

June 30, 1942.

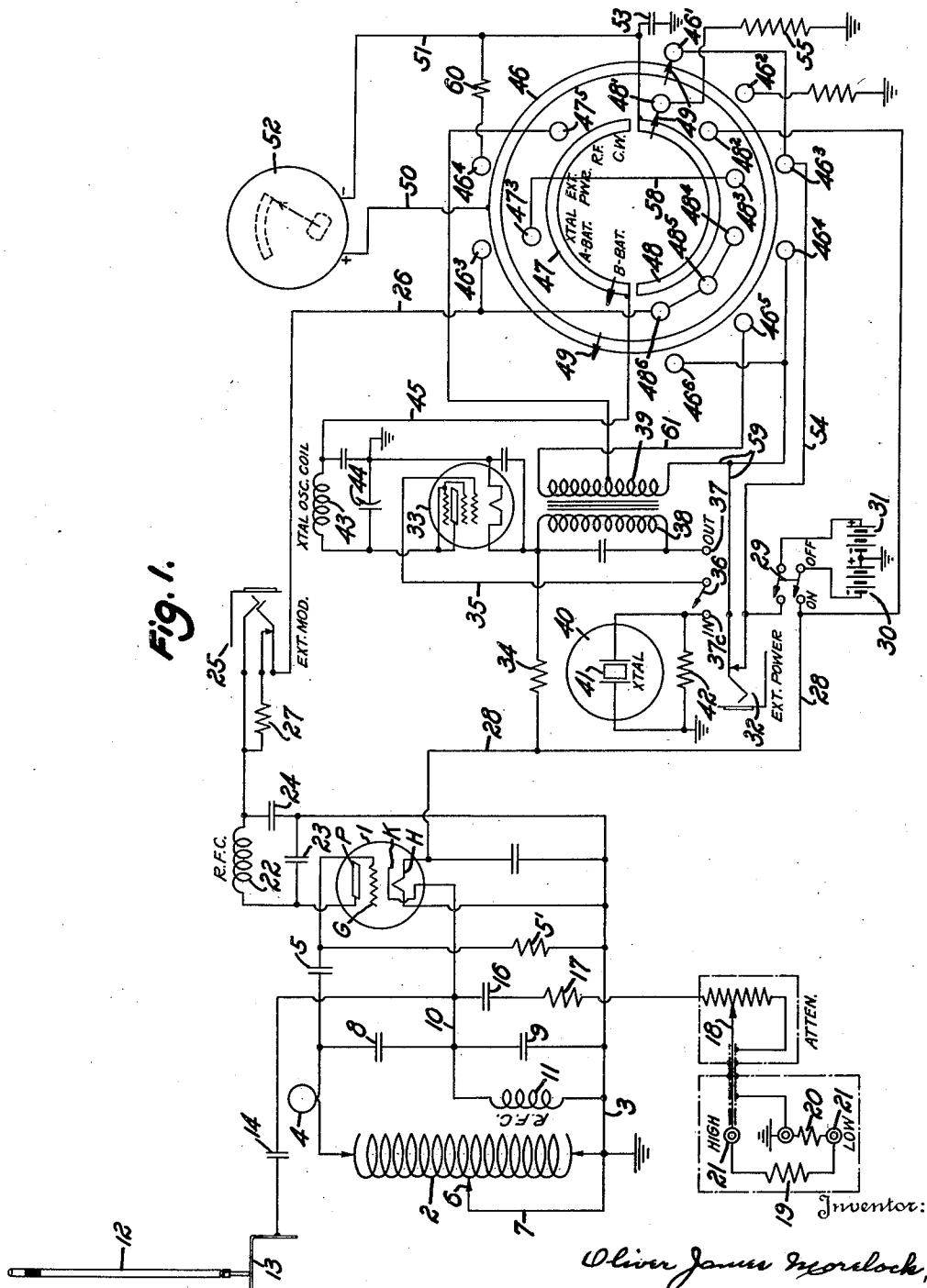
O. J. MORELOCK

2,288,294

ULTRA HIGH FREQUENCY OSCILLATOR

Filed Oct. 18, 1939

3 Sheets-Sheet 1



