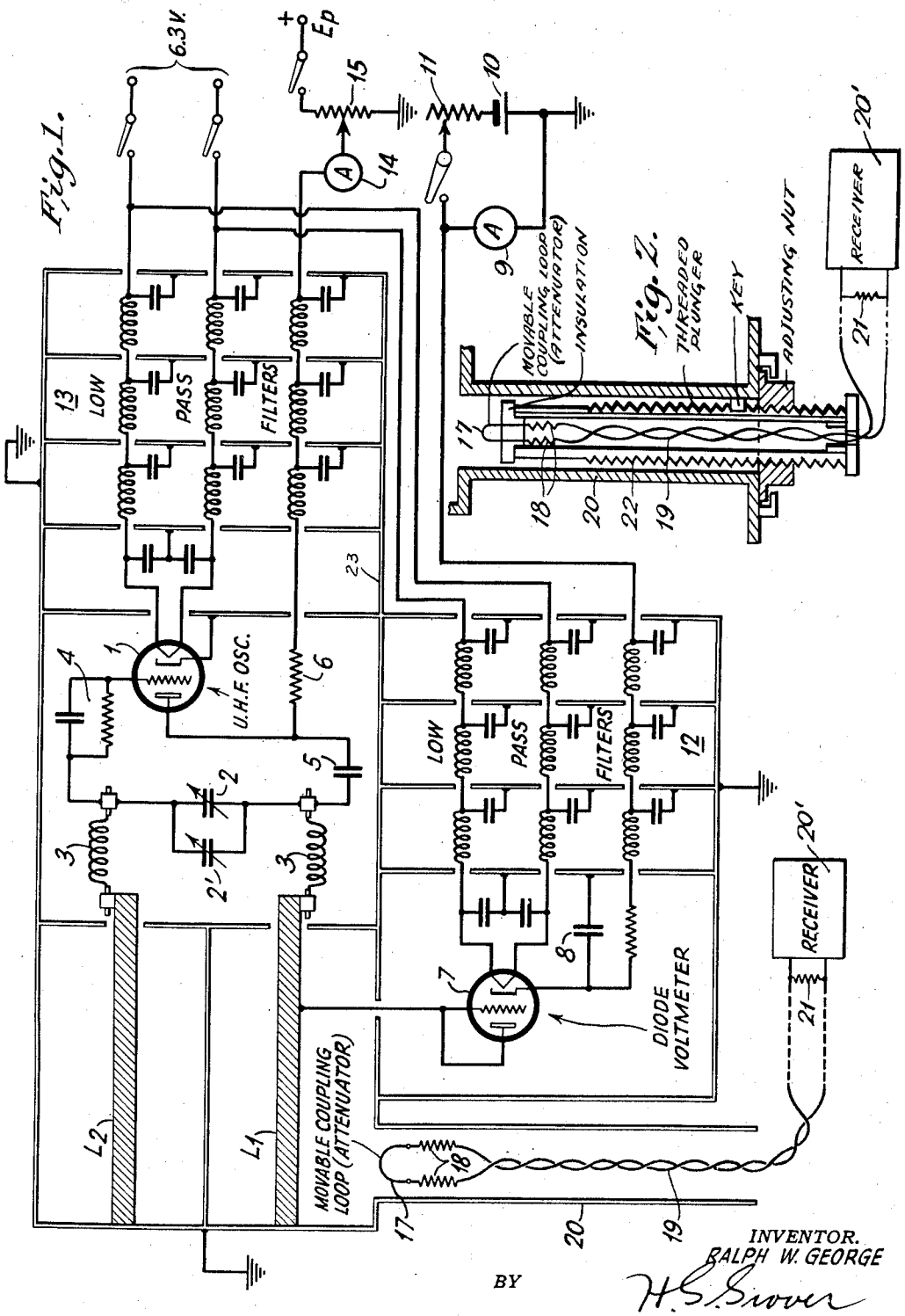
June 11, 1940. R. W. GEORGE 2,204,179

ULTRA HIGH FREQUENCY SIGNAL GENERATOR

Filed July 1, 1938



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Patented June 11, 1940 2,204,179

UNITED STATES PATENT OFFICE

2,204,179

ULTRA HIGH FREQUENCY SIGNAL GENERATOR

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Application July 1, 1938, Serial No. 216,874

15 Claims. (Cl. 250—20)

The present invention relates broadly to improvements in signal generators, and specifically to an ultra high frequency signal generator.

As is known, signal generators are used for the generation of radio frequency signals of known strength and are employed for making measurements of field strength, and in the testing of radio receivers.

An object of the invention is to provide a simple and efficient signal generator for use at frequencies in the range of 30 megacycles to 200 megacycles and higher.

Another object of the invention is to provide a signal generator which is extremely stable at ultra high frequencies above 30 megacycles.

