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STRAIGHT-LINE-FREQUENCY TUNER

Filed July 17, 1956

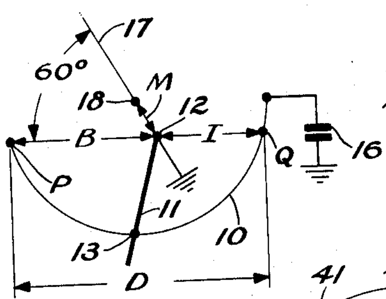


FIG 1

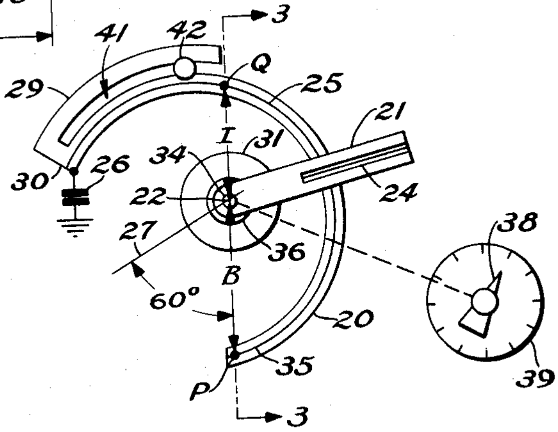


FIG 2

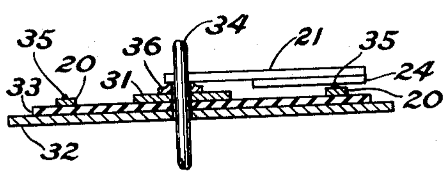
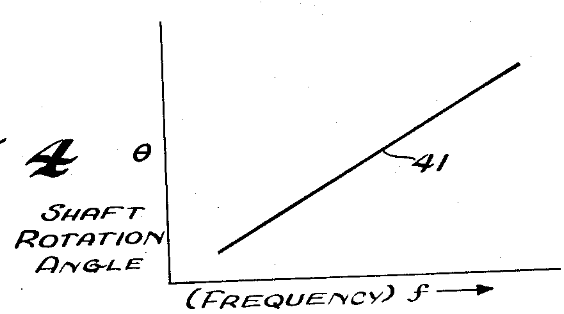


FIG 3

FIG 4



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STRAIGHT-LINE-FREQUENCY TUNER

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5 Claims. (Cl. 250—40)

This invention relates generally to tuners which are adaptable for ultra-high-frequency operation, and relates particularly to such tuners that are capable of providing straight-line-frequency operation.

A tuner is basically a resonant device which can have its resonant frequency varied in a controlled manner over a given range. A straight-line-frequency tuner is a tuner which has a substantially linear relationship between its resonant frequency and the variation of its control means, which often is a rotatable shaft.

The merits of straight-line-frequency tuning are well known. For example, it enables ease in frequency calibration. Also, it enables ease in tracking where a plurality of tuners must be controlled together.

In the invention the control means is a rotatable shaft, and a straight-line-frequency characteristic is provided between rotation of its shaft and its resonant frequency.

The invention provides a tuner having simple and economical construction, while providing straight-line-frequency operation.

It is, therefore, the principal object of this invention to provide an ultra-high-frequency tuner that has straight-line-frequency operation and that is simple in construction, space-saving, and economical to make in production.

It is a further object of this invention to provide a tuner which can obtain a substantially large unloaded Q.

It is a further object of this invention to provide an ultra-high-frequency tuner which is reliable in operation.

It is still another object of this invention to provide a tuner which can have a variable-inductance element that can be made simply from a wire that is bent according to the teachings of this invention, or from a plate that is stamped or etched with a configuration taught by this invention.

This invention provides a circular-shaped inductance element and a wiper contact which pivots about an eccentrically located point that is located according to the teaching of this invention.

Further objects, features and advantages of the invention will be obvious to a person skilled in the art upon further study of the specification and drawings, in which:

FIGURE 1 illustrates the basic layout of the invention;

FIGURE 2 is a modified form of the invention;

FIGURE 3 is a sectional view taken along line 3—3 in FIGURE 2; and,

FIGURE 4 is a diagram illustrating the operational capabilities of the invention.

Now referring to the invention in more detail, FIGURE 1 illustrates the basic form of the invention, which has a variable-inductance element **10** of conducting material having a circular shape.