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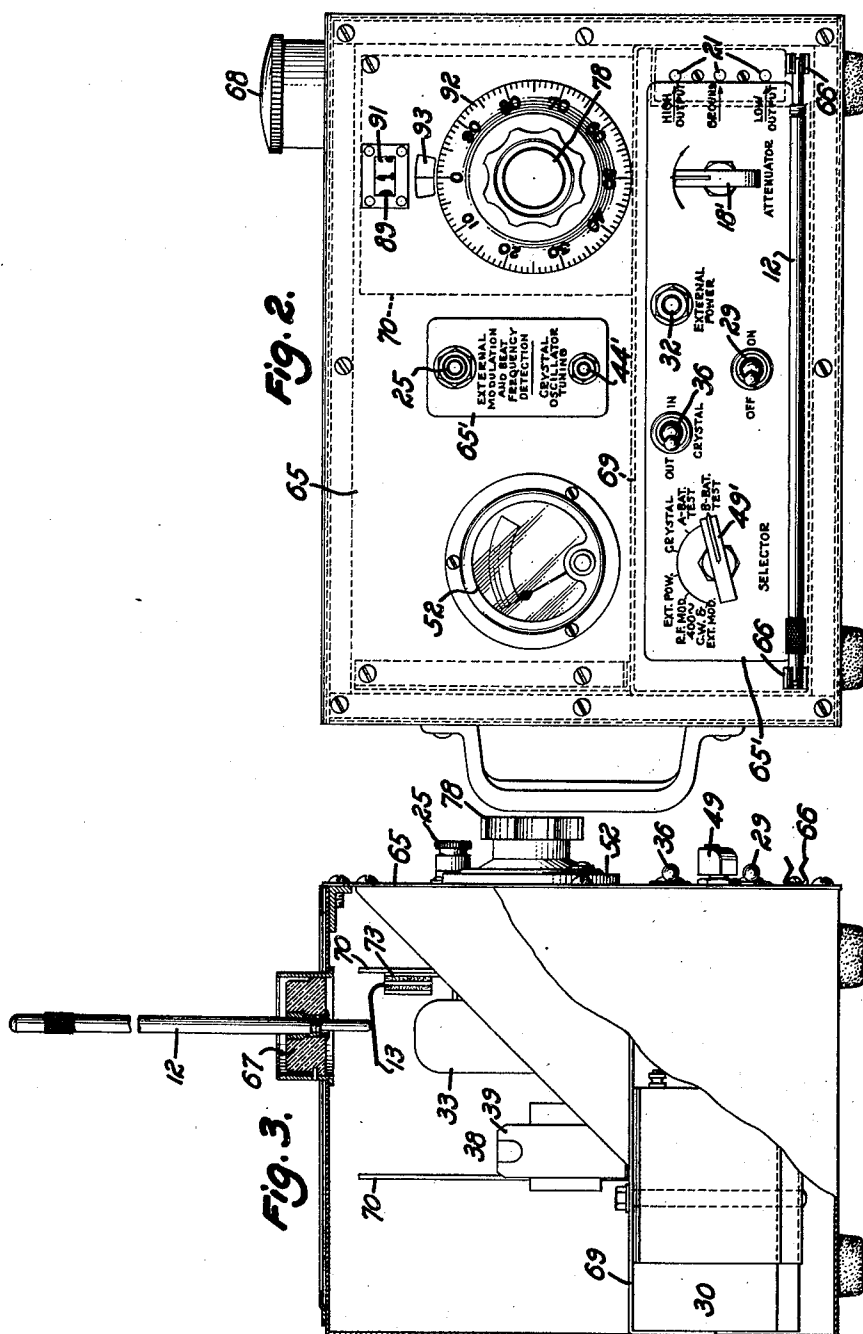
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Fig. 4.

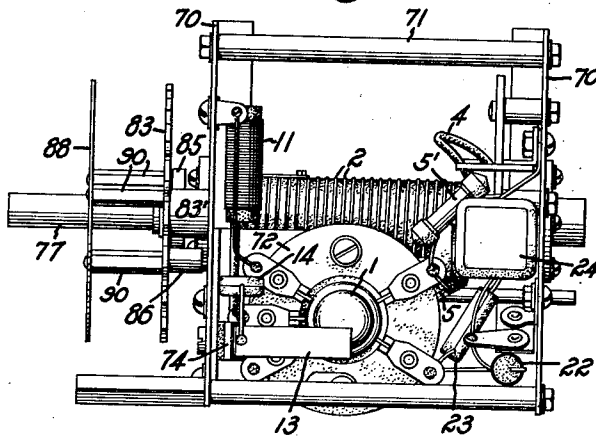


Fig. 6.

