March 8, 1932. F. H. KROGER 1,848,133

TRANSMITTER

Filed July 5, 1928

Fig. 1

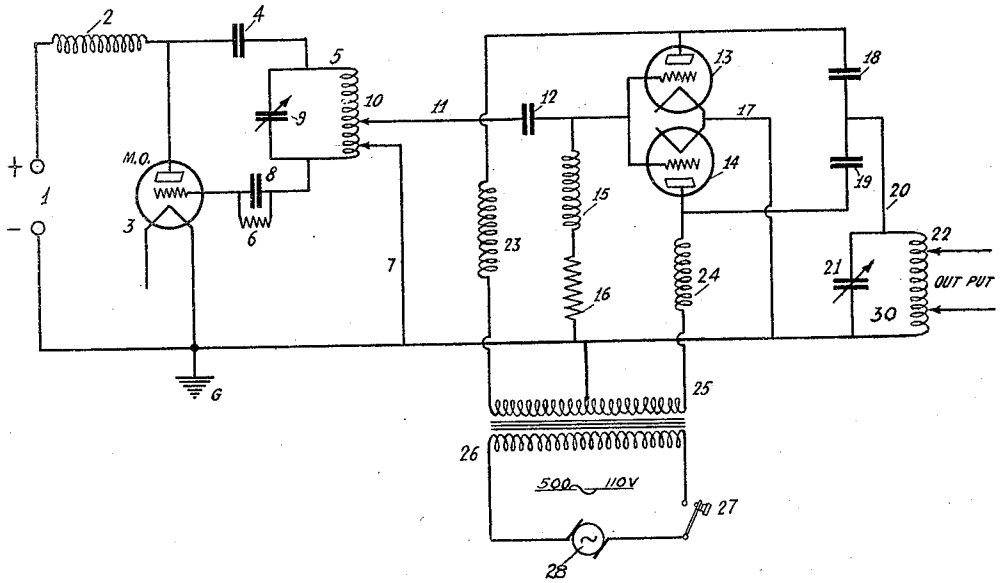
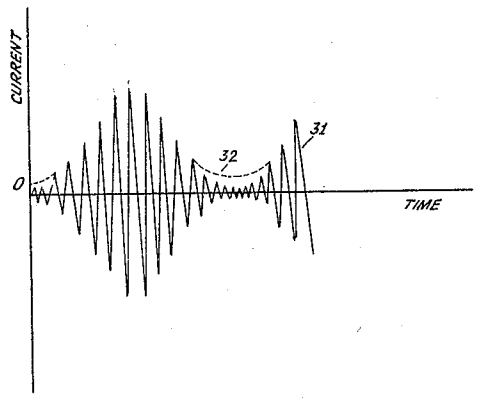


Fig. 2



INVENTOR
FRED. H. KROGER
BY Ira J. Adams
ATTORNEY

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UNITED STATES PATENT OFFICE

FRED H. KROGER, OF NEW YORK, N. Y., ASSIGNOR TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE

TRANSMITTER

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This invention relates to transmitters and in particular to transmitters for mobile use operating at 100 meters or under.

In certain classes of communication where wavelengths below 100 meters are used, it is desirable to be able to change the transmitter's wavelengths quickly a definite arbitrary amount while still remaining in the wavelength band assigned for this type of communication. An illustration of this practice is that of the present marine communication system.

The short wave transmitter used in this type of communication which are generally constructed without frequency control means, other than the oscillator and associated tuned circuits, such as that obtained by the use of a crystal control, tend to generate oscillations having their frequencies vary to more or less extent depending upon the precaution taken in constructing the apparatus. Designing the transmitter in a practical manner does not eliminate entirely the frequency variations of the transmitted wave. Consequently the heterodyne note at the receiver may be due to these frequency variations, at times, difficult to copy. Particularly is this so in transmitters designed for mobile use.

Briefly and in its broadest aspect the object of this invention is to provide a transmitter in which frequency control other than that obtained by the oscillator and its associated circuits is not necessary and which includes means for reducing the effect at the receiver of the varying frequencies transmitted.

This object is attained by the use of a master oscillator which is arranged in construction and circuit together with the character of plate and filament supplies, within practical limits to give constant frequencies as established by the oscillator tube or tubes and associated tuned circuits. The master oscillator excites continuously the grid of an amplifier. The amplifier preferably consists of two tubes which are arranged in a self-rectifying circuit and with which is associated a radio frequency tank circuit from which the energy may be supplied to an antenna or other load circuit. The plates of the amplifier tubes are supplied from the secondary of a transformer the primary of which is fed by an alternating current generator.

Keying of the transmitter may be done in any convenient manner.

The form of energy delivered to the tank circuit from the output circuits of the amplifier is of varying amplitude and of a frequency double that of the alternating current generator while the frequency of the carrier wave is determined by the master oscillator. The tank circuit of the amplifier in the simpler arrangement supplies the energy to the antenna or transmission line or to any other work circuit.

