June 1, 1948. W. S. PERCIVAL 2,442,615

HIGH-FREQUENCY TUNER

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Fig. 1.

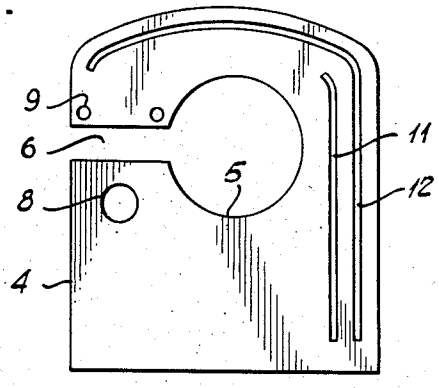


Fig. 2.

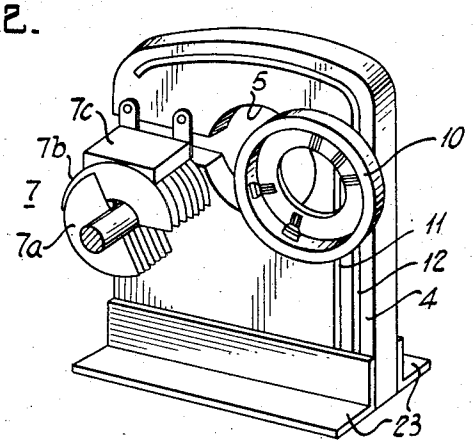
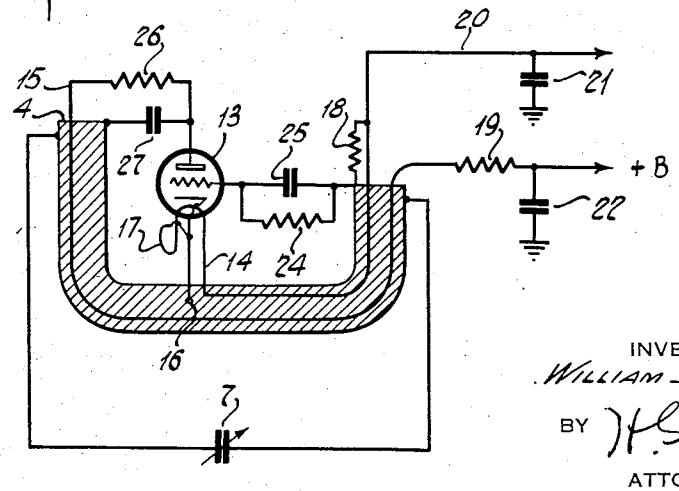


Fig. 3.



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Fig. 4.

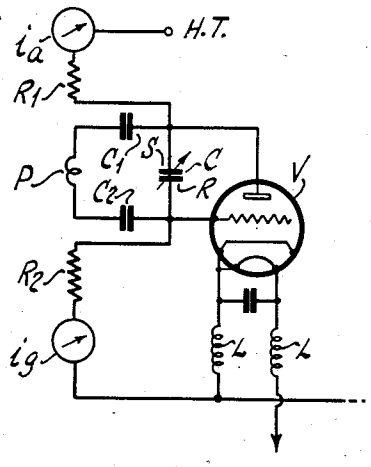


Fig. 5.

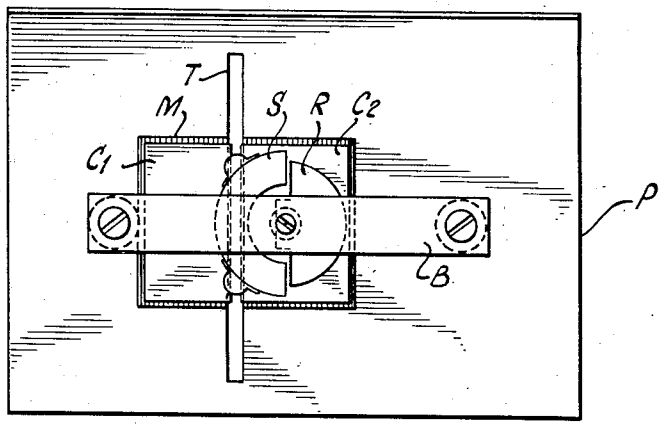
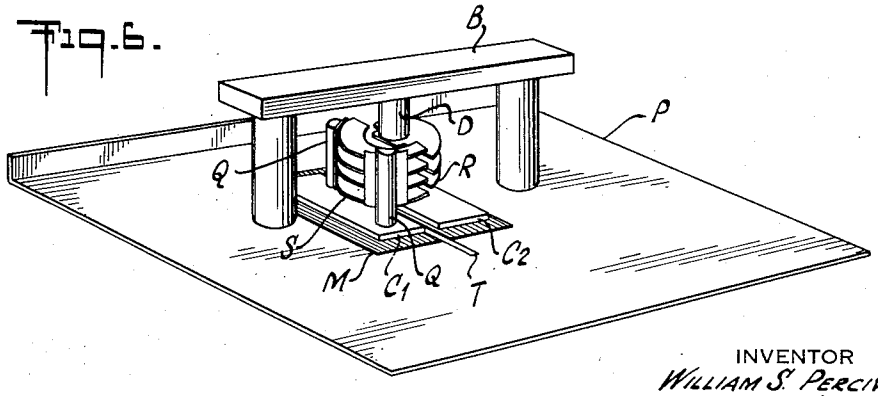