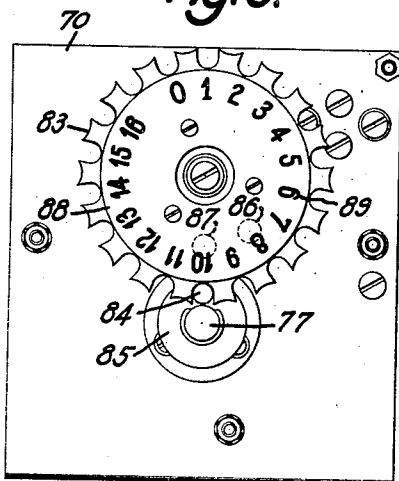
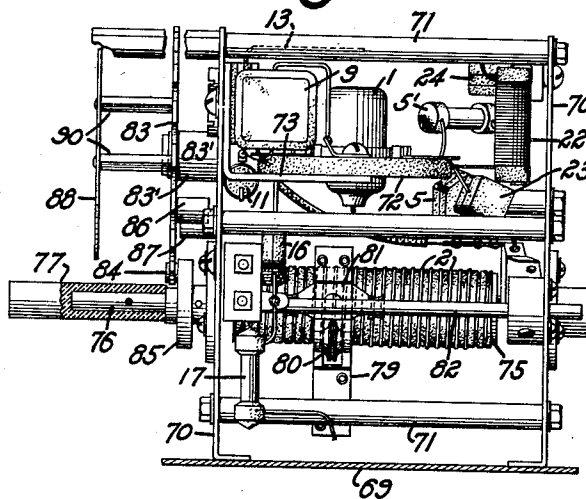


Fig. 5.



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UNITED STATES PATENT OFFICE

2,288,294

ULTRA HIGH FREQUENCY OSCILLATOR

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7 Claims. (Cl. 250-17)

This invention relates to ultra high frequency oscillators and particularly to oscillators that may be tuned continuously, without band switching, over an extended range of frequencies.

An object of this invention is to provide a compact portable oscillator of high stability that may be accurately and continuously tuned over a wide range of high and ultra high frequencies. An object is to provide an ultra high frequency oscillator including a continuously variable inductance for tuning over a wide frequency band, and a modulator that is operable, under control of the operator, to impose on the generated oscillatory current a low frequency modulation. An object is to provide a portable ultra high frequency oscillator having an energizing circuit into which an external modulator may be connected to apply a television modulation to the oscillatory current output. An object is to provide a compact selfcontained ultra high frequency oscillator having a demountable rod antenna and an attenuator that are adapted for alternative use. A further object is to provide an oscillator including a modulating tube with which a crystal may be associated, whereby the modulator tube oscillates at the fundamental frequency of the crystal and a harmonic of that frequency beats with the ultra high frequency oscillations to provide a desired frequency check.

These and other objects and advantages of the invention will be apparent from the following specification when taken with the accompanying drawings in which:

Fig. 1 is a diagram of the circuits of an oscillator embodying the invention;

Fig. 2 is a front elevation of a portable self-contained oscillator;

Fig. 3 is an end view, with part of the casing broken away and some parts omitted, showing the rod antenna and associated parts;

Fig. 4 is a plan view of the ultra high frequency oscillator assembly as seen when removed from the casing; and

Figs. 5 and 6 are a side elevation and front view, respectively, of the oscillator assembly.

In the drawings, the reference numeral 1 identifies the high frequency oscillator tube that is preferably a miniature tube, such as the "955" type, with a heater H, cathode K, grid G and plate P. The frequency determining element is a rotatable coil 2 having one end connected directly to the ground lead or chassis 3 and its other end connected to the grid G through a short end inductance 4 and coupling condenser 5, the grid G being connected to ground 3 by a leak

resistor 5'. The effective length of the inductance is controlled by a tap 6 that is grounded through a lead 7, the tap being movable along the inductance as the latter is rotated. The capacitive reactance that is shunted across the effective portion of inductance 2 comprises the serially connected condenser 8, 9 whose junction is connected to the cathode K of tube 1 by the lead 10. A radio frequency choke 11 is shunted across the condenser 9, and the output circuits of the oscillator are connected to the cathode lead 10.

