April 14, 1936. M. FERRIS 2,037,160

RADIO FREQUENCY OSCILLATOR

Filed Jan. 13, 1931

Fig. 1.

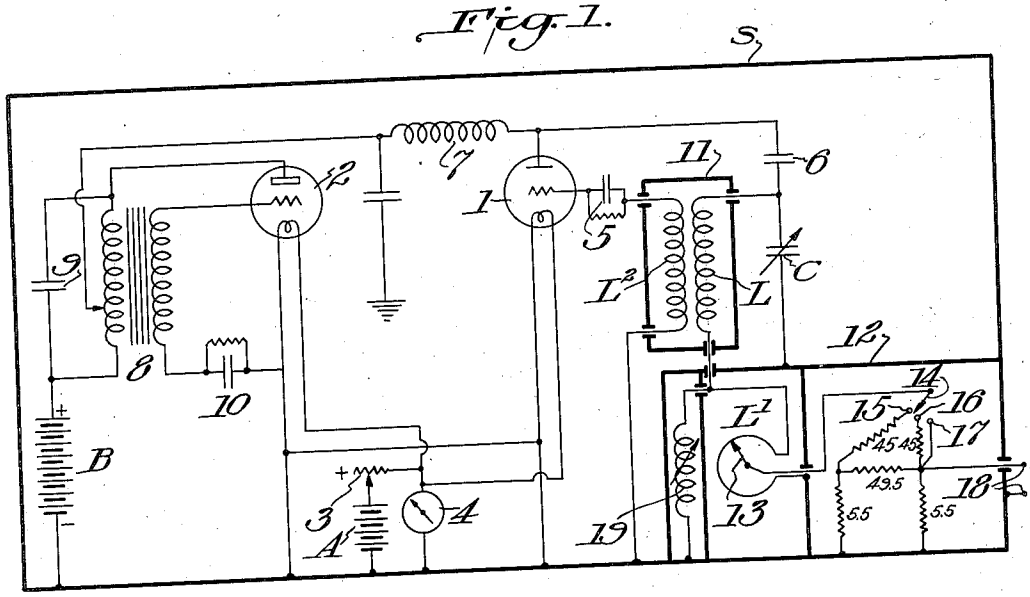



Fig. 3.

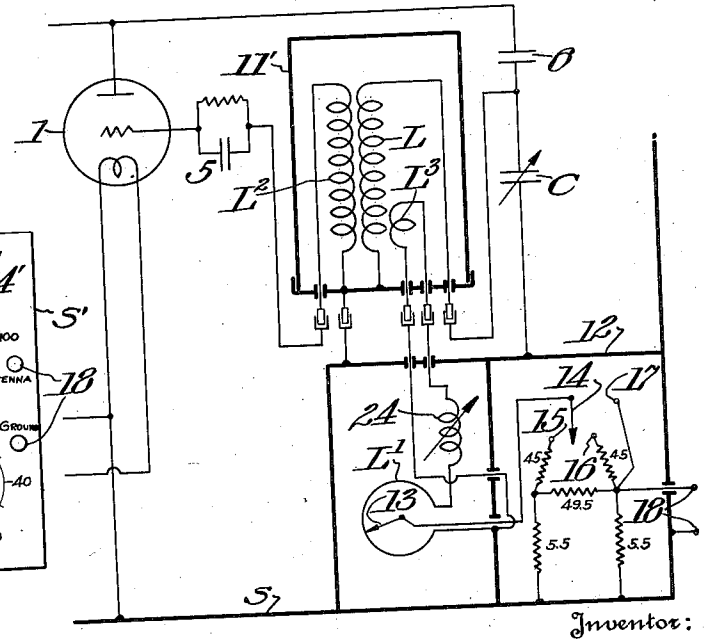
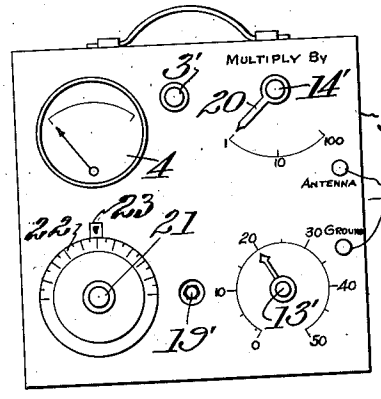



Fig. 2.