Fig. 6.



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UNITED STATES PATENT OFFICE

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HIGH-FREQUENCY TUNER

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Patent expires April 25, 1960

2 Claims. (Cl. 250—40)

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The present invention relates to high frequency electrical apparatus and has particular but not exclusive reference to ultra short wave oscillators.

In oscillators for which frequency stability is important, operating at frequencies corresponding to wavelengths of two meters or less, it is generally considered unsatisfactory to form the tuned circuits of the oscillators with ordinary inductance coils and condensers because circuits formed in this way do not have a sufficiently high Q or impedance. Thus, in apparatus for operating at the wavelength referred to, it is common to employ oscillators in which the tuning circuit consists of a resonator in the form of a short length of metal tube colloquially termed a "pipe" line.

The main object of the present invention is to simplify the construction of electric circuit arrangements such as high frequency oscillators.

A further object of the invention is to provide an element for use in, or which itself constitutes, a tuned circuit for operation on ultra short wavelengths, which enables such circuits and arrangements including them to be made more cheaply and more compact than has hitherto been possible.

Still another object of the present invention is to provide a high frequency tuning circuit for an ultra short wave oscillator which affords a large tuning range.

In accordance with the present invention, a high frequency electric circuit arrangement is provided, including a frequency determining circuit constituted by a plate of electrically conducting material providing inductances with or without means for building out the capacity of the circuit to a desired value.

In the preferred form of the invention, said plate affords support for some or all of the other elements in the arrangement.

The invention further provides an element for use in a high frequency electric circuit arrangement to afford inductance, said element being in the form of an apertured plate of electrically conducting material having a slot or gap and having electrically conducting members mounted on said plate one on either side of said slot or gap and arranged in relation to each other in such manner that the capacity of the element in shunt with said inductance is built up to a predetermined value.

Preferably, one of said members is a fixed member or stator and the other of said members is adjustable to enable said capacity to be varied.

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In order that the said invention may be clearly understood and readily carried into effect, the same will now be more fully described with reference to the drawing, wherein:

Fig. 1 is a plan view of an inductive element in accordance with the invention;

Fig. 2 is a diagrammatic perspective view of the principal parts of an electron discharge valve oscillator built on the element shown in Fig. 1;

Fig. 3 is a circuit diagram of the electron discharge valve shown in part in Fig. 2.

Fig. 4 shows a circuit arrangement; and

Figs. 5 and 6 are plan and perspective views, respectively, of an oscillator assembly, including an inductance element in accordance with the invention, the oscillator valve not being shown in the drawing.

Referring now to Figs. 1 and 2 of the drawings, it will be seen that the element therein shown comprises a plate 4, for example, of copper; or, if rigidity is desired, silver-plated brass, the plate being of considerable thickness as shown clearly in Fig. 2. (It will be appreciated that as ultra high frequency currents travel in the surface of a conductor, only the skin of the plate 4 is required to be highly conductive.) The plate 4 is provided with a gap formed by an aperture in the plate as shown at 5 and a slot 6 extending from the aperture to the periphery of the plate.

It will be readily appreciated that the plate 4 of Fig. 1, cut in the manner shown, constitutes an inductance coil having a single rigid turn. If it is desired to vary the length of the current path in the turn, thereby varying the inductance of the element, the size of the gap can be varied, and if desired the gap may consist merely of a slot such as 6 cut to the desired depth. Moreover, at the highest frequencies, for example, where the wavelength range is from 46–66 centimeters, an inductance element constituted by a solid plate of material can be employed, the aperture 5 and slot 6 being omitted.