One output circuit comprises the short rod antenna 12 whose lower end rests upon a resilient metal strip 13 that is connected to the cathode lead 10 through a condenser 14 and lead 15. The other and alternative output circuit is through the coupling condenser 16 and resistor 17 to an adjustable attenuator potentiometer 18, and the serially connected resistors 19, 20. Pin jacks 21 are connected to the terminals of the resistors 19, 20 to receive leads from a circuit or receiver that is to be tested. The capacitive coupling to the attenuator is important as it provides an approximately constant voltage input to the attenuator by compensating for the decreasing voltage across the active part of the inductance as the oscillator is tuned to the higher frequencies. As indicated by the legends "High" and "Low," different ranges of output voltages are obtained by connecting the external circuit across both resistors or across only the resistor 20.

A filter consisting of the radio frequency choke 22 and condensers 23, 24 is arranged in the plate current supply and closely adjacent the tube 1 to keep the ultra high frequency current out of the lower frequency and direct current circuits of the apparatus. A jack 25 for plugging in an external modulator is connected into the plate supply lead 26 and a resistor 27 is so connected to the jack terminals that it is in the plate circuit when using the local modulator but is excluded when an external modulator is plugged in. The plate lead 26 extends to certain contacts of a multiple position selector switch that will be described later.

One terminal of the heater H of tube 1 is connected to the grounded lead 3 and the other terminal is connected through lead 28 and one blade of the double pole switch 29 to the heater or "A" battery 30. The negative terminals of battery 30 and the plate or "B" battery 31 are grounded and the positive terminal of the plate battery 31 is connected through the other blade

of the switch 29 and a jack 32 to contacts of the selector switch.

The modulator tube 33 has circuits that permit the tube to operate as an audio frequency oscillator or as a crystal controlled oscillator. Tube 33 may be a screen grid tube such as type "1A5G" but with the screen grid and plate connected for operation of the tube as a triode. The heater circuit is connected between ground and the battery lead 28, a resistor 34 being included in the circuit to reduce the battery voltage to the rated value for the tube.

The control grid of the modulator tube is connected through a lead 35 to the blade 36 of a switch that has contacts 37a, 37c in the audio frequency and the crystal oscillator circuits, respectively. Switch contact 37a is connected through the winding 38 of a transformer to the filament of the tube 33, the other transformer winding 39 being a center tapped winding with one end connected to the plate battery 31, the other end and the center tap being connected to contacts of the selector switch. Switch contact 37c is connected to one terminal of a socket 40 into which a crystal 41 may be plugged, the other active terminal of the socket being grounded and connected to switch contact 37c by a resistor 42. The crystal oscillator coil 43 is shunted by a condenser 44 that is adjustable to tune the coil to the frequency of the crystal 41. One end of the coil 43 is connected to the joined plate and screen grid of the tube 33 and the other end of the coil is connected by lead 45 to a conducting member of the selector switch.

The selector switch is adjustable to two voltage measuring positions and four operating positions. The legends of Figs. 1 and 2 indicate the circuit connections established by the several adjustments of the switch and, since Fig. 1 shows the switch as viewed from the rear of the panel, the relative positions of the legends are reversed in these views. The switch includes an annular conducting member 46, two semi-circular conducting members 47, 48, and contact blades 49 that bear upon the several conducting members and are angularly adjustable as a unit to engage various contacts that are adjacent the conducting members. Lead 45 from the crystal oscillator coil is connected to the switch contact member 47 and leads 50, 51 connect the milliammeter 52 to the switch contact members 46 and 48, respectively, the negative meter terminal and lead 51 being grounded through a bypass condenser 53.

The several contacts of the selector switch are arranged in three groups associated with the contact members 46, 47 and 48, and angularly spaced in six operating positions of the contact blades 49. The reference numerals applied to the switch contacts are indicative of their associated contact members and of their angular location, the illustrated position of the switch blades 49 for measuring the "B" battery voltage being considered the first position. For example, contacts 46¹ and 46³ are adjacent the annular contact member 46 and positioned for engagement by the associated blade 49 in its first and third positions, respectively.

Contact 46¹ and the lower contact 46³ are joined and connected to the positive terminal of the battery 31 through a lead 54 and switch 29, and contact 48¹ is connected to ground through a multiplier resistance 55 that determines the sensitivity of the measuring instrument 52. The instrument is thus connected across the B battery 31, in series with resistor 55, when the selec-

tor switch is set in the illustrated "B Bat." position.

