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TUNING MEANS

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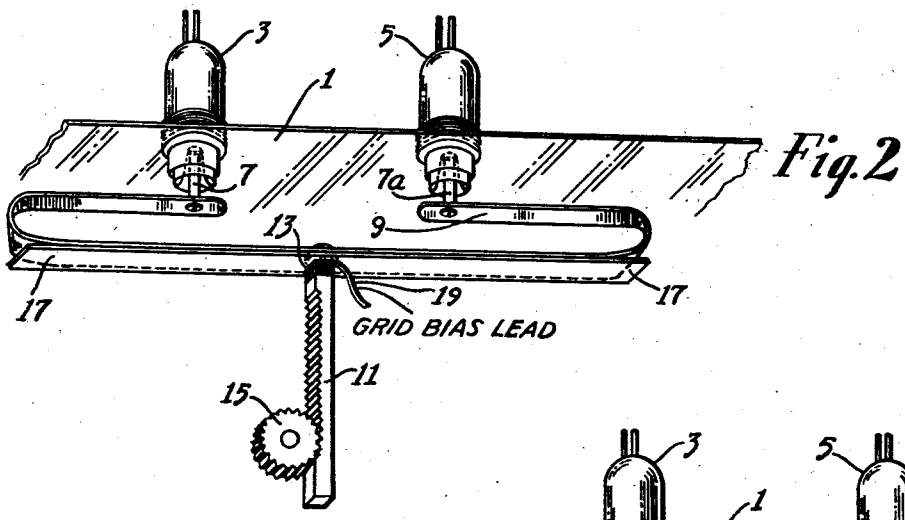


Fig. 2

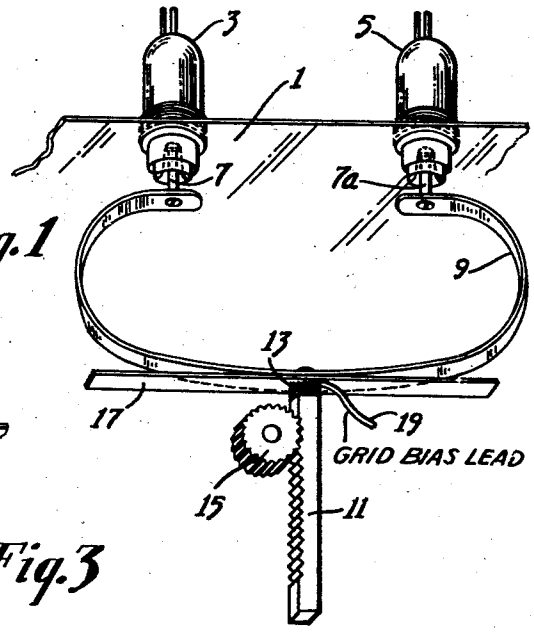


Fig. 1

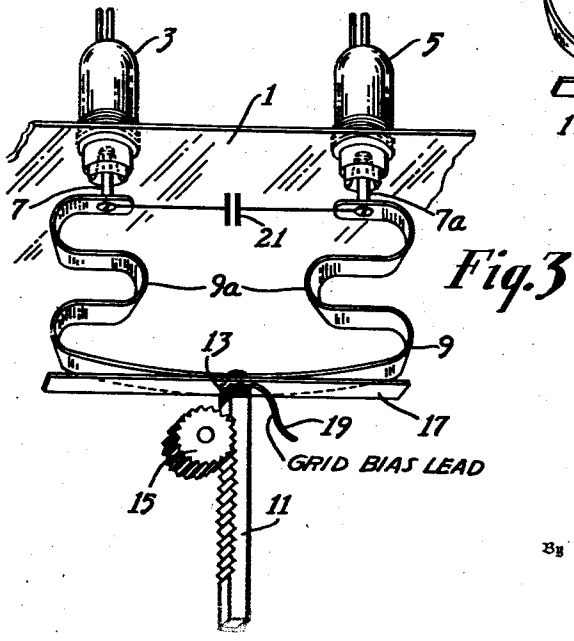


Fig. 3

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TUNING MEANS

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9 Claims. (Cl. 250—40)

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The invention covered herein may be manufactured and used by or for the Government of the United States for any governmental purpose without payment to me or assigns of any royalty thereon.

This invention relates to improvements in tuning apparatus and particularly to improvements in variable tuners for use in radio, radar and analogous high and ultra-high frequency systems for the communication of intelligence.