A further object of the invention is to provide a signal generator which will give a large range of output voltages from 1 to 10,000 microvolts and higher, over a wide range of ultra high frequencies. This last object is achieved, inter alia, by careful shielding and filtering of the elements which go to make up the signal generator, and by giving the attenuator a logarithmic characteristic. Additional output voltage range is obtainable by virtue of the readable range of a voltmeter.

Known types of signal generators are unsatisfactory at the very high frequencies above 30 megacycles due to the fact that the attenuators thereof cause errors to arise on account of their appreciable reactance. Because of such reactance, the calibration of the signal generators varies with frequency, the desideratum being that calibration be constant with frequency.

The signal generator of the present invention, on the other hand, has for one of its features an attenuator which has a negligible frequency characteristic within a range of 30 megacycles to 200 megacycles and higher. This is because the attenuator of the present invention is composed of a small substantially semicircular loop whose reactance is negligible at the high frequencies. As an example, in one signal generator constructed in accordance with the principles of the invention, the impedance of the attenuator loop was approximately 7 ohms at 100 megacycles.

Another important feature of the signal generator of the invention lies in the use of one or more straight rods or lines which serve as inductances. These line inductors are low-loss circuits (high Q) at the highest frequencies, thus stabilizing the frequency of the oscillator of the signal generator. Because of their mechanical construction, the lines are rigid and provide fixed standards of inductance across one or both of which, or a portion thereof, the voltage may be measured. By measuring voltage across such a fixed inductor, to which an attenuator is coupled, in accordance with the invention, there is provided a reference by which the output, or voltage, induced in the attenuator is known, the voltage relations being established by suitable calibrating means.

A better understanding of the invention may be had by referring to the following description which is accompanied by a drawing, wherein Fig. 1 illustrates, schematically and by way of example only, an ultra high frequency signal generator in accordance with the invention, and Fig. 2 illustrates the details of construction of the attenuator system of Fig. 1.

Referring to the drawing, there is shown as my improved signal generator, a balanced ultra high frequency vacuum tube oscillator 1 whose oscillatory circuit is essentially of the Hartley type using a tuning condenser 2 and an additional vernier 2' in parallel therewith. A pair of inductors L_1 and L_2 in the form of rods or lines constitute the fixed inductor elements of the tank circuit. Inductance coils 3, 3 are of the plug-in type and are inserted into the generator unit for various frequency ranges, it being understood that different coils will be used for different frequency ranges. In circuit with the grid of tube 1 is a grid condenser and grid leak combination 4, and in circuit with the anode of tube 1 is the blocking condenser 5, and the shunt feed resistor 6 leading to the source of energy supply $+E_p$ for the anode.

In the construction of the signal generator, special care has been taken to make all leads short and direct and care has been taken with the inductor elements L_1, L_2 so that they have a rather high "Q" to maintain oscillator frequency stability at the highest frequencies and so that the same flux about one conductor always links with the attenuator loop 17. Reference numeral 7 represents a triode-tube diode connected as a vacuum tube voltmeter and tapped across a portion of inductor L_1; 8 is the diode load resistor by-pass condenser connected between the cathode and the grounded partition; 9 is the microammeter for the tube voltmeter and is connected in the cathode lead; 10 the battery in circuit with the cathode for balancing out the emission current, and 11 the balancing potentiometer. The low pass filter circuits for the voltmeter filament and cathode leads and for the oscillator filament and anode leads are designated 12 and 13, respectively. In the oscillator anode circuit there is provided a meter 14 and a potentiometer 15 for adjusting the amplitude of the oscillations.

The voltmeter 7 is tapped across a portion of line L_1 (between L_1 and ground) and its primary purpose is to insure that there is always a known voltage drop across the inductor to which the output or attenuator loop 17 is coupled. Although a particular type of voltmeter has been shown,

it should be appreciated that other types can be employed provided they are suitable radio frequency voltage indicators. The inductor L_1, to which the attenuator or output loop is coupled, is shielded, thus insuring that the coupling coefficient between loop 17 and inductor is constant, irrespective of frequency and changes in other parts of the circuit.

The oscillator 1 and its associated tuned circuit as well as the diode voltmeter 7 and the low pass filters are enclosed within a grounded shield 23, as shown.