The only contacts in the second or "A Bat." position are the contact 46² that is grounded through the sensitivity adjusting resistor 56 and the contact 48² that is connected by lead 57 to the A battery lead 28.

The third or crystal oscillator position of the selector switch has contacts 47³, 48³ connected by a jumper 58, and an upper contact 46³ that is connected to the plate supply lead 26 of the oscillator tube 1. The circuits from the plate battery 31 may be traced through switch 29 and lead 54 to the lower contact 46³, blade 49, contact member 46 and, in parallel, through the upper contact 46³ to the plate lead 26 of oscillator tube 1 and through the lead 50 to the instrument 52. The instrument circuit then extends through lead 51 and switch contact member 48, contacts 48³, 47³ and jumper 58 to contact member 47, and through lead 45 to the plate circuit coil 43 of the crystal oscillator. Oscillations of the fundamental and harmonic frequencies of the crystal 41 are thus impressed on the oscillator tube 1, and the oscillator tube output includes various beat frequencies. The crystal is so selected that a harmonic beats with the ultra high frequency oscillations of tube 1 to provide a current output of a desired frequency corresponding, for example, to the frequency of a police transmitter.

The fourth or "external power" position of the selector switch permits the connection of an external battery or other power source in series with the self-contained plate battery 31. Lead 59 connects lower contact 46⁴ to the contact of jack 32 that is connected to a terminal of the audio frequency winding 39, and upper contact 46⁴ is connected to the instrument lead 51 through a multiplier resistor 60. The power output varies approximately as the square of the voltage on the plate of the oscillator tube 1, and the external power source is desirable when a high oscillator output is required. Contacts 48⁴, 48⁵ and 48⁶ are connected to each other and to the plate lead 26 of tube 1, and the selector switch thus connects the plate supply sources to the oscillator through the instrument 52 and lead 26.

The fifth or low frequency modulation position of the selector switch has a contact 46⁵ that is connected to the upper terminal of transformer winding 39 by a lead 61, and a contact 47⁵ that is connected to the center tap of winding 39 by a lead 62. The plate supply to the oscillator is thus through the transformer winding 39 of the modulator tube 33, and the ultra high frequency output is modulated at a frequency determined by the transformer, for example a frequency of 400 cycles per second.

The sixth selector switch position, corresponding to a continuous wave or externally modulated ultra high frequency carrier, has contacts 46⁶ and 48⁶ for connecting the plate battery 31 to the oscillator plate lead 26 through the instrument 52. The frequency of an external modulator that is plugged into the jack 25 may be of any desired order and preferably is relatively high to simulate a television frequency modulation.

A practical embodiment of the invention, as shown in Fig. 2, includes a casing having a front wall 65 on which the instrument 52, the several switches, and the jacks are mounted. The output jacks 21 are at the lower right corner of the panel adjacent the knob 19' of the attenuator

potentiometer 18, and the main or power switch 29 is at the lower center below the external power jack 32 and the crystal control switch 36. The selector switch knob 49' is at the lower left below instrument 52, and the external modulator jack 25 and a screw 44' for adjusting the crystal oscillator tuning condenser are at the center of the panel. The casing is preferably of metal and subpanels 65' of insulating material are mounted on the front wall 65 to support those parts that should be insulated from ground and to carry engraved legends indicating the functions of the several switches and jacks. Clips 66 are mounted at the lower corners of the panel to receive the short antenna rod 12 when it is not in use, and the top of the casing carries a socket 67, normally closed by a cap 68, into which the rod 12 may be threaded to engage the spring connecting strip 13, Fig. 1. A shelf 69 is secured to the front wall 65 and supports the various parts that are not mounted on the wall 65 or subpanels 65'.

The physical construction of the oscillator assembly, Figs. 4 and 5, is important as it contributes to the electrical efficiency and mechanical stability of the apparatus. The several components of the oscillator are supported by and between a pair of vertical end plates 70 that are flanged at their lower ends for mounting on the shelf 69, and are held in spaced parallel relation by spacer rods 71. The socket 72 for the oscillator tube 1 is located between the end plates and supported on a bracket 73 that is attached to the front plate 70. The resilient strap 13 is also mounted on the front plate and insulated from it by spacer strips 74. The several condensers, resistors and chokes of the oscillator circuit that appear in Figs. 4 and 5 are identified by the same reference numerals as in Fig. 1 but will not be described in detail. It is to be noted that the circuit elements are compactly arranged adjacent the end plates 70 with their terminal leads directly connected to each other or to the socket terminals. These elements are of the customary small commercial sizes and are supported mechanically by their terminal connections.