The form of energy obtained from a transmitter constructed in accordance with my invention gives a pleasing musical effect in the receiver when heterodyning and is of a nature easy to pick up when tuning. The many variations of frequency which would appear predominent after heterodyning a carrier wave of practically constant amplitude are now in the background due to the predominating of the frequency of modulation.

One advantage to be gained by the use of a transmitter constructed in accordance with my invention is that the high voltage direct current generator usually used to supply the plates of the amplifiers in transmitters of this type is replaced by an alternating current generator thereby materially decreasing the cost of the apparatus.

Another advantage to be gained by the use of a transmitter constructed in accordance with my invention is that the high voltage direct current generator generally used in transmitters of this type is replaced by an alternating current generator of low voltage thereby materially increasing the reliability of the apparatus.

A further advantage to be gained by the use of a transmitter arranged in accordance with my invention is that control means such as for instance a crystal control may be omitted without appreciable sacrifice in readability of signals.

An added advantage to be gained by the use of a transmitter constructed in accord-

ance with my invention is that transmission on the shorter wavelengths may be carried out by apparatus permitting a convenient change in wavelength.

An additional advantage to be gained by my novel transmitter is that the radiation therefrom provides two side bands adjacent to the carrier wave which are helpful in reducing fading at the receiver.

Other objects and advantages will become apparent from the specification and therefrom when read in connection with the accompanying drawings in which;

Figure 1 illustrates the at present preferred form of the invention; while

Figure 2 is a curve showing the current oscillations in the tank circuit.

Referring to Fig. 1 of the drawings the radio frequency carrier wave is generated by a master oscillator of any standard type, which for purposes of illustration has been shown as an oscillator of the Hartley type. This oscillator M.O. consists of a vacuum tube oscillation generator 3, the anode of which is supplied from a high potential direct current source 1 through a radio frequency choke coil 2 the purpose of which is to prevent oscillations at radio frequency from passing through the current source. The frequency of the oscillations generated by the master oscillator is determined by the oscillation circuit 5 which consists of a condenser 9 shunting an inductance 10 a portion of which inductance is common to the grid cathode and anode cathode circuits of the master oscillator 3. The grid cathode circuit is completed from the grid through a grid leak 6 shunted by a condenser 8, through a portion of the inductance 10 to the cathode. The amount of the inductance 10 in this circuit depends on the position of the point at which the conductor 7 connects this inductance to the cathode. The grid leak 6 shunted by the condenser 8 assures proper bias for the grid of vacuum tube 3. The anode cathode circuit is completed from the anode through a blocking condenser 4 a portion of the inductance 10 and the conductor 7 to the cathode of the tube. The inductance 10 being common to the anode and grid circuits provides the required feedback coupling inductive and conductive between said circuits to set up sustained oscillations in the anode cathode circuit.

This oscillation generator which has been described merely for purposes of illustration it being understood that many alterations in the arrangement thereof can be made without departing from the spirit thereof, will not produce oscillations at constant frequency but will within reasonable limits produce oscillations at substantially constant frequency.

This master oscillator with changes thereto which are well known in the art permits the addition thereto of a crystal frequency control unit in case a substantially constant carrier wave is required thereby gaining all the advantages to be drived from a constant frequency generator while still retaining the advantages to be obtained by maximum simplicity of structure and ease in change of frequency of the oscillations produced.

The oscillations generated by the above described master oscillator are led through a coupling condenser 12 to the grids of an amplifier of the push-pull type by means of a conductor 11 variably tapped to the inductance 10 a portion of which is in the amplifier grid cathode circuit which is completed through leads 7, 17 to the cathodes of the amplifier tubes. The anodes of the tubes of this amplifier, which preferably consists of two tubes arranged in a self rectifying circuit, are supplied with low frequency modulating alternating potentials from the secondary winding of a transformer fed by a low voltage alternating current generator 28. Alternating potentials from this generator 28 are set up in the primary 26 of a transformer, the secondary 25 of which is connected to the anodes of the tubes 13 and 14 through radio frequency choke coils 23, 24. The purpose of the choke coils 23 and 24 is to keep high frequency oscillations from being set up in the transformer secondary 25. The midpoint of the secondary winding of the transformer is grounded at G. The cathodes of the tubes 13 and 14 are connected to ground through a conductor 17 thus completing the anode cathode circuit for the modulating current. The grids of the amplifier tubes 13 and 14 are grounded through a choke coil 15 the purpose of which is to exclude radio frequencies from the low frequency circuits, and a high resistance 16 the purpose of which is to provide the proper potential on the grids of 13 and 14. The output circuit of this amplifier includes two symmetrical portions comprising conductors connecting the respective anodes of the amplifier tubes 13 and 14 through two blocking condensers 18 and 19 with a conductor 20 connecting the grounded tank circuit 30 to a point between the condensers 18 and 19. This output circuit is completed through the grounded conductor 17.

The tank circuit 30 comprises an inductance 22 shunted by a condenser 21 thus forming an oscillation circuit tuned to the desired frequency. Energy may be taken from the tank circuit by means of a pair of conductors variably tapped to the inductance 22 of the tank circuit and designated output in the drawings.

