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RADIO SYSTEM

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Fig. 1.

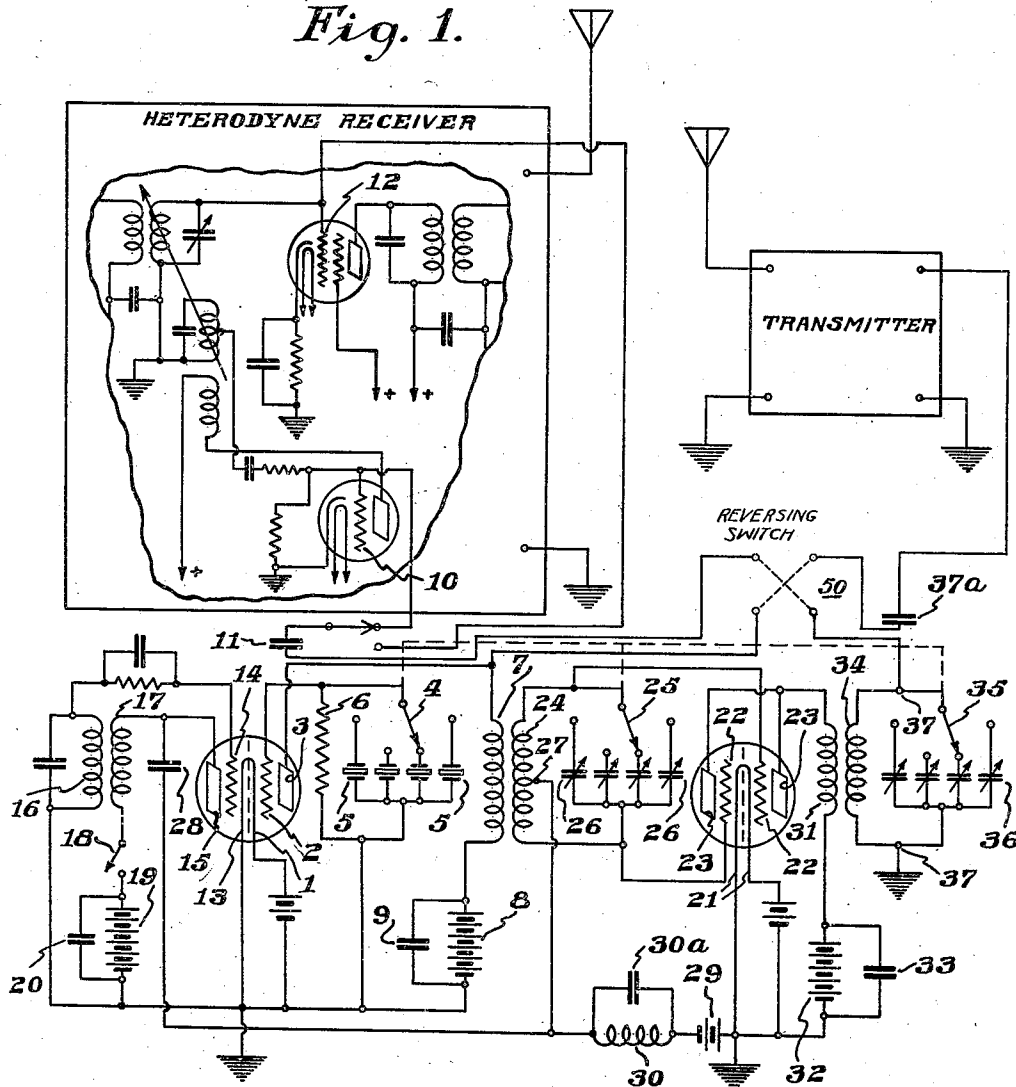
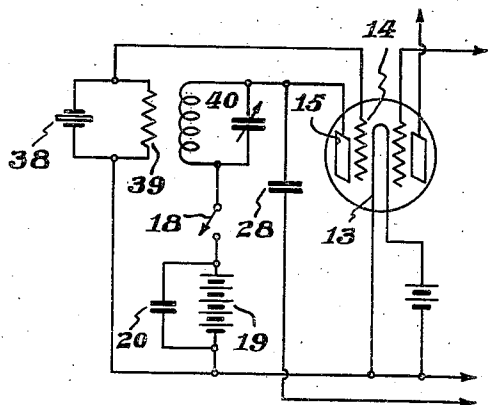


Fig. 2.