The output attenuator system consists of a very small loop 17 coupled inductively to the lower of the two cencentric line inductors L_1. Loop 17 is located near the maximum current end of inductor L_1, in order to insure maximum flux density in the region of the attenuator and a minimum of electrostatic coupling between L_1 and the attenuator. By this arrangement there is obtained a substantially balanced output without the use of electrostatic shielding between L_1 and the loop 17. It should be observed (note Fig. 2) that loop 17 is located within a metallic cylindrical shield 20 which is arranged at right angles to the length of inductor L_1. This loop 17, it should be noted, does not extend beyond the end of this cylinder 20. Cylinder 20 is an essential part of the attenuator, the flux distribution inside of which varies substantially in a logarithmic manner to produce a logarithmic attenuator characteristic with respect to its position within tube 20, regardless of frequency. Movable coupling loop 17 is kept within the range of this desirable flux density relation. The diameter of cylinder 20 determines the flux distribution inside it, and thereby the law of attenuation. The length of cylinder 20 within reasonable limits determines the attenuation range. The impedance of loop 17 is, by calculation, approximately 7 ohms at 100 megacycles. Directly at the loop are connected low or negligibly reactive resistors 18 of 37.5 ohms each. The values of these resistors are chosen to match the characteristic impedance of line 19, which in turn is terminated by a load 21, 20' of similar impedance. The resistors 18 further maintain a balanced output circuit, and also tend to prevent multiple reflections or standing waves caused by possible mismatch at the other end of the leads 19 to which a receiver 20' may be connected, as shown. With resistors of the values indicated, a balanced radio frequency transmission line of preferably 75 ohms impedance should be employed. With the constants chosen as above described, the effect at the receiver 20' is the same as if the receiver were connected through line 19 to a simple dipole receiving antenna having the customary impedance of approximately 75 ohms. In practice, the elements 17, 18 and 19 are located in and carried by a threaded brass plunger, and attenuation is secured by withdrawing the plunger from the cylinder 20 by means of combination nut and dial. The plunger is diagrammatically represented in Fig. 2 by element 22. The variation of output with movement of the loop 17 is logarithmic, approximately 2½ turns of the attenuator (20 threads per inch) giving 6 db. attenuation for a particular model successfully tried out. The range of the attenuator is about 80 db. or 10,000 to 1. The loop 17 does not rotate but is merely drawn away from L_1.

The output is calibrated by comparison with other standard generators at 30 to 40 megacycles and the calibration is made in terms of the microvolts induced in the loop 17 per se. Thus, when using the generator for signal strength measurements, the generator appears to the receiver 20' as a 75 ohm source, equivalent to a simple dipole antenna. A resistor 21 may be employed to aid in matching the impedance of the receiver 20' to the leads 19. For other source impedances, different resistors may be substituted for elements 18 with a suitable transmission line to match.

Due to the use of this special attenuator system of the invention, a minimum variation of calibration with frequency is obtained and consequently existing standards at 30 megacycles may be extended to 200 megacycles and higher, the attenuator system also giving an extremely large amplitude range of 80 db.

Although the signal generator of the invention is extremely efficient at the high frequencies above 30 megacycles, it will be appreciated that its use is to some extent limited in frequency ranges much below 30 megacycles because of the very low impedance at such frequencies of the standard inductors L_1 and L_2. In one embodiment of the invention successfully tried out in practice, the signal generator was operated at 25 megacycles. By the use of more power in the oscillator the signal generator might be operated at a somewhat lower frequency. For lower frequencies, my type of attenuator may be used with several turns in a coil for L_1 and likewise for coil 17.

What is claimed is:

1. In a signal generator of the type including a radio frequency oscillator tunable over a band of frequencies, said oscillator having a tuned circuit for determining the frequency of the signals generated by said oscillator, said circuit including in series two inductor elements having uniformly distributed inductance and capacitance, and means for shielding said elements from each other, and a voltage attenuator inductively coupled to at least one of said inductor elements.

2. In a signal generator, a vacuum tube having a tuned circuit for determining the frequency of the signals generated by said tube, said circuit including in series two inductors of the plug-in type and two other inductors having uniformly distributed inductance and capacitance, a condenser in shunt of said series inductors and adjustable to tune the generator over a band of frequencies, and means for shielding said other inductors from each other.

3. In a signal generator, a vacuum tube having a tuned circuit for determining the frequency of the signals generated by said tube, said circuit including in series two inductor elements having uniformly distributed inductance and capacitance, means for shielding said elements from each other, an attenuator in the form of a single turn loop inductively coupled to at least one of said inductor elements, and a voltage indicator also coupled to said one inductor element.

4. In a signal generator, a vacuum tube having a tuned circuit for determining the frequency of the signals generated by said tube, said circuit including in series two inductor elements having uniformly distributed inductance and capacitance, means for shielding said elements from each other, and an attenuator in the form of a single turn loop inductively coupled to at least one of said inductor elements, leads extending from said loop to terminals external of said signal generator, a hollow metallic shield surrounding said loop and leads, and means for moving said

loop and leads toward or away from said one inductor element to which it is coupled.

5. In a signal generator of the type including a radio frequency oscillator tunable over a band of frequencies, an inductor element in circuit with said oscillator, said element having uniformly distributed inductance and capacitance, a voltage attenuator having a single turn loop inductively coupled to said inductor element and a hollow metallic shield surrounding said loop, said shield having an opening for enabling said loop to couple to said inductor element.