Although for purposes of illustration I have shown a pair of conductors for taking the energy from the tank circuit, I do not limit myself thereby as the energy may be taken from the tank circuit in any known manner to supply any work circuit as for in-

stance by inductive, or capacitive coupling to an antenna circuit.

The transmitter may be keyed by means of a key 27 in the circuit of the alternating current generator 28.

The opposed potentials applied to the anodes of the tubes of the self-rectifying amplifier by the secondary of the alternating current transformer 25, 26 will cause direct current to flow alternately in the direct current anode cathode circuits of the tubes 13 and 14. The sum of these currents flowing in the respective anode cathode circuits of the tubes 13 and 14 would if plotted with respect to time be represented by a series of direct current impulses the frequencies of which are double the frequency of the alternating potentials applied to the anodes of the amplifier tubes and the amplitude of which vary in accordance with the variation of potential applied to the anodes of the amplifier tubes by the transformer 25, 26. This curve would follow the general form of a sine wave.

In Figure 2 of the drawings is shown a curve illustrating the current oscillations set up in the tank circuit in response to the effect of the voltage of the oscillations of the master oscillator on the input circuit of the amplifier and to the modulating effect of the alternating potentials applied to the anodes of the amplifier tubes. In this figure 31 indicates the oscillations set up in the tank circuit. The frequency of these oscillations is determined by the tuned impedance 30 and is to obtain maximum amplitude variation equal to the frequency of the oscillations impressed on the input circuit of the amplifier by the master oscillator. As shown in the drawings these radio frequency oscillations vary in amplitude from zero to maximum and back to zero at double the frequency of the generator 28 the amplitude of these radio frequency oscillations being a function of the amplitude of the potentials applied to the anodes of the tubes of the self rectifying amplifier.

If rectification of the alternating current fed to the amplifier anodes by the generator 28 is not complete, modulation of the radio frequency oscillations in the tank circuit will not be complete but will be substantially as indicated by the dotted line 32 in Figure 2 of the drawings.

To briefly describe the operation of my novel transmitter, the oscillations generated by the master oscillator are fed to the input circuit of the amplifier by the conductor 8 and are modulated therein by the low frequency anode supply provided by the generator 28 and rectified by the novel amplifier arrangement. These low frequency oscillations will produce in the direct current anode cathode circuit of the amplifier rectified pulsations of double the frequency of the oscillations provided by the generator 28. These pulsations might be said to form an envelope for the amplified radio frequency oscillations produced in the radio frequency output circuit of the amplifier in response to the voltage changes applied to the grid cathode circuit thereof by the oscillations from the master oscillator. Radio frequency current oscillations are set up in the tank circuit from which they may be utilized in any well known manner.

I have found that when the generator 28 is operated at a frequency of 500 cycles per second the note obtained in the receiver by heterodyning is easy to listen to, and that even though the frequency of the master oscillator varies the musical note will still be present in the receiver and though somewhat "mushy" will always be readable.

Although for purposes of illustration I have shown and described the at present preferred form of my invention and the operation thereof I do not wish to limit myself thereby except as marked out in the claims hereto appended:

1. An apparatus for signalling at radio frequencies the combination of an amplifier system comprising a plurality of thermionic tubes having input and output elements arranged in a self-rectifying circuit including an output circuit and an input circuit, a tank circuit in said output circuit, means for oppositely supplying low frequency alternating current potentials to the anodes of said tubes including a transformer secondary winding the midpoint of which is connected to the grids of said tubes, keying means associated with said supplying means, and means for supplying high frequency oscillations to the input circuit of said amplifier.

2. In apparatus for generating high frequency oscillations the combination of an amplifier system comprising a pair of tubes each having an anode grid and cathode electrode, an input circuit connected between the grid and cathode electrodes of said tubes, an output circuit including capacitive means for coupling said anodes together and to a tank circuit comprising a tuned impedance, associated with said anodes and cathodes, a low frequency alternating current generator associated with the primary circuit of a transformer having a secondary symmetrically tapped and grounded to the cathodes of said tubes, means including a high resistance and a choke coil for connecting the mid-point of said secondary to the grids of said tubes, means including impedances for connecting each of the outer ends of said secondary to the anode of one of said tubes, a high frequency thermionic generator having coupled input and output circuits and means for connecting the input circuit of said amplifier to the output circuit of said thermionic oscillation generator.

3. In an arrangement for producing substantially constant high frequency oscillations, the combination of an amplifier system comprising a plurality of thermionic tubes having input elements including a control electrode, and output elements, means for connecting a source of high frequency oscillations between the input elements of said tubes, said connecting means including a capacity, a high frequency output circuit including a pair of condensers connected in series between the anodes of said tubes and a tank circuit connecting the midpoint of said condensers to the filaments of said tubes, a source of alternating current at audible frequency, a transformer having a primary winding connected with said source, and a secondary winding having its terminals connected through inductances to the anodes of said tubes, an inductance and a resistance connecting the electrical midpoint of said transformer to the control electrodes of said tubes, and keying means in series with the primary winding of said transformer.

FRED H. KROGER.