July 18, 1950 F. BABIN 2,515,436

TUNING DEVICE FOR TRUE ANTENNAS

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Fig. 1.

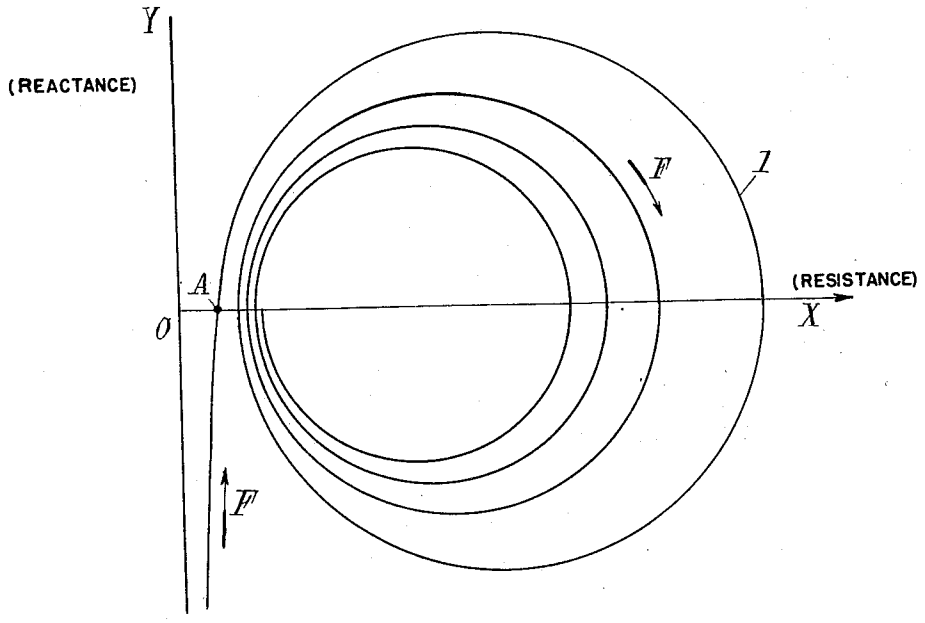
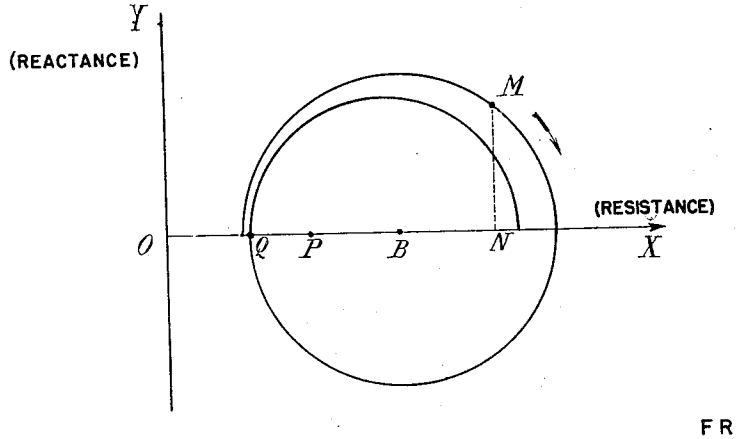


Fig. 2.



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Fig. 3.

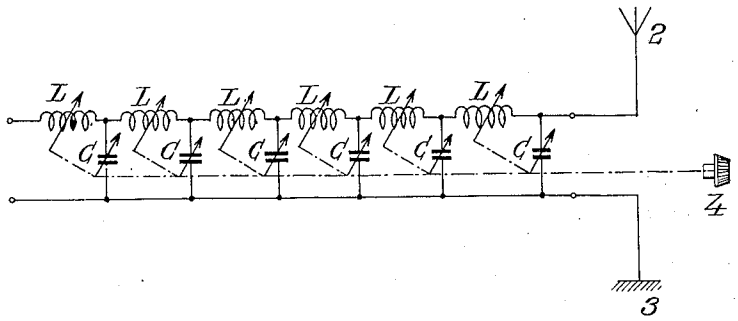
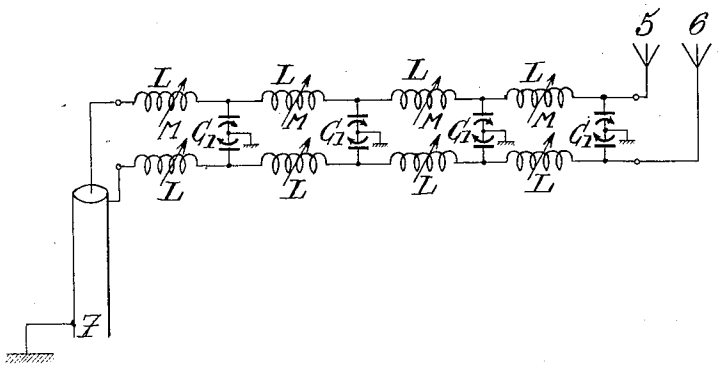


Fig. 4.