A rotatable inductance arm **11** is grounded at a pivoting point **12**. Arm **11** pivots about point **12** and slideably contacts circular-inductance element **10** at a point **13** that varies in its distance from pivoting point **12** with rotation of arm **11**.

A capacitor **16** is fixed between ground and one end of circular-inductance member **10**. Its value includes a combination of distributed, stray, tube and any trimmer capacitance which may be associated with it.

Circular-inductance member **10** is formed as follows: A line is drawn through a pair of points P and Q. These points will lay on circular member **10**, when it is constructed. A distance D exists between points P and Q.

Point **12** is laid out on line PQ, and it will have a distance I from point Q and a distance B from point P. The distances D, I and B have substantially the following ratios:

$$I/B = 0.717 \quad (1)$$

$$I/D = 0.417 \quad (2)$$

$$B/D = 0.583 \quad (3)$$

Accordingly, the position of pivoting point **12** on line PQ is defined by Expressions 1, 2, and 3.

Afterward, a line **17** is constructed through point **12** at an angle of 60 degrees with respect to line B.

A second point **18** is provided on line **17** at a distance M from pivoting point **12**. Distance M is related to distance D by the following ratio:

$$M/D = 0.1622 \quad (4)$$

Point **18** provides the center of a circle that defines circular-inductance element **10**. Inductance element **10** preferably extends at least about the smaller portion of the circle intersected by line PQ, which is a chord of the circle. Thus, 180 degrees of rotation are provided in rotating inductance arm **11** from point Q to point P.

Inductance element **10** may be formed of a wire having constant diameter. It is insulatingly positioned in a plane parallel to a ground-plane (not shown in FIGURE 1).

The effective length of variable-inductance arm **11** is between points **12** and **13**. The effective length varies as arm **11** is rotated in a clockwise direction from point Q in FIGURE 1, by first decreasing and then increasing in effective length.

The straight-line-frequency characteristic of this invention is primarily obtained in rotating arm **11** between points Q and P. Accordingly, circular element **10** need not be extended much beyond point P. However, an initial inductance for the tuned circuit may be provided by extending circular-element **10** beyond point Q.

Due to the fixed spacing between circular inductance **10** and a ground plane (not shown in FIGURE 1), there will be distributed capacitance along the length of circular member **10**; and this distributed capacitance will be varied in its effect upon the tuned frequency of the tuner as arm **11** is rotated.

A resonant circuit can be traced from ground through capacitor **16**, through the fixed-inductance portion of circular member **10** up to point Q, through the adjustable length of circular member **10** between points Q and **13**, and through the active-arm length between point **13** and grounded point **12**.

The highest straight-line tunable frequency for the tuner of FIGURE 1 is obtained when arm **11** is at point P. Then, the active inductive portion of arm **11** is between point Q and **12**. Consequently, at the highest-frequency position of arm **11**, circular element PQ has substantially no inductive effect, but it has a substantial capacitive effect between it and the ground plane that effects the highest frequency of the tuner.

The range and absolute frequency values of the form of the invention in FIGURE 1 are primarily controlled by the diameter of wire **10** and its length.

Capacitor **16** may be made adjustable to provide an adjustment at the high-frequency end of the tunable range of the tuner. Its adjustment will not substantially affect the straight-line-frequency characteristic of the invention or its frequency range.

The form of the invention in FIGURE 2 is similar to the form shown in FIGURE 1, and its circular element is constructed by the same method.

An annular plate **20** of non-ferrous conducting material forms the circular-inductance element in FIGURE 2 and is comparable to circular member **10** in FIGURE 1. When using an annular plate **20** rather than a circular wire **10** as in FIGURE 1, the center-line **25** of the plate may be constructed in the same manner as the circle of FIGURE 1.

Hence, in constructing annular member **20** in FIGURE 2, a pair of points P and Q are provided and a line is drawn between them to define the chord of a circle. The spacing between points P and Q determines to a first order of magnitude the size of the tuner and its frequency of operation.

Pivoting point **22** is determined along chord PQ by the ratios of Formulas 1, 2, and 3 above. A sixty-degree line **27** is drawn, and center point **22** is provided using the ratio of Formula 4 above.

Center line **25** of annular member **20** can then be drawn, since its radius will extend from point **22** to either point P or Q.

The width of annular plate **20** does not appear to have a large effect upon the highest frequency of operation or upon the straight-line-frequency characteristic of the tuner, since the inductance of annular member **20** decreases while its capacitance to the ground plane increases as its width is increased. However, the tuning range decreases as plate **20** is made wider due to its decrease in inductance per unit length.