In employing an element in accordance with the invention, it is usually necessary to build up the capacity in parallel with the inductance of the plate forming the element to a desired value. Thus, as shown at 7 in Fig. 2, a variable condenser may be mounted on the plate 4 of Fig. 1, said variable condenser comprising a rotor 7a mounted on one side of the aforesaid gap and a stator 7b mounted on the other side of said gap, the spindle of the rotor 7a being mounted in an aperture 8 in the plate 4 and the stator 7b being mounted on a bracket 7c secured in mounting

holes 9 on the plate. It will be observed that by mounting the condenser directly on the inductive element in this way it is not necessary to provide any solid dielectric bushes in association with the securing screws for the condenser and consequently no losses arise due to the provision of such bushes. In the case illustrated, the plate 4 also carries a valve holder, shown at 10 in Fig. 2, for reeciving the oscillator valve (not shown), thus permitting the length of the leads to the valve to be kept as low as possible.

It has been found important, in order to reduce losses, to arrange that substantially no current is induced in the leads from the electrodes of the valve to the supply points. Accordingly, such leads are arranged in grooves indicated at 11 and 12 in Figs. 1 and 2 in such manner that the leads are sunk beneath the surface of the plate 4. In this way the leads are screened and may pass from points at high potential in respect to high frequency currents to points at earth potential in respect to high frequency currents without any appreciable high frequency current being induced in them.

The oscillator is mounted directly on a sheet of copper (not shown) between brackets 23 (Fig. 2) and is enclosed in a copper shield (not shown).

In the case illustrated in Figs. 2 and 3, the circuit arrangement used for the oscillator is of the Hartley type, the grid of the oscillator valve 13 being arranged to be nearer to earth potential than either the anode or cathode of the valve. The anode is connected to one end of the plate 4, that is to say to one side of the aforesaid gap, and the grid is connected to the other end of the plate 4, that is to say to the other side of the aforesaid gap, while the cathode is tapped about half way round the plate 4. Thus, groove 11, which is the shorter of the two grooves provided in the plate 4, accommodates the supply lead 14 for the heater filament and the longer groove 12 accommodates the high tension supply lead 15 to the anode. The return lead for the heater circuit is connected to the cathode tapping 16 through a short loop which may be a full turn or more, as shown at 17 in Fig. 3, this loop being so arranged as to pick up some electromotive force from the plate equal and in opposite sense to that picked up by the loop formed by the two-heater leads within the valve.

In the arrangement shown in the aforesaid Figs. 2 and 3, it has been found that even when every precaution has been taken, a small electromotive force may be picked up by the supply leads. This is of no importance at the fundamental frequency, unless the leads form a resonating circuit at this frequency. Even if this is avoided, the leads may form a circuit resonating at a harmonic frequency. This absorbs power from the oscillator at the harmonic frequency and has been found to reduce the output power. This trouble can be completely eliminated by suitably damping the circuit formed by the supply lead and the return path along the coil. For example, damping may be provided by resistances 18 and 19 of about 100 ohms connected in series with the H. T. supply lead 15 and the grid lead 20, respectively. These resistances are decoupled to earth by means of the condensers 21 and 22 which may each be of 100 micro-micro-farads capacity. If a resistance connected in parallel is employed to provide damping, however, a short length of lead should be left between the point at which the resistance is placed and the decoupling condenser so that the condenser does not short the resistance.

In addition to the elements referred to above, the oscillator circuit further includes the grid biasing resistance 24, having a value of, for example, 5000 ohms, and associated by-pass capacity 25, and a decoupling resistance 26 of high value (for example 3000 ohms or more) in the anode lead 15 before the lead enters groove 12 in plate 4 and a blocking condenser 27 between the anode of valve 13 and the end of plate 4.

In the form of the invention which is the subject of Figs. 4, 5 and 6, the panel or plate P which is employed as an inductance element has a slot T cut in it as clearly seen in Figs. 5 and 6. The slot T does not extend to the periphery of the element, which may thus be regarded as equivalent to two elements of the form shown in Fig. 1 with their ends bonded together.