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RADIO SYSTEM

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7 Claims. (Cl. 250—13)

My invention relates to radio communicating systems especially adapted for aircraft use.

Aircraft radio communication is often made at one frequency during the day and at a different frequency during the night. One set of day and night frequencies may be assigned to each division of a given airline route. In an airline route having four divisions, an airplane passing through these divisions should be provided with a radio transmitter and receiver, each having a frequency controlling piezo element or crystal for each of the frequencies assigned to this route, or eight transmitting and eight receiving crystals, making a total of sixteen crystals for the complete radio equipment. This large number of crystals is a very costly part of the aircraft radio equipment.

Furthermore, tuning the receiver is limited to the frequencies of the crystals. Reception, in case of emergency, on frequencies other than those of the crystals is not possible.

One object of my invention, therefore, is to provide a radio communicating system in which one crystal for each signalling frequency will control alternately the frequency for transmitting and the frequency for receiving, whereby a lesser number of crystals will be required to effect communication at the day and night frequencies mentioned above, thereby reducing the cost of aircraft radio equipment.

Another object is to provide a crystal controlled system in which the receiver may be tuned to frequencies other than those of the crystals for emergency reception.

A further object is to provide a crystal frequency-controlling unit which may be readily used with commercial transmitting and receiving equipment.

These objects and other advantageous results I attain by providing an oscillation generator which comprises three circuits, namely, a high frequency oscillator circuit, a low frequency oscillator circuit, and a frequency mixer circuit. The high frequency oscillator circuit includes piezo elements for stabilizing oscillations which primarily control the assigned aircraft frequencies at which communication is to be made. The low frequency oscillator circuit need only be a tuned feed back circuit, but a piezo element circuit may be used instead for extremely accurate control of the generated low frequency current oscillations.

The frequency mixer or converter circuit is similar to the well known balanced modulator circuit and it is understood that other circuit

arrangements may be used to produce the same result.

For transmitting, the oscillations are generated by the high and low frequency oscillator circuits and converted by the mixer circuit into the transmitting carrier frequency which is passed through the transmitter in the usual way.

For receiving, a superheterodyne receiver is utilized in which the local oscillator may be used in the regular way for reception of any frequency within its tuning range. But when receiving fixed aircraft frequencies, the local oscillator is tuned to the frequency of the piezo element oscillator and the incoming frequency, when mixed with the local frequency, will produce the intermediate frequency which is passed through the receiver in the usual way. The grid of the local oscillator circuit has a capacitive or other coupling with the piezo element oscillator from which it receives potentials at an accurately controlled frequency. Thus this local heterodyning oscillator in the receiver, when its tuning is approximately correct, will lock-in at the frequency of the piezo element oscillator and will be held constant on the correct frequency for reception.

When receiving, the low frequency oscillator circuit is turned off with a switch to prevent undesirable influences being carried into the receiver.

A full understanding of the invention may be had by referring to the drawing in which,

Figure 1 is a diagrammatic view of a circuit embodying my invention, and

Fig. 2 is a diagrammatic view of a modification of a portion of the circuit shown in Fig. 1.

Referring to the drawing, the high frequency oscillator circuit includes a space charge device having a grid circuit and a plate circuit connected with a cathode 1, a grid 2, and an anode or plate 3. The grid circuit extends from the grid 2 through a multi-point switch 4 and any one of several piezo elements 5 to cathode 1. An impedance device shown as a resistor 6, shunts the switch 4 and its piezo elements 5. As many piezo elements are used as the number of frequencies at which aircraft communication is to be made. For simplicity I have shown only four piezo elements for controlling two day and two night-frequencies.

The plate or output circuit of the high frequency oscillator extends from the plate 3 through a primary coil 7, a source of plate potential shown as a battery 8 to the cathode 1. A

condenser 9 shunts the battery 8 for by-passing the high frequency currents.

The output circuit is coupled with the grid 10 of the local oscillator of a superheterodyne receiver, through a coupling condenser 11. Oscillations at a frequency accurately controlled by the piezo elements, will be impressed through the condenser 11 on the grid of the local oscillator to keep it in accurate tune despite the usual potential or temperature changes which tend to vary the frequency. In some instances it may be desirable to produce the same effect by coupling the condenser 11 directly to the grid 12 of the first detector tube instead of the grid 10 of the local oscillator.