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# UNITED STATES PATENT OFFICE

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## RADIO FREQUENCY OSCILLATOR

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Application January 13, 1931, Serial No. 508,504

17 Claims. (Cl. 250—20)

This invention relates to a radio frequency oscillator and more particularly to the type of oscillator designed to deliver modulated or unmodulated radio frequency voltages of predetermined magnitude. The principal use of such device is as a generator of standard signals for use in the testing of radio receivers for sensitivity and selectivity, but oscillators of this type are useful wherever radio frequency signals of predetermined magnitude are desired.

In my copending application Ser. No. 311,911, filed Oct. 11, 1928, now Patent Number 1,793,601, granted February 24, 1931, I have described and claimed a signal generator that is useful where extreme accuracy is not essential, and in application Ser. No. 378,091, filed July 13, 1929, I have described and claimed a standard signal generator of great accuracy, i. e., a precision instrument. The present invention relates to a portable generator of the type described in the earlier application.

An object of the invention is to provide a portable radio frequency oscillator or signal generator including a continuously adjustable element for controlling the output voltage. A further object is to provide a generator of the type stated which is of simpler construction and may be more economically manufactured than previous devices of the same general type. More specifically, an object is to provide a signal generator having a tuned circuit across which an approximately constant radio frequency voltage is developed, a slide wire inductance so connected into or associated with the tuned circuit that the voltage drop across the same remains approximately constant, and a voltage attenuator associated with the slide wire inductance.

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

Fig. 1 is a circuit diagram of one embodiment of the invention;

Fig. 2 is a front elevation of a convenient physical embodiment of the apparatus shown diagrammatically in Fig. 1; and

Fig. 3 is a fragmentary circuit diagram of an alternative form of the radio frequency circuits.

The tubes, circuit elements and voltage attenuator are enclosed within a shield S and the radio and audio frequency circuits are preferably grounded on the shield. The radio frequency oscillator tube 1 and audio frequency oscillator tube 2 may be of any convenient type and are illustrated as triodes having filamentary cathodes which are heated by the battery A, the voltage impressed on the cathodes being regulated by the combined switch and rheostat 3 in accordance with the indication of a voltmeter 4.

The radio frequency circuits of the oscillator tube 1 include a fixed plate inductance L in series with a slide wire inductance L', the inductance L being coupled to the inductance $L^2$ which is connected to the grid through the grid leak and condenser 5. The tuning condenser C is shunted across the serially connected inductances L, L', and the oscillator circuits are so designed as to give an approximately constant radio frequency voltage across the tuned circuit for all frequencies within its range of adjustment. The high potential terminal of the tuned impedance is coupled to the plate of tube 1 through the blocking condenser 6 and the positive potential from a suitable source, such as battery B, is impressed upon the plate through the radio frequency choke 7.

For the generation of modulated radio frequency signals, the plate supply to the radio frequency oscillator 1 may be connected through a portion of the plate winding of the transformer 8 of the audio frequency oscillator 2. The plate winding of transformer 8 is tuned by means of condenser 9 to produce the desired frequency, for instance 400 cycles. The usual grid leak and condenser 10 is provided between the grid and cathode. So far as concerns the present invention, an external source of audio frequency current may be employed to modulate the radio frequency signals, some other type of modulator may be included within the shielding cabinet S, or unmodulated signals may be generated.