In the oscillator of Figs. 4, 5 and 6, the panel P is shown carrying a bridge support B of insulating material provided with a bearing D for the rotor of the tuning condenser, the spindle of which (not shown) passes through a bearing (not shown) which is fixed to the plate indicated at C2 in Fig. 5, and the spindle then passes through the panel to the underside. The stator is mounted upon and electrically connected to a metal plate indicated at C1, a sheet of mica M forming a dielectric layer between this plate and the panel P. The rotor is electrically connected by means not shown to the plate C2, which plate is also insulated from the panel P by the mica M. The plates C1 and C2 thus each constitute one plate of a fixed condenser through which the panel P is electrically connected to the stator or rotor, as the case may be, of the tuning condenser.

The oscillator valve itself is not shown, but it is preferably supported closely adjacent the tuning condenser by the wiring connected to its electrodes and not in a valve holder. The grid is connected to the upper bearing of the rotor and the anode to the stator, preferably in each case at a point near the upper end. These grid to rotor and anode to stator connections may be interchanged. The earthed ends of the choke coils, which are not shown in Figs. 5 and 6 but are shown at L in Fig. 4, are soldered to the panel P, and these coils should be mechanically stiff enough to assist in supporting the valve. The grid and anode of the oscillator valve are connected to the extremities of the stator and rotor remote from the condenser plates on which they are mounted in order to obtain the maximum impedance between the grid and anode, a condition which is essential for good efficiency, particularly on very short waves.

The circuit connection of the arrangement shown in Figs. 5 and 6 will be clearly seen by reference to Fig. 4. From this it will be seen that the resonant circuit of the oscillator consists of the capacity of the valve V, the inductance of the grid and anode leads, the variable capacity C of the tuning condenser, the inductance of the rotor R and the stator S and the inductance of the path through the panel P, represented by a coil coupling the rotor and stator. In order to obtain a large tuning range the inductance of the leads from the valve to the rotor should be as small as possible, and accordingly the valve electrodes are connected directly to the rotor and stator without the intervention of fixed condensers, the functions of which are carried out by the condensers formed between the plates C1 and C2 and the panel P, which may be each 100 microfarads or more in capacity. It will be seen that the condensers C1 and C2 isolate the panel

P from direct current potentials applied to the anode and grid electrodes. One of these condensers could be omitted if desired. The choke coils L in the cathode and heater leads of the valve V should be similar, but their optimum value is best ascertained by a process of trial and error. The anode decoupling resistance R1 which may conveniently be of 3000 ohms and the grid lead resistance R2 which may be of 5000 ohms are connected to the points at the lowest possible high frequency potentials, namely, the condenser plates C1 and C2 upon which the rotor and stator are mounted, in order to reduce high frequency losses in these resistances. Further, these resistances and their associated decoupling condensers are disposed on the panel P remote from the tuning condenser and valve.

Although the inductances of the rotor and stator cannot be neglected, the rotor should be of stout material and stout supports Q may conveniently be used for the stator if the highest frequencies are to be obtained. The slot T cut in the panel, as shown in Figs. 2 and 3, increases the length of the lines of current flow in the panel. In one constructional form of inductance panel, a range of 50–86 centimeters wavelength was obtained with a slot and by extending the slot the upper end of the range can be increased.

With the above arrangements over the wavelength ranges mentioned, satisfactory efficiency has been obtained, the performance of the oscillator circuit arrangements being characterized by a notable absence of the sudden peaks and depressions usual with known forms of oscillator circuits.

What is claimed is:

1. An ultra high frequency tuning unit comprising a single turn inductive element in the form of a rigid flat metallic plate which has a relatively large aperture therein and a slot extending from said aperture to one edge of said plate, to

thereby form an incomplete substantially annular band, a rotary condenser having a stator connected to and mounted on one side of said slot and a rotor connected to and mounted on the other side of said slot, said plate forming a mounting at a distance from said slot for a multi-electrode electron discharge device, said plate having a pair of spaced relatively narrow grooves of unequal length and parallel to each other for at least a portion of said length, said grooves being of sufficient depth to enable leads for electrodes of a discharge device to be sunk beneath the surface of said plate and thus be screened for high frequency currents flowing over the surface of said plate.

2. An ultra high frequency tuning unit comprising an inductive element in the form of a flat metallic plate having a slot therein, a rotary condenser having a stator electrically coupled to and mounted on one side of said slot and a rotor electrically coupled to and mounted on the other side of said slot, said plate forming a mounting for an electron discharge device to which said tuning unit is to be coupled.

WILLIAM SPENCER PERCIVAL.

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