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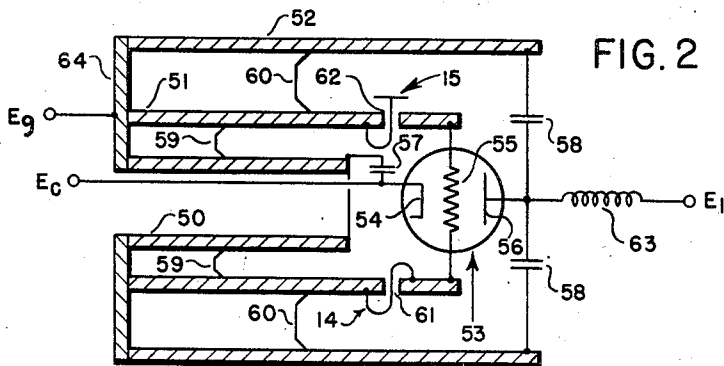
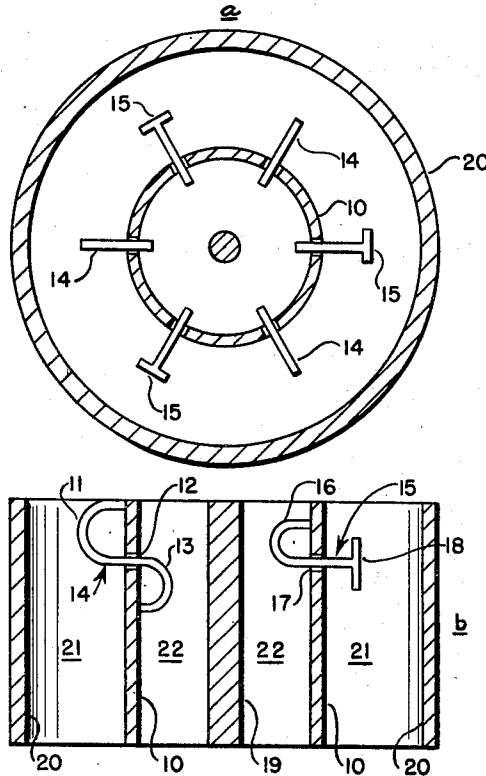
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ELECTRICAL COUPLING STRUCTURE

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FIG. 1



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ELECTRICAL COUPLING STRUCTURE

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5 Claims. (Cl. 250—36)

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This invention relates generally to electrical apparatus and more particularly to a multiple feedback device for use in the feedback portion of a resonant coaxial line oscillator.

In one type of radio frequency oscillator, two resonant coaxial lines are connected between the grid and plate and the grid and cathode, respectively, of a triode vacuum tube to form the resonant circuits of the oscillator. The lengths of the resonant coaxial lines may be varied in order to allow the frequency of oscillation to be adjusted. Feedback probes are provided between the grid-plate and the grid-cathode coaxial resonant lines. The feedback probes which have been employed heretofore, enabled the oscillator to operate satisfactorily over only a limited frequency range. Accordingly, one object of this invention is to provide a feedback means which affords adequate coupling between two coaxial resonant lines for frequencies over a relatively wide range.

Another object is to adapt the aforesaid feedback means to any application wherein a relatively wide band of frequencies are to be coupled from one coaxial resonant line to another. It follows that for any cavity or in other instances where wide-range feedback is desired, the feedback system for coaxial resonant lines as disclosed herein may prove applicable.

Other objects, features and advantages of this invention will suggest themselves to those skilled in the art and will be apparent when taken in connection with the accompanying drawings in which:

Fig. 1a is a top view of a feedback assembly embodying the principles of this invention;

Fig. 1b is a vertical sectional view of the aforesaid feedback assembly; and

Fig. 2 is a schematic diagram of a dual coaxial resonant line, radio frequency oscillator including the feedback assembly shown in Fig. 1.

In Fig. 1b a vertical cross-sectional view of two concentric coaxial lines are shown. Cylinder 10 is concentrically spaced about center conductor 19. Cylinder 20 surrounds cylinder 10 and is also concentrically spaced with respect to center conductor 19. The cylinders 10 and 20 form a first resonant coaxial line 21. Cylinder 10 and center conductor 19 form a second resonant coaxial line 22. Radio frequency energy over a relatively wide band of frequencies is to be coupled from the first resonant coaxial line to the second.

One end of a loop of metal conductor 11 is connected to the outer surface of cylinder 10. The opposite end of the loop 11 projects through a hole 12 in cylinder 10, and, when bent and con-

nected to the inner surface of the cylinder, forms a second loop 13 inside the cylinder. The combination including loops 11 and 13 will hereinafter be referred to as the inductive probe 14.

Diagonally opposite the inductive probe 14 a capacitive probe 15 is attached to cylinder 10. Capacitive probe 15 includes a loop of metal conductor 16 within cylindrical ring 10, one end of which is attached to the interior surface of cylinder 10 and the opposite end of which projects through hole 17 in the cylinder. A circular disc 18 (side view shown) is attached to the projecting end of the metal conductor 16 on the outside of the cylinder. Circular disc 18 is substantially the capacitive coupling portion of capacitive probe 15. The exact shape of the circular disc 18 may be altered to fit particular requirements.

A plurality of inductive and capacitive probes as 14 and 15 may be equally spaced around the circumference of the cylinder 10. This is more clearly shown in Fig. 1a, in which three inductive probes 14 are shown, symmetrically spaced about a circumference of cylinder 10. Three capacitive probes 15 are also symmetrically spaced about said circumference, each capacitive probe being placed midway between the successive inductive probes.