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TUNING DEVICE FOR TRUE ANTENNAS

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3 Claims. (Cl. 250—33)

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The present invention relates to tuning devices for true antennas, the expression "true antennas" being used to differentiate them from "artificial" or "dummy" antennas, the invention being more especially concerned with the case when said antennas are used to work on wave-lengths shorter than four times their length.

It is known that an antenna, when it is used to work on different wave-lengths, and in particular wave-lengths shorter than four times its length, has a total impedance which consists of two portions, to wit: an active one (resistance to radiation) and a reactive one (reactance). The "adjustment" or "tuning" of this antenna is the operation which consists in adding thereto circuits such that, with little losses, the impedance thereof is caused to assume a purely active form and a predetermined value.

This result is generally obtained by proceeding in two steps; the first step consists in reducing the reactance to zero by inserting in series with the antenna inductance coils or capacitors, according to the direction of this reactance; the second step transforms the new impedance thus obtained, for instance by circuit coupling.

The chief object of my invention is to provide a tuning device of the kind above referred to which is better adapted to meet the various requirements of practice than those used up to this time, in particular which permits of tuning the antenna in a single operation.

Preferred embodiments of my invention will be hereinafter described with reference to the accompanying drawings, given merely by way of example and in which:

Fig. 1 shows a curve representing the variation of the total impedance of an antenna when the wave-length varies;

Fig. 2 shows a portion of the same curve on a different scale;

Fig. 3 diagrammatically shows a system of tuning circuits according to the invention;

Fig. 4 diagrammatically shows another system of tuning circuits also according to the invention.

It is known that when an antenna is caused to work on wave-lengths shorter than four times its length, the variations of its impedance when the wave-length varies may be represented by a curve such as that of Fig. 1, by plotting in abscissas the active resistance, and in ordinates the reactance. The theoretical curve in question is a spiral which intersects the axis of abscissas at points grouped in two series, to wit: so-called resonance points, of low impedance, and so-called anti-resonance points, of high impedance.

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For practical purposes, this curve may be considered as constituted by a set of semi-circles, alternately located on one side and the other of the axis of abscissas OX having their centers on this axis, and extending each from a resonance point to the next anti-resonance point. On such a curve I (Fig. 1), the point that represents the antenna impedance travels in the direction of arrow F when the wave-length decreases, point A being the representative point for the antenna working in quarter-wave fashion.

Theory and experience show that the geometrical power of origin point O with reference to all these circles is approximately equal to the characteristic impedance Z of the antenna that is utilized.

Being given an antenna of characteristic impedance Z, the point that represents its total impedance for the wave-length on which it is caused to work is for instance located at M, on a circle of center B (Fig. 2).

Up to now, tuning the antenna consisted in bringing the figurative point from M to N, then from N to a point P, upon the axis OX of the active resistances.

The essential feature of the present invention consists in providing, in series with the antenna, circuits including inductance coils and capacitors and adjusting the values of said inductance coils and capacities simultaneously and in such manner that the point that represents this total impedance travels along the impedance curve toward the first resonance point that is reached when turning in the clockwise direction.

This result can be obtained by making use of an adjustable feeder having like the antenna (to ensure the minimum of losses) a characteristic impedance equal to Z.

By varying the working length of this feeder without modifying its characteristic impedance, its inductance and its capacity are caused simultaneously to vary. Consequently the point M that represents the antenna impedance for the wave-length that its utilized will be caused to travel on the circle above defined so as to come to the nearest resonance point Q.

Preferably, the feeder includes a plurality of suitably grouped variable elements for adjustment thereof.

For instance, as shown by Fig. 3, it consists of a line including inductance coils L in series with antenna 2 and capacitors C in shunt with the earth 3. All these elements are made variable and caused to vary simultaneously, by means of a single control 4, in such manner as to keep the

characteristic impedance of this line constant during this variation, and equal to Z, to wit: the characteristic impedance of antenna 2.

The system may for instance include six cells consisting each of an inductance coil L in series and a capacitor C in shunt; the control means for varying these values are coupled together in such manner that the expression

$$\sqrt{\frac{L}{C}}$$

remains constant and is equal to Z.