6. In a signal generator of the type including a radio frequency oscillator tunable over a band of frequencies, an inductor element in circuit with said oscillator, said element having uniformly distributed inductance and capacitance, a voltage attenuator having a single turn loop inductively coupled to said inductance, a resistance in series with each leg of said loop, said resistances being of equal value and having a total value substantially equal to the impedance of the output leads.

7. In a signal generator of the type including a radio frequency oscillator tunable over a band of frequencies, an inductor element in circuit with said oscillator, said element having uniformly distributed inductance and capacitance, a voltage attenuator having a single turn loop inductively coupled to said inductance, a resistance in series with each leg of said loop, said resistances being of equal value and having a total value substantially equal to the impedance of the output leads, a shield for said inductor element, said shield having an opening at the location where said attenuator couples to said inductance, and a cylindrical shield within which said loop and resistances are movably arranged said cylindrical shield having an opening at the end nearest said inductance.

8. In a signal generator, a vacuum tube having a tuned circuit for determining the frequency of the signals generated by said tube, said circuit including in series two straight parallelly arranged inductor rods of low loss, means for shielding said rods from each other, and a voltage attenuator substantially in the form of a semi-circular loop coupled to a portion of one of said rods, said attenuator being so constructed and arranged that the voltage induced therein varies logarithmically with movement of said loop.

9. In a signal generator, a vacuum tube having a tuned circuit for determining the frequency of the signals generated by said tube, said circuit including in series two straight parallelly arranged inductor rods of low loss, means for shielding said rods from each other, a voltage attenuator substantially in the form of a semi-circular loop coupled to a portion of one of said rods, a diode voltmeter coupled across a portion of said one rod, and low pass filters connected in the leads extending from the electrodes of said oscillator and voltmeter to the polarizing sources of potential.

10. An ultra high frequency signal generator for use at frequencies above approximately 30 megacycles comprising a vacuum tube oscillator tunable over a band of frequenices, a low-loss inductor element in circuit with said oscillator and having substantially uniformly distributed inductance and capacitance, and a voltage attenuator whose reactance is negligible inductively coupled to said low-loss inductor element, said voltage attenuator comprising a single turn loop located within a hollow metallic shield, said shield having an opening at the location where said loop couples with said inductor element.

11. In a signal generator of the type including a radio frequency oscillator tunable over a band of frequencies, an inductor element in circuit with said oscillator, said element having uniformly distributed inductance and capacitance, a voltage attenuator including a single turn loop inductively coupled to said inductance, and a cylindrical shield around said loop, said shield having an open end near said inductor element, said loop being adjustable in position within said shield and arranged not to extend beyond said open end, whereby the voltage induced in said loop changes by substantially the same fraction for a given displacement of the loop within the shield regardless of the position of the loop within said shield.

12. In a signal generator of the type including a radio frequency oscillator tunable over a band of frequencies, an inductor element in circuit with said oscillator, said element having uniformly distributed inductance and capacitance, a radio frequency voltage indicating device connected to said inductor element, a voltage attenuator including a single turn loop inductively coupled to said inductance, and a cylindrical shield around said loop, said shield having an open end near said inductor element, said loop being adjustable in position within said shield and arranged not to extend beyond said open end, whereby the voltage induced in said loop changes by substantially the same fraction for a given displacement of the loop within the shield regardless of the position of the loop within said shield.

13. The combination with an oscillator for generating radio frequency signals and having a tuned circuit, a voltage attenuator coupled to a part of said tuned circuit comprising a metallic shield containing therein a single turn loop, a resistance in series with each leg of said loop, a voltage indicator also coupled to said same part of said tuned circuit, said loop and said resistances being movable within and along a portion of the length of said shield, whereby there is obtained in said loop an output voltage whose variation with movement of said loop within said shield is logarithmic regardless of frequency.

14. The combination with an oscillator for generating radio frequency signals and having a tuned circuit, a voltage attenuator coupled to a part of said tuned circuit comprising a metallic shield containing therein a single turn loop, a resistance in series with said loop, a voltage indicator also coupled to substantially said same part of said tuned circuit, said loop and said resistance being movable within and along a portion of the length of said shield, whereby there is obtained in said loop an output voltage having a desired relation with frequency.

15. In a signal generator of the type including a radio frequency oscillator tunable over a band of frequencies, an inductor element in circuit with said oscillator for determining the frequency range of said oscillator, a shield box surrounding said oscillator and inductor element, a voltage attenuator having a single turn loop inductively coupled to said inductor element, a hollow metallic shield surrounding at least the major portion of said voltage attenuator, said last shield having an opening in the end thereof for enabling said loop to couple to said inductor element.

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