In accordance with the present invention, the voltage attenuator is connected across the slide wire inductance L' which may, and preferably does, consist of a single turn of wire or metal strip. Electro-magnetic coupling between coils L and L' is prevented by the shield 11 which surrounds the coupled coils L, $L^2$, and a shield 12 which houses the slide wire inductance L'. The adjustable slider 13 of the slide wire inductance is connected to the switch arm 14 that cooperates with the contacts 15, 16, 17, to provide a multiplier for the voltage attenuator. The voltage attenuator is of the usual type and comprises a resistance network in which the resistances are so related that adjustment of the switch arm 14 will effect a decimal variation in the magnitude of the radio frequency voltage available at the output terminals 18 of the network. Appropriate values for the several resist-

ances are indicated in Fig. 1 but detailed description of this known type of attenuator is not believed to be necessary.

The slide wire inductance L' may be shunted by an adjustable inductance **19** when relatively high accuracy is desired. The voltage attenuator and the adjustable inductance **19**, when one is used, are housed in individual compartments.

Since the radio frequency oscillator is so designed that an approximately constant radio frequency voltage is developed across the plate impedance, it is apparent that the voltage drop across the slide wire inductance L' remains substantially constant for all frequency adjustments. Inasmuch as the current varies substantially inversely as the frequency and the reactance of the fixed inductance varies directly as the frequency, then the voltage drop across the fixed slide wire inductance L' will be independent of frequency, so that regardless of frequency a given setting of variable tap assures a given voltage. If the drop across the inductance L' remains constant, any predetermined portion of that potential may be impressed upon the input terminals of the voltage attenuator by a suitable manipulation of the slider **13**. By calibrating the signal generator with a standard signal generator or precision instrument, the voltage developed across the output terminals **18** may be indicated, in microvolts, upon a graduated scale associated with the slider **13**. Such calibration is preferably made when the switch arm **14** is in engagement with the contact **15**, thereby providing the maximum attenuation, and the values indicated on the slide wire scale should then be multiplied by 10 or 100 when the switch arm is moved to contacts **16** and **17**, respectively.

The signal generator is not intended to be a precision instrument but it may be employed to check the selectivity of radio receivers even though there may be a comparatively large error between the actual output and the theoretical output indicated by the adjustment of the slide wire and the multiplier. The signal generator is a convenient instrument for the use of service men in checking the operation of a radio receiver, and in manufacturing plants it provides convenient and economical apparatus for the final inspection of the receivers. The calibration of signal generators of this type may be checked against a standard signal generator at intervals, say once or twice a day, and inductance **19** adjusted to bring the operation within the desired range of accuracy.

The design of the radio and audio frequency oscillator circuits will be governed by the particular frequency range or ranges to be covered. If external batteries are used, filters should be employed to prevent radiation of energy from the batteries and external leads.

To prevent a residual signal when the slider **13** is set at zero position, the low potential terminal of inductance L' should be grounded upon the shielding case through as short a connecting wire as is possible and the lead from slider **13** should run closely adjacent the zero position of the slider, thus reducing to a minimum the inductive coupling between the tuned circuit and the attenuator leads.

Apparatus of the type shown diagrammatically in Fig. 1 may be conveniently assembled in a small size portable kit such as shown in front elevation in Fig. 2. The front panel S' may be and preferably is a metal plate forming a part of the shielding casing S, within which the batteries A, B, and the several parts of the generator are located. The dial **3'** for the combined switch and rheostat in the filament circuits of the tubes is mounted on the panel S', preferably near the voltmeter **4**. The knob **14'** of the multiplier switch is provided with a suitable pointer **20** for indicating the value, 1, 10, or 100, by which the scale reading adjacent the knob and pointer **13'** of the slide wire inductance should be multiplied to obtain the value of the radio frequency voltage developed across the terminals **18**. The knob **21** for controlling the adjustment of the tuning condenser C carries a dial **22** that moves adjacent a fixed fiducial marker **23** to indicate the frequency of the generated signals. The adjustable control element **19'** of the variable inductance **19** is shaped for engagement by the end of a socket wrench or other equivalent tool, thus reducing the likelihood of an inadvertent change in the magnitude of the shunt inductance **19** during the normal operation of the signal generator.