The continuous variable inductor 2 is a bare winding in the grooved surface of an insulating cylinder 75 on a shaft 76 that extends between and is rotatably supported on the end plates 70. An insulating rod extension 77 is secured to the front end of the shaft 76 to carry the knob 78 by which the shaft and coil form are manually rotated to adjust the effective length of the inductance. The continuously variable inductance may be and preferably is of the type described in the patent to Paul Ware, No. 2,163,645, granted June 27, 1939. The grounding tap 6, not shown in Fig. 5, is on the carriage 79 that has a grooved insulating roller 80 for engagement with the coil 2 to displace the carriage along the coil as the shaft 76 is rotated. The lower end of the carriage bears against one of the spacing rods 71, and it is resiliently pressed towards the coil form by the U-shaped spring clip 81 that slides along a rod 82. The resilient contact tap, as described in the Ware patent, is grounded on the carriage and through it and the clip 81, upon the end plates 70. The grounded end of the coil 2 is towards the front of the assembly and the end inductance 4, in the form of a short loop of heavy copper wire, is connected between the high potential end of the coil and the junction of the

coupling condenser 5 and oscillatory circuit condenser 8.

An important feature of the invention is the stop mechanism for arresting the rotation of the coil when the sliding carriage reaches its desired end positions. The resilient mounting of the carriage precludes the use of stops that directly engage the carriage and, in view of the high number of revolutions of the coil 2 to cover the tuning range, it is not practical to locate the stop on a member that is connected to the shaft 76 through a worm or other reduction gearing. The illustrated coil is adjustable through 16 complete turns and gearing of the order of a 16 to 1 reduction results in such high forces at the stop member that the stop may be broken by the manual turning of shaft 76 or, if the stop be of massive design, that the end plates are warped by a relatively small turning force applied to the knob 78.

In accordance with this invention, this possibility of damage is avoided and a positive stop action is obtained by mounting the cooperating stop elements on the front plate 70 and on a disk 83 that is coupled to the shaft 76 through an intermittently operating or Geneva gearing. The edge of the stop disk 83 is notched to cooperate with the eccentric pin 84 of a collar 85 that is fixed to shaft 76, whereby the disk 83 is advanced one step for each complete rotation of the shaft 76. The disk 83 is journaled on a hub 83' fixed to the front plate 70 and carries a stop stud 86 that cooperates with a stop stud 87 fixed to the front plate 70. The stop studs are threaded or riveted to their respective supporting members. The location of the stops is not critical, as was the case when the movable stop was on a disk driven from the main shaft through a reduction gearing, and manufacturing variations in the location of the stop studs result in only a small angular departure of the end displacement of coil 2 from its intended position. A single stop stud 87 is sufficient when the stop disk 83 rotates through approximately 360° but an additional stop may be fixed to the front plate 70 when the stop disk 83 is to rotate through a substantially smaller arc.

The devices for indicating the tuning of the continuously variable inductance 2 may be of any desired design but, preferably, the indicator of complete turns is associated with the stop mechanism. As shown, an indicator dial 88 carrying a scale of turns 89 is secured to the stop disk 83 by studs 90. The upper edge of the indicator dial is visible through a window 91 in the front plate 65 and above the dial 92 that is carried by the adjusting knob 78. Dial 92 is graduated from 0 to 100 and cooperates with a fiducial mark 93, on panel 65, to indicate fractions of a turn of the coil 2. The exact setting of the adjustable tap 6 along the inductance 2 is thus indicated in full turns by the markings on indicator disk 88 and in fractional turns by the dial 92 on knob 78. A calibration chart will be furnished with the apparatus to show the relationship between the angular adjustment of the coil 2 and the frequency of the generated oscillations.

The invention may be embodied in apparatus of any desired size but the maximum advantages are obtained in the case of small portable units that are tunable over a wide band of frequencies. The illustrated apparatus has a tuning range of from 22 to 150 megacycles and, as now manufactured commercially, weighs only 16 pounds.

This apparatus is especially useful in checking antenna installations for television receivers as the oscillator output may be modulated at television frequencies by plugging an external modulator into the jack 25. The oscillatory currents are effectively blocked from the supply circuits and the external modulator by filter 22-24. A simple filter design is possible as the 22 megacycle low limit of the tuning range of the oscillator is substantially above the television modulation frequencies.