The low frequency oscillator circuit includes a space charge device having a cathode 13, a grid 14 and an anode or plate 15 to which a grid circuit and a feed back circuit are connected. The grid circuit extends from the grid 14, through a grid-leak and condenser and a tuned circuit 16 to the cathode 13. The feed-back circuit extends from the plate 15 through a feed-back coil 17, a switch 18, a source of plate potential, shown as a battery 19, to the cathode 13. A condenser 20 shunts the battery 19 for by-passing the high frequency oscillations. A switch 18 is used to turn off the low frequency oscillator while receiving.

The space charge devices of the high and low frequency circuits are shown as being built in a single duplex triode tube. However, it will be understood that two single tubes may be substituted with equally good results.

The mixer circuit may be any of the well known arrangements and I have shown one which employs a single duplex triode tube having a pair of cathodes 21, a pair of grids 22 and a pair of anodes or plates 23. The grids 22 are connected in series with each other through a resonant circuit which includes a secondary coil 24, a second multi-point switch 25 and any one of several condensers 26. This resonant circuit is tuned to the same frequencies as those of the piezo elements 5 by switching in any one of the corresponding piezo elements 5 and condensers 26 simultaneously with their respective switches 4 and 25, both of which may be operated from a common switch knob (not shown).

The secondary coil 24 is coupled to the primary coil 7 of the output or plate circuit of the high frequency oscillator. The output or feed-back circuit of the low frequency oscillator is connected to the mid-point 27 of the secondary 24 through a condenser 28. The cathodes 21 are also connected to the mid-point 27 through a grid bias source, shown as a battery 29, and a choke coil 30, which is by-passed by condenser 30a. The circuit of 30 and 30a is designed to have high impedance to the frequency to which the circuit 16 is tuned, and a low impedance to the frequencies of the piezo element oscillator.

The plates 23 are connected to each other and through a primary 31 and a source of potential shown as a battery 32, to the cathodes 21. A by-pass condenser 33 shunts battery 32 for the high frequency oscillations. A secondary 34 is coupled with the primary 31 and is part of a resonant circuit which includes a third multi-point switch 35 and any one of several condensers 36. This resonant circuit is tuned to the transmitting frequency which is the resultant of the high and low frequency currents fed through the mixer circuit. This third switch 35 is preferably mechanically connected for simultaneous opera-

tion with the other two switches 4 and 25 so that the corresponding piezo element and condensers will be switched in at the same time.

A pair of output terminals 37, one of which is grounded, are connected with opposite ends of the resonant circuit. The ungrounded terminal 37 may be connected with the input terminal of a transmitter of any suitable type, as by a coupling capacitor 37a as shown, to supply a carrier frequency thereto for subsequent amplification and modulation.

In Fig. 2 I have shown a modified arrangement of the low frequency oscillator circuit in which piezo elements are used for controlling the oscillations. A piezo element 38 and an impedance 39 connect the grid 14 to the cathode 13. In the plate circuit a resonant circuit 40 connects the plate 15 with switch 18. In all other respects the connections are same as shown in Fig. 1. This arrangement may be used where extremely close limits of transmitter frequencies must be held.

In operation, the switches 4, 25, and 35 are operated simultaneously by appropriate means (not shown) to switch in the proper piezo element 5 and the corresponding condensers 26 and 36, for generating one of the predetermined frequencies to be used for communication. Assuming that the transmitting frequency is 4,000 kilocycles and the frequency of one of the piezo elements 4,510 kilocycles, the resonant circuit 16 would then be pretuned to oscillate at 510 kilocycles which is the same frequency as the intermediate frequency of the heterodyne receiver. The resonant circuit formed by secondary 24 and one of the condensers 26, would be tuned to respond at 4,510 kilocycles and the resonant circuit formed by secondary 34 and one of the condensers 36 would be tuned to 4,000 kilocycles.

The output of the high frequency oscillator circuit induced on the mixer circuit, would then be at 4,510 kilocycles accurately controlled by the piezo element. The output of the low frequency oscillator circuit impressed through condenser 28 on the mixer circuit, would then be at 510 kilocycles.

The output of the mixer or converter circuit would be combinations of 4,510 and 510 kilocycles and only the 4,000 kilocycle component would be received by resonant circuit 34—36 for supplying the transmitter.