A simple form of signal generator which is particularly useful when two or more frequency bands are to be covered is shown in Fig. 3. For each frequency range, a plug-in unit is provided which includes the plate inductance L, the grid inductance $L^2$ and a coupling inductance $L^3$. These inductances may be wound on a cylindrical form of insulating material and enclosed in a shielding can or box **11'**. As illustrated, connections are made to contact pins which engage coöperating sockets to connect the coils L and $L^2$ in the plate and grid circuits, respectively, and to connect the coupling coil $L^3$ in series with an adjusting inductance **24** and the slide wire inductance L' which feeds the attenuator system.

The remaining elements of the signal generator may be of the form shown in Fig. 1, and need not be described in detail but have been identified by corresponding reference numerals.

For each of the interchangeable coil units, the coils L and $L^3$ are so designed that the voltage drop established across the slide wire inductance L' is the same for all frequency ranges. Such inequality as may arise in the mechanical construction of the coil units may be compensated by adjustment of the variable inductance **24**. A single scale of graduations adjacent the knob and pointer which controls the setting of the slider **13** will then apply equally well for all frequency ranges.

It will be apparent that there is considerable latitude both in the electrical and the physical design of equipment embodying the invention.

I claim:

1. In a signal generator of the type including a radio frequency generator tunable over a band of frequencies, a plate circuit inductance, a slide wire inductance coupled thereto to establish across said slide wire inductance a potential drop less than and having a fixed ratio to the potential drop established across said plate circuit inductance, and a voltage attenuator having the input terminals thereof connected across an adjustable portion of said slide wire inductance.

2. The invention as set forth in claim 1, wherein said slide wire inductance is serially connected to a coil coupled to said plate circuit inductance.

3. In a signal generator, the combination with a vacuum tube and circuit elements cooperating therewith to constitute a tuned radio frequency oscillator, one of said elements being an inductance across which the potential drop established by oscillatory currents remains substantially constant for all frequencies within the range of adjustment of said oscillator, of a slide wire in-

ductance in series with the said element, and a voltage attenuator connected across the slider of said inductance and one terminal thereof.

4. In a standard signal generator, the combination with a vacuum tube, and a voltage attenuator including a slide wire inductance, of a removable coil system comprising three inductively coupled windings, cooperating terminals on said coil system and the relatively fixed circuit elements of said generator for connecting one of said windings in the grid circuit of said tube, a second winding in the plate circuit and the third winding in series with said slide wire inductance.

5. The invention as set forth in claim 1, wherein said plate circuit inductance and said slide wire inductance are series elements in the tuned circuit of said generator.

6. A signal generator of the type including a radio frequency oscillator having a tuned circuit adjustable over a band of frequencies to determine the frequency of the generated oscillatory current, and a voltage attenuator, characterized by the fact that said tuned circuit includes two serially connected inductances of fixed magnitude, and adjustable means connected in circuit with one of said inductances for impressing upon the input terminals of said attenuator the radio frequency voltage developed across such portion of the said inductance as is determined by the position of said adjustable means.

7. In a signal generator, the combination with a vacuum tube, a tuned circuit for determining the frequency of the signals generated by said tube, said circuit including in series two inductances and a condenser adjustable to tune the oscillator over a band of frequencies, one of said inductances comprising a single turn coil, and means grounding the junction of said coil and said condenser; of a contact adjustable upon said single turn coil, and a voltage attenuator having the input terminals thereof connected to said contact and to ground.

8. In a vacuum tube oscillator of the type tunable over a range of frequencies and including means for automatically maintaining the radio frequency output voltage delivered thereby approximately constant over its said frequency range; a vacuum tube, a tuned circuit including in series a fixed inductance and a slide wire shunted by an adjustable inductance, and a voltage attenuator network having the input terminals thereof connected respectively to the slider and to one terminal of said slide wire inductance.

