cylinder to the plate of said vacuum tube through said second dielectric means, first and second annular pistons, said first piston being positioned in the cavity formed by said first and second cylinders, said second piston being positioned in the cavity formed by said second and third cylinders, means allowing the driving of said pistons in an axial direction simultaneously, magnetic coupling means for coupling energy between the cavity formed by said first and second cylinders and the cavity formed by said second and third cylinders, electrostatic coupling means for coupling energy between the cavity formed by said first and second cylinders and the cavity formed by said second and third cylinders, a capacitor plate placed in the proximity of the anode of said vacuum tube, means for adjusting the proximity of said plate to said anode, coupling means inserted through said third cylinder into the cavity formed by said second and third cylinders, means for adjusting said latter coupling means in an axial direction, and means for adjusting said latter coupling means in a radial direction.

2. Apparatus in accordance with claim 1 in which operation in at least two modes is obtainable by adjustment of one of said pistons.

3. In an oscillation generator, conducting means forming a first annular resonant cavity, conducting means forming a second annular resonant cavity concentric with and disposed externally of said first annular resonant cavity, electron tube means having at least cathode, grid and anode electrodes, means electrically coupling said first annular resonant cavity between the cathode and grid of said electron tube means, means electrically coupling said second annular resonant cavity between the grid and anode of said electron tube means, at least a portion of the anode of said tube being disposed externally of said second cavity resonator, said external portion being equipped with heat dissipating means, coupling means between said first and second annu-

SEARCH ROOM

lar resonant cavities comprising a plurality of electrostatic probes and electromagnetic loops, means for tuning said first and second annular resonant cavities, adjustable means for deriving energy from said second cavity, means for altering the natural resonant frequency of said heat dissipating means whereby maximum output may be obtained from said oscillation generator at all frequencies of operation.

4. Apparatus in accordance with claim 3, wherein said means for altering the natural resonant frequency of said heat dissipating means comprises a capacitor plate in proximity with said heat dissipating means and means for adjusting said proximity as required for altering the natural resonant frequency.

EUGENE FUBINI.
HEGAR C. KRIEGEL.
JOHN G. STEPHENSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,284,405	McArthur	May 26, 1942
2,287,845	Varian	June 30, 1942
2,289,846	Litton	July 14, 1942
2,353,742	McArthur	July 18, 1944
2,408,355	Turner	Sept. 24, 1946
2,409,640	Moles	Oct. 22, 1946
2,412,805	Ford	Dec. 12, 1946
2,416,080	Bailey	Feb. 18, 1947
2,416,565	Beggs	Feb. 25, 1947
2,416,567	McArthur	Feb. 25, 1947