It is to be understood that the invention is not limited to the portable apparatus herein illustrated and described, or to the particular frequency ranges of the described apparatus as various changes may be made in the design and construction of the apparatus without departing from the spirit of my invention as set forth in the following claims.

I claim:

1. An ultra high frequency oscillator comprising a vacuum tube having as elements thereof a cathode cooperating with a grid and plate, current sources for establishing energizing potentials between the tube elements, a condenser by-passing said plate to a grounding point for the oscillator frequencies, a pair of fixed tuning condensers serially connected between the grid and the grounding point, a connection from the junction of said tuning condensers to the cathode, a continuously variable inductance connected across said tuning condensers to form therewith an oscillatory circuit tunable over a range of frequencies, a voltage attenuator resistance network having output terminal means for receiving connections from external circuits, and means connecting said network to said oscillatory circuit to develop at said output terminal means a voltage output that is substantially independent of the tuning of said oscillator circuit, said connecting means being a capacitor.

2. An ultra high frequency oscillator as claimed in claim 1, wherein said continuously variable inductance comprises a coil of spaced turns of bare wire on an insulating cylinder, means supporting said cylinder for rotation, a tap bearing on said coil and connected to the grounding point, and means supporting said tap for movement axially of the coil as said cylinder is rotated.

3. An ultra high frequency oscillator as claimed in claim 1, in combination with an antenna rod, a resilient strip connected to said cathode through a condenser, and a rod-receiving socket adjacent said strip, said socket and antenna rod having cooperating means for detachably securing said antenna rod in said socket with an end thereof bearing against said resilient strip.

4. An ultra high frequency oscillator comprising a vacuum tube having as elements thereof a cathode cooperating with a grid and plate, current sources for establishing energizing potentials between the tube elements, a condenser by-passing the plate to a grounding point for the oscillator frequencies, a pair of fixed tuning condensers serially connected between grid and the grounding point, a connection from the junction of said tuning condensers to the cathode, a con-

tinuously variable inductance connected across said tuning condensers to form therewith an oscillator circuit tunable over a range of frequencies, an antenna rod, and means connecting said antenna rod to the oscillatory circuit to develop a voltage output from said antenna rod that is substantially independent of the tuning of said oscillator circuit, said connecting means being a capacitor.

5. In an ultra high frequency oscillator, a pair of spaced supporting plates, an inductance comprising a coil of bare wire on an insulating cylinder between said plates, means rotatably supporting said cylinder for rotation about its axis, a tap bearing on said coil and connected to one end thereof, means supporting said tap for axial movement by said coil when the cylinder is rotated, capacitive means tuning said inductance over a band of ultra high frequencies as the rotation of said cylinder displaces said tap along said coil, a tube socket, a bracket secured to one of said plates for supporting said tube socket between said plates, a tube in said socket and having as elements thereof a cathode cooperating with a grid and plate, means for establishing energizing potentials upon the tube elements, circuit elements connecting said inductance to said tube elements for operation of the tube as an oscillator, a metal strip supported on and insulated from said plates, and a condenser coupling said strip to an element of said tube, said strip constituting means for connecting an antenna to said oscillator.

6. In a self-contained and portable ultra high frequency oscillator, the combination with a casing housing a tube having as elements thereof a cathode cooperating with a grid and plate, and an ultra high frequency tunable circuit connected to said tube elements to determine the frequency of the oscillatory current output of said tube, of means for modulating the oscillatory current output; said modulating means comprising a second vacuum tube and means for operating the same as a low frequency oscillator, circuit connections for impressing oscillatory output of the second vacuum tube on the plate of the first vacuum tube, a crystal-receiving socket, and circuit connections including switch means operable to alternative positions for connecting said socket to or disconnecting the same from said second vacuum tube, whereby the oscillatory current output of said second vacuum tube may be determined by a crystal in said socket when said switch means is adjusted to connect said socket to said second vacuum tube.

7. In a portable self-contained ultra high frequency oscillator, an oscillator tube and means for tuning the oscillator tube output to a desired frequency, a modulator tube having circuits for developing an oscillatory current for modulating the output of said oscillator tube, a crystal controlled oscillator circuit, a source of current for energizing said tubes, and switch means operable to disconnect the modulator tube from said circuits thereof and to connect said modulator tube to the crystal controlled oscillator circuit to provide a standard reference frequency.

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