It is well known to those skilled in the art to which this invention appertains that the problem of tuning high and ultra-high frequency circuits is far more complex than that of tuning relatively low frequency circuits. This is so because the circuit parameters and the circuit components become increasingly small with an increase in frequency. Thus, the variable capacitor method of tuning radio circuits becomes practically unworkable at very high frequencies, especially in high powered transmitters because the spacing necessary to prevent voltage breakdown makes it impossible to provide sufficient capacity to tune the circuit with elements which are small compared with a wave length. Conventional variable inductance methods become unworkable at very high frequencies for a like reason and also because there is often insufficient space available to couple the inductor to the line. In order to obviate the foregoing difficulties it has previously been the practice to employ a transmission line as the tunable circuit in high frequency installations and to tune the line by varying its effective length, as by means of a movable shorting bar or "plug," or by means of a variable capacitor connected across the line or a small inductor variably coupled to one end of the line. The movable shorting bar method has been, up to now, the only practical tuning method available for many uses. Shorting bars, however, are not always satisfactory, principally because their use involves slidable or other "friction type" contacts. These contacts are very often at a point of high current and therefore the resistance must be especially low to prevent a reduction in the efficiency of the circuit. This is not always practical because the contacts may become dirty in use and prevent the maintenance of a low resistance path for the current. Further, dirty contacts result in the introduction of noise into a receiver circuit and, their presence in a transmitting circuit results in a reduction in usable power. It is also bad practice to tune a transmitter by means of a movable shorting bar when the power is on because the movement of the shorting bar usually

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causes sparking which burns the contacts and thus increases the rate at which failure may occur.

Accordingly, the principal object of the present invention is to obviate the foregoing and other less apparent objections to present day high frequency tuners.

Another and related object of the invention is to provide an improved continuously variable tuner suitable for use at high and ultra-high frequencies and one characterized by the simplicity and economy of its parts and by its absence of slidable contacts or other adjustable elements of a type presenting a substantial impedance to the flow of current at the frequencies indicated.

Other objects and advantages together with certain preferred details of construction will be apparent and the invention itself will be best understood by reference to the following specification and to the accompanying drawing wherein:

Figs. 1 and 2 are views in perspective of a radio transmitter installation embodying an improved tuner within the present invention, and

Fig. 3 is a similar view of an alternative embodiment of a tuner within the invention and wherein the tuner is designed to handle a relatively wide wave band of a lower order of frequencies than the apparatus of Figs. 1 and 2.

In the accompanying drawing wherein like reference characters designate the same or corresponding parts in all figures, 1 designates a chassis or panel of a radio apparatus and 3 and 5 designate, respectively, two vacuum tubes which are mounted in spaced relation upon the said panel. These tubes have dependent grid leads 7, 7a respectively, which extend below the underside of the panel 1 and the said leads are connected to the opposite ends of a flat strip 9 of thin conducting material such, for example, as phosphor bronze. The strip 9 is of a length substantially greater than the space between the electrode elements or leads 7, 7a, to which it is connected, and may be said to comprise an inductive loop of less than one full turn. A rack 11 is connected to the midpoint of the strip or lead 9 through an insulating element or grommet 13 and is driven by a pinion 15. The rack 11 and pinion 15 provide a convenient mechanism for altering the area embraced by the loop and hence the effective inductance of the strip 9 comprising the said loop. A flat rigid strip 17 constituted of insulating material prevents the loop from buckling when it is compressed.

The inductance L provided by this flat conductive strip or loop 9, together with the relatively

fixed interelectrode capacitance C within the tubes 3 and 5, comprise a tunable L—C circuit wherein tuning is achieved by varying the area embraced by, and hence the effective inductance of, the loop.

In Fig. 1 the loop 9 is shown in its expanded (maximum area, maximum inductance) position, and Fig. 2 shows the loop in its compressed (minimum area, minimum inductance) position.

It should be noted that since the conductor 9 comprises a flat strip, it can flatten out in one direction only, hence it will not twist or buckle as it would if a round or square cross-section conductor were used. Further, the flat strip here illustrated exhibits a low radio-frequency resistance because the current flows mostly on the side surface of the loop and not on the thin edges.

As previously pointed out, the driving mechanism 11, 15 is insulated from the center of the conductive strip or loop 9 by the insulator 13. This permits a direct current connection 19 to be made at this point to the grid bias supply (not shown).

As the loop 9 is compressed or expanded by the driving mechanism 11, 15, the effective area embraced by the loop is altered without relatively moving the ends of the loop 9 which, as above pointed out, are rigidly secured to the grid leads 7, 7*a*. This change in the area embraced by the loop results in a change in inductance, the inductance being less when the loop is compressed than when it is expanded. The compressed loop therefore tunes the circuit to the higher frequencies. The inwardly extending oppositely located bends in the flexible metal strip 9 will be folded quite sharply when the loop is entirely compressed and when thus folded act as by-pass capacitors in the extreme compressed position and therefore short out part of the length of the strip, thereby further increasing the available tuning range.