9. In a signal generator, the combination with a vacuum tube and circuit elements including a tuned circuit cooperating therewith to constitute a radio frequency oscillator tunable over a band of frequencies, said tuned circuit comprising in series an adjustable condenser, a fixed inductance and a fixed impedance having one terminal grounded, of a voltage attenuator network, connections from the input terminals of said network to said fixed impedance and to ground respectively, and output terminals for said network connected respectively to ground and to a point on the terminal impedance of said network, said fixed impedance to which the input terminals of said attenuator network are connected comprising a slide wire inductance, one of the terminals being connected to the adjustable slider of said inductance.

10. In a signal generator, the combination with a radio frequency oscillator comprising a vacuum tube, and a tuned impedance in an electrode circuit of said tube and including in series a coil and a slide wire inductance, of a voltage attenuator, means connecting the input terminals of said attenuator to the slider and to one terminal, respectively, of said inductance, and individual shields for said attenuator and said inductance.

11. In a signal generator of the type including a vacuum tube and circuit elements cooperating therewith to constitute a tuned radio frequency oscillator having a substantially constant radio frequency output voltage at all frequencies to which said oscillator may be tuned, a tuned circuit which includes two inductances in series with each other and in multiple with a tuning condenser, means shielding said inductances against electromagnetic coupling, a voltage attenuator, and means for connecting the input terminals of said attenuator across an adjustable portion of one of said inductances.

12. In a signal generator, the combination with a vacuum tube, and circuit elements cooperating therewith to constitute a generator of modulated radio frequency signals, said elements including a tuned circuit comprising in series a fixed inductance and a slide wire inductance, of a voltage attenuator network having the input terminals thereof connected respectively to the slider and to one terminal of said slide wire inductance.

13. In apparatus for generating modulated radio frequency signals, a vacuum tube and circuit elements cooperating therewith to constitute an audio frequency oscillator, a second vacuum tube and circuit elements cooperating therewith to constitute a radio frequency oscillator tunable over a band of frequencies and delivering a substantially constant radio frequency voltage throughout said frequency range, connections between said oscillators to impress the generated audio frequency oscillations upon a circuit of said radio frequency oscillator, said radio frequency oscillator including in the tuned circuit thereof two serially connected inductances, a voltage attenuator, and adjustable inductance means for impressing upon the input terminals of said attenuator the radio frequency voltage developed across such portions of one of said inductances as is determined by the position of said adjustable means.

14. In a signal generator, a shield box, a slide wire inductance within said shield box, a lead grounding one terminal of said inductance upon said shield box, a lead extending from the slider of said inductance to the exterior of said shield box, said leads being arranged adjacent each other substantially to prevent induced currents in said slider lead when said slider is adjacent said terminal of said inductance.

15. In a signal generator, a shield box, a slide wire inductance within said shield box, a connection grounding one terminal of said inductance upon said shield box, a connection extending from the slider and a connection from the other terminal of said inductance to the exterior of said shield box, an inductance coil coupled to said last connection, means for impressing oscillations on said coil, a second shield box surrounding said coil and means, and utilization means in circuit with said slider connection.

16. In a signal generator, a shield box, a slide wire inductance within said shield box, a connection grounding one terminal of said inductance upon said shield box, a connection extending from the slider and a connection from the other terminal of said inductance to the exterior

of said shield box, an inductance coil coupled to said last connection, means for impressing oscillations on said coil, a second shield box surrounding said coil and means, a voltage attenuator coupled to said slider, and a third shield box surrounding said voltage attenuator.

17. In a signal generator of the type including a radio frequency generator tunable over a band of frequencies, a plate circuit inductance, a shielded slide wire voltage divider in the form of an inductance having no appreciable resistance coupled thereto to establish across said voltage divider inductance a potential drop less than and having a fixed ratio to the potential drop established across said plate circuit inductance, and a voltage attenuator having the input terminals thereof connected across an adjustable portion of said shielded slide wire voltage divider.

MALCOLM FERRIS.