The feedback device shown in Fig. 1 may be used in a dual coaxial resonant line, radio frequency oscillator, of the type, for example, described in a patent by Eugene Fubini, Hegar C. Kriegel, and John C. Stevenson, entitled High-Frequency Concentric Line Oscillator, Serial No. 651,310, filed March 1, 1946, Patent No. 2,472,204, issued on June 7, 1949. The radio frequency oscillator referred to above is shown in the schematic diagram of Fig. 2.

The aforesaid radio frequency oscillator includes a triode vacuum tube 53 having a cathode 54, a control grid 55 and a plate 56. A cylinder 50 is surrounded by a concentric hollow cylinder 51. Hollow cylinder 51 is surrounded by a concentric hollow cylinder 52. Concentric cylinder 51 is connected directly to the control grid 55 of the triode 53. Cylinders 50 and 52 are capacitively coupled through capacitors 57 and 58, respectively, to cathode 54 and plate 56, respectively, of triode vacuum tube 53.

Cylinder 50 together with concentric cylinder 51 forms a resonant coaxial line between the control grid 55 and the cathode 54 of the triode vacuum tube 53. Concentric cylinder 51 together with concentric cylinder 52 forms a resonant coaxial line between the control grid 55 and the plate 56 of the triode vacuum tube 53. The

lengths of the grid-cathode and the grid-plate resonant lines are adjusted by means of the terminating ends 59 and 60, respectively, which are movable. The cylinder 50 and cylindrical conductors 51 and 52 are joined together at the ends thereof which are farthest away from the vacuum tube by means of a metal disc 64 which is connected to each of these elements.

Coupling between the resonant coaxial lines of Fig. 2 is provided by means of the feedback device shown in Fig. 1. The cylinders 10 and 20 in Fig. 1a are represented in Fig. 2 as a continuation of the cylindrical conductors 51 and 52, respectively. Inductive probe 14 projects through hole 61 in cylindrical conductor 51. Capacitive probe 15 projects through hole 62 in cylindrical conductor 51. One inductive probe 14 and one capacitive probe 15 have been shown in Fig. 2 for purposes of illustration only. Any desirable symmetric arrangement including more than one of each probe may be used when found applicable.

A suitable positive potential from a source designated herein as E_b is applied to plate 56 of triode vacuum tube 53 through radio frequency choke 63. To disc 64 is applied a suitable bias potential from a source designated herein as E_c . Disc 64, as mentioned beforehand, is connected to cylindrical conductor 51 which in turn is connected to control grid 55 of triode vacuum tube 53. To cathode 54 of triode vacuum tube 53 is applied a suitable potential from a source designated herein as E_c .

The oscillator circuit is tunable to a particular frequency by adjusting the respective terminating ends 59 and 60 of the grid-cathode and the grid-plate coaxial resonant lines. For the oscillator to operate satisfactorily the feedback probes 14 and 15 must return a voltage of the proper phase, frequency, and amplitude from the grid-plate resonant line to the grid-cathode resonant line.

At frequencies of oscillation below a certain value the field configuration in the coaxial resonant lines becomes predominantly of a transverse magnetic mode. At these frequencies the inductive probes are more effective in feeding back a voltage of sufficient amplitude to sustain oscillations.

At frequencies of oscillations above said value the field configuration in the coaxial resonant lines becomes predominantly of a transverse electric mode. At these frequencies the inductive probe coupling becomes less effective and the capacitive probe coupling becomes more effective.

A greater range of feedback frequencies may be covered by the above-described feedback system than would be possible by using capacitive or inductive probes separately. The number and size of the inductive and capacitive coupling probes is governed by the total amount of feedback energy which is desired. The symmetrical spacing of the probes within the coaxial resonant lines allows the electrical fields to be symmetric and prevents undesirable modes of oscillation from becoming dominant.

It would be evident to those skilled in the art that such a feedback system entailing the principles of this invention can be used in coupling any type of resonant cavities or resonant coaxial lines together.

While there has been described hereinabove what is at present considered to be a preferred embodiment of this 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.

What is claimed is:

1. In a coaxial line oscillator for generating radio frequency energy and including two coaxial resonant lines having a common metallic member, a plurality of inductive probes spaced symmetrically around the circumference of said metallic member and each extending through said metallic member to form a loop on each side thereof, and a plurality of capacitive probes spaced symmetrically around the circumference of said metallic member and each extending through said metallic member to form a loop on one side thereof, each of said capacitive probes being terminated by a metallic disc on the opposite side of said member, said probes serving to provide feedback between said lines.

2. In a coaxial line oscillator for generating radio frequency energy and including two coaxial resonant lines having a common member, a plurality of inductive probes spaced symmetrically around the circumference of said member and extending through said member, and a plurality of capacitive probes spaced symmetrically around the circumference of said member and extending through said member, said probes serving to provide feedback between said lines.

3. In combination with a plurality of coaxial resonant lines having at least one member in common, a plurality of inductive coupling means projecting through said common member, and a plurality of capacitive coupling means projecting through said common member, said inductive and capacitive coupling means serving to couple said plurality of resonant lines together.

4. In combination with a plurality of cavity resonators having at least one member in common, a plurality of inductive coupling means projecting through said common member, and a plurality of capacitive coupling means projecting through said common member, said inductive and capacitive coupling means serving to couple said plurality of cavity resonators together.

5. In an ultra-high frequency electrical apparatus including a plurality of inclosures having at least one member in common, means for inductively coupling adjacent inclosures through said member, and means for simultaneously capacitively coupling said adjacent inclosures through said member.

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