A lip member **29** provides an adjustable inductance at the high-frequency end of tuner operation. This added inductance makes a smaller frequency range with better stability. It is connected to plate **20** at its end **30** and has its main portion separated therefrom by a slotted space **41**. A shorting member **42** is located in slot **41** and is adjustable along the slot. Positioning of member **42** along slot **41** provides an inductance adjustment for the tuner. Once the adjustment is made, member **42** may be permanently fixed, such as by soldering.

A capacitor **26** is connected between ground and the end portion **30**. If there is a proper amount of stray or tube capacitance, capacitor **26** may be eliminated and a trimmer adjustment may be obtained by adjusting the inductance of portion **30**–Q by positioning member **42**. On the other hand, if capacitor **26** is adjustable then a two point adjustment is provided for aligning the frequency and range of the tuner.

Furthermore, a blocking capacitor is provided by a circular plate **31**, with respect to the ground plane. In FIGURE 3, plate **31** is separated from a ground-plane plate **32** by a dielectric **33**. Dielectric **33** also insulatingly separates annular inductance member **20** and lip member **29** from ground-plane **32**. Dielectric **33** should be thin to obtain a large capacitance for plate **31**.

The geometric configuration of plate **31**, dielectric **33**, and ground plate **32** (shown in FIGURE 3) provide a large capacitance at ultra-high-frequencies to, in effect, maintain plate **31** at substantially ground potential for radio frequencies.

However, plate **31** is insulated from ground and it permits direct-current potentials on the tuner, which are essential when the tuner is utilized in the plate circuit of a vacuum tube.

Tuning arm **21** in FIGURE 2 is formed of non-ferrous material of high conductivity and has a **V**-shaped portion **24** that provides substantially line contact with the surface of circular-inductance plate **20**. A plurality of **V**-shaped portions **24** may be used where the power capacity of the tuner is large to improve efficiency. Its straight-line-frequency characteristic is indicated by line **41** in FIGURE 4.

The tuning range of the invention can be extended without greatly deviating from the straight-line-frequency characteristic of the tuner by connecting a linearly-variable capacitor in parallel with either capacitor **16** or **26**. That is, the capacitance of the added capacitor varies linearly with shaft rotation, with adjustable tabs being preferably provided.

The input and output of the invention can be taken across capacitor **16** in FIGURE 1 and across capacitor **26** in FIGURE 2.

Although this invention has been described with respect to particular embodiments thereof, it is not to be so limited, as changes and modifications may be made therein which are within the full intended scope of the invention as defined by the appended claims.

I claim:

1. A straight-line-frequency tuner comprising an inductance member formed as a circular arc, with said circle having a chord, a pivoting point dividing said chord into two parts having a ratio of about 0.717, and the center of said circular arc being located on a line positioned about 60 degrees from the larger of said two chord parts and passing through said pivoting point, the distance between said center point and said pivoting point having a ratio to said chord length of about 0.1622, a wiper arm of conducting material having one end rotatable about said pivoting point, a ground-plane insulatingly supported substantially parallel to the plane of said inductance member, means for maintaining the pivoted end of said arm at substantially ground potential for radio frequencies, and said wiper arm slideably and conductively engaging said inductance member, with the straight-line-frequency characteristic of said tuner being obtained by rotation of said arm over the circular arc portion of said inductance member.

2. A tuner as defined by claim 1 in which said inductance member is formed of a conducting wire member, with a capacitor connected between said ground plane and that end of said inductance member which is adjacent to the shorter part of said two chord parts, and input-output terminals of said tuner being provided across said capacitor.

3. A tuner as defined by claim 1 in which said inductance member is formed of an annular plate, said annular plate having a raised portion formed with the configuration of said circle, and said arm slideably and electrically engaging said raised portion.

4. A tuner as defined in claim 1 in which said circular inductance member is extended at its end adjacent to the shorter one of said two chord parts, a lip member connected at one end to the extended end of said circular inductance member, with a slot formed between said extended end and said lip member and being open at one end, and adjustable shorting means received across said slot to adjust the combined inductance of said extended end and said lip member.

5. A tuner as in claim 1 having an annular plate located substantially concentrically about said pivoting point, dielectric means insulatingly supporting said circular plate from said ground plane, with said arm being connected near its pivoting point to said circular plate and insulated from said ground plane, and the pivoted end of said arm being grounded for radio frequencies by the capacitance between said circular plate and said ground plane.

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