The tuning system shown in Figs. 1 and 2 has been used with success in a high powered (100 kilowatt) radar transmitter. In this case the tubes 3 and 5 comprised a pair of Navy type CV92 (RCA type 8026) tubes. The tuning loop 9 comprised a phosphor bronze strip ½ inch wide and 0.010 inch thick and about 7½ inches long. The tubes 3 and 5 were spaced with their centers 3⅜ inches apart. The movement at the center of the loop was ¾ of an inch. This gave a frequency range of at least 205 to 260 megacycles. The insulating backing strip 17 was 4½ inches long and ⅝ of an inch wide. In comparative tests with a conventional variable capacitor tuning system, the prior art system exhibited a tuning range of only 10 megacycles without sparking-over and another prior art tuning system employing a variable coupling to a small loop exhibited a similar inadequate coverage. It should be mentioned that the use of the insulating strip 17 to back up the conductive strip 9 prevents the loop from assuming a heart-shape configuration when the adjusting force is applied at its mid-point and this contributed materially to the successful operation of the apparatus over the above-mentioned tuning range. (When the backing strip was omitted the tuning range was very much smaller, say 200–220 megacycles.)

Referring now to the embodiment of the invention shown in Fig. 3: A still wider tuning range is achieved by providing the flexible loop 9 with an accordion pleat or fold 9*a* intermediate its ends. As this accordion fold 9*a* is compressed or expanded by the force applied to the strip 9 by the driving mechanism 13, 15, the area embraced by the said strip or loop is more greatly altered and the resulting tuning range is several times that exhibited by the simple loop of Figs. 1 and 2. A fixed capacitor, which is indicated symbolically at 21, may be connected across the ends of the loop 9 to augment the interelectrode capacitance of the tubes 3 and 5 and thereby render the tuning system of the invention operable at frequencies lower than those mentioned above.

Other modifications and applications of the invention will suggest themselves to those skilled in the art. Accordingly, the foregoing description of certain preferred embodiments of the invention should be interpreted as illustrative and not in a limiting sense except as required by the prior art and by the spirit of the appended claims.

What is claimed is:

1. In combination, an electrically resonant circuit wherein the capacitance is fixed and the inductance comprises a flexible conductive loop of less than one full turn, and means for deforming said loop to vary the area embraced by and hence the effective inductance of said loop.

2. An electrically resonant circuit comprising a flexible conductive loop of less than one full turn, means for securing the ends of said loop against relative movement, means establishing a substantially fixed value of capacitance between the said ends of said loop, and means for flexing said loop to vary the area embraced by and hence the effective inductance of said loop, whereby to vary the electrical resonance of said circuit.

3. Radio tuning apparatus comprising a support, a pair of circuit elements mounted in spaced relation upon said support, said circuit elements each possessing a substantially fixed value of capacitance, a flexible conductor connected adjacent to one of its ends to one of said circuit elements and adjacent to the other of its ends to the other of said circuit elements, said conductor being longer than the distance between said spaced circuit elements and comprising an inductive loop of less than one full turn, and means connected to said flexible conductor intermediate its ends for altering the contour of said loop, the effective value of its said inductance, and the frequency to which said radio apparatus is tuned.

4. The invention as set forth in claim 3 and wherein said circuit elements comprise a pair of vacuum tubes each containing a control grid, and said flexible conductor is connected at each of its opposite ends to one of said control grids.

5. The invention as set forth in claim 3 and wherein a capacitor is connected across the open ends of said loop to augment the said fixed value of capacitance.

6. In combination, a pair of capacitive circuit-elements, a flexible conductive strip connected at its opposite ends to said pair of capacitive circuit-elements, said circuit-elements being spaced apart a distance less than the length of said strip to form an inductive loop of less than one full turn, and adjustable means connected adjacent to the mid-point of said strip for altering the area embraced by said loop and hence the effective inductance of said conductive strip.

7. The invention as set forth in claim 6 and wherein said conductive strip is provided with an accordion fold intermediate its ends.

8. The invention as set forth in claim 6 and wherein a rigid piece of insulating material is provided intermediate said adjusting means and said conductive strip for controlling the contour

of said conductive strip when the area embraced by said loop is altered by said adjusting means.

9. An inductively tuned circuit comprising a resilient conductor of predetermined length and constituting substantially the entire inductance of said circuit, means for securing the ends of said conductor against relative movement, means for establishing a substantially fixed value of capacitance between said ends of said conductor, said last mentioned means constituting substantially the entire capacitance of said circuit, and means for flexing said conductor whereby to vary its effective inductance and hence the tuning of said circuit.

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