Any suitable means may be used for controlling the variable inductance coils and variable condensers from a single control shaft (cams, coils and condensers of special shapes, etc.) for ensuring the constancy of expression

$$\sqrt{\frac{L}{C}}$$

Of course, the number of cells—including each a variable inductance coil and a variable capacitor—may vary. Calculation shows that, in order to obtain a very fine adjustment, six cells are to be employed but that a lower number (as low as two in certain cases) may be sufficient for obtaining a rough adjustment.

The variations being more important for long wave-lengths than for short ones, it is of advantage to make use of inductance coils having non-linear variations so as to obtain a relatively accurate adjustment for short wave-lengths and a sufficiently quick one for long wave-lengths.

For this purpose, for instance, I will make use of variable inductance coils of the slider contact type wound on cones, or in flat spiral fashion, in combination with variable condensers the control cam or profile of which will correspond with the law of variation of the inductance coils to comply with the condition of constancy of expression

$$\sqrt{\frac{L}{C}}$$

These features are adapted to permit the adjustment of a dissymmetrical antenna 2 (Fig. 3). If now it is supposed that it is desired to act upon a symmetrical or doublet antenna 5, 6 (Fig. 4), the artificial line will include two sets of inductance coils L in series connected two by two through balanced or split condensers C. In this case also the inductance coils and the capacitors will be varied simultaneously and in such manner as to comply with the condition

$$\sqrt{\frac{L}{C}}=Z$$

(characteristic impedance of the antenna); that is to say, in fact, in such manner as to keep the values of L and C in the same ratio to each other.

I may further couple together, with a variable coupling coefficient M, homologous inductance coils in the two branches of the artificial line. The values of L, C, M will be varied in such manner as always to remain proportional to one another, in order to comply with the condition of constancy of the characteristic impedance of the artificial line thus constituted.

It is thus possible to act on a symmetrical or doublet antenna 5, 6 (Fig. 4) from a dissymmetrical transmitter or line such as a coaxial cable 7. Reciprocally, a dissymmetrical antenna might be acted upon from a symmetrical transmitter or line.

It is to be noted that, in most cases, a slight adjustment variation occurs, due to the fact that the value of the impedance of the point of resonance increases when the wave-length that is chosen decreases; but this increase is small and most often can be neglected. As a matter of fact, when the antenna is attacked directly through a transmitter, the tubes work with the maximum of power supplied for the impedance that is utilized, and this power varies little with the wave-length, as any function close to a maximum; and when the antenna is attacked through a feeder with progressive waves which ends on its characteristic impedance—which ensures the minimum of losses—these losses will remain small, as any function close to a minimum, if a slight unbalancing takes place.

My tuning device has, over the already existing devices of the kind in question, among other advantages, that of performing the adjustment very simply in a single operation.

The consecutive inductance coil elements could be coupled together, with a view in reducing the volume of the apparatus.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of my invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

What I claim is:

1. For use with a radio transmitter antenna, a tuning device which comprises, in combination, feeder means including at least two variable inductance coils in series with said antenna and two variable capacitors in shunt between the earth and said antenna, and control means for simultaneously adjusting said coils and said capacitors to keep the approximate characteristic impedance of said feeder means, as expressed by the square root of the inductance to capacity ratio thereof, substantially constant and equal to the approximate characteristic impedance of said antenna.

2. For use with a radio transmitter doublet antenna, a tuning device which comprises, in combination, feeder means including a line for each antenna element with at least two variable inductance coils in series therein and at least two variable balanced capacitors inserted in shunt between said lines, and control means for simultaneously adjusting said coils and said capacitors to keep a given proportional relation between the respective inductances and capacities thereof, said control means being adapted to keep the approximate characteristic impedance of said feeder means, as expressed by the square root of the inductance to capacity ratio thereof, substantially equal to the approximate characteristic impedance of said antenna.

3. For use with a radio transmitter doublet antenna, a tuning device which comprises, in combination, feeder means including a line for each antenna element with at least two variable inductance coils in series therein and at least two variable balanced capacitors inserted in shunt between said lines, means for coupling together with a variable coupling coefficient the respective inductance coils of said lines, and control means for simultaneously adjusting said coils and said capacitors and varying said coupling to keep a given proportional relation between the respective inductances, capacities and coupling coefficients, said control means being adapted to keep the approximate characteristic impedance

of said feeder means, as expressed by the square root of the inductance to capacity ratio thereof, substantially equal to the approximate characteristic impedance of said antenna.

FRANÇOIS BABIN.

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