It should be noted that large percentage variations in the 510 kilocycle frequency would effect comparatively small percentage variations in the 4,000 kilocycle frequency. This small variation has no material effect to impair keeping the transmitting frequency within the allowable limits. In special application it may be desirable to eliminate these small variations in the 4,000 kilocycle transmitter frequency. This may be done by generating the 510 kilocycle frequency with the piezo element circuit shown in Fig. 2 instead of the circuit shown in Fig. 1. However, this extra piezo element adds extra cost to the radio equipment.

For receiving a superheterodyne receiver is used and the 510 kilocycle frequency is cut off by opening switch 18, and only the 4,510 kilocycle frequency will be impressed on the local oscillator circuit to control its frequency accurately at 4,510 kilocycles. The incoming signal at 4,000 kilocycles will mix with this 4,510 kilocycle frequency and the 510 kilocycle component will be received as the intermediate frequency and carried through the receiver in the usual way. It should be noted that the intermediate frequency is the same as

the frequency of the low frequency oscillator circuit.

When the oscillation generator is not in use the local oscillator of the superheterodyne receiver may be used in the regular way to tune in any desired signalling frequencies within its band.

It is thus seen that one set of piezo elements alternately controls the frequencies for transmitting and for receiving, that the receiver may be used to tune in frequencies other than those of the piezo elements and that the cost of radio aircraft equipment will be materially reduced.

In certain cases, a modification of the arrangement of frequencies noted above may be desirable. For example, when transmitting on relatively high frequencies, it is often convenient to arrange one of the transmitter stages as a doubler. In this case, the signalling frequency which is radiated is twice the frequency of the frequency controlling device.

By a slight modification, the method already described may be adapted to this case. Suppose, as before, that the signalling frequency is 4000 kc. The frequency of the corresponding piezo element 5 would then be 2256 kc., and the low frequency oscillator represented by circuit 16 would be adjusted to 256 kc. The circuit of coil 24 and condenser 26 would be tuned to 2256 kc. The circuit of coil 34 and condenser 36 would be tuned to 2000 kc., which frequency would result from the operation of the modulator.

During reception, the low frequency oscillator would be stopped by opening switch 18. In this case, a voltage would be supplied through coupling condenser 11 at a frequency of 2256 kc. to the local oscillator in the receiver. This oscillator, when tuned to twice this frequency, that is 4512 kc., would lock in at twice the controlling frequency. Thus the transmitter and receiver would be controlled as before for a signalling frequency of 4000 kc., but the frequency controlling device would be such that a frequency doubler stage was used in the transmitter.

While this invention has been disclosed as embodied in a particular form it will be understood that it may be embodied in other and different forms without departing from the spirit and scope of the appended claims. For example, as will be obvious to those skilled in the art, the beat note may be utilized to control the frequency of the local heterodyne oscillator and the output from one of the oscillators may be utilized for the transmitter frequency. Since this modification involves merely interchanging the coupling leads to the receiver and the transmitter, respectively, from the capacitors 11 and 37a, as illustrated by the reversing switch 50 shown in Fig. 1.

I claim as my invention:

1. In combination with a transmitter and a heterodyne receiver, a mixer circuit, a high frequency oscillator circuit so coupled as to supply current oscillations to the mixer circuit and for heterodyning with signal currents received by said receiver, a low frequency oscillator circuit coupled to supply current oscillations to the mixer circuit, means for receiving current oscillations from the mixer circuit to supply the transmitter, and means for rendering the low frequency oscillator circuit inoperative while receiving.

2. In combination with a transmitter and a heterodyne receiver, a mixer circuit, a high frequency oscillator circuit coupled to supply current oscillations to the mixer circuit and for

heterodyning with incoming currents impressed on said receiver, piezo elements connected for controlling the input current oscillations to the high frequency oscillator circuit, a low frequency oscillator circuit coupled to supply current oscillations to the mixer circuit, means for receiving current oscillations from the mixer circuit to supply the transmitter, and means for rendering the low frequency oscillator circuit inoperative while receiving.

3. In radio apparatus, a transmitter, a receiver of the heterodyne type including a local oscillator, a high frequency oscillator and a low frequency oscillator, means for producing a beat note through interaction of fluctuating currents from said high frequency oscillator and said low frequency oscillator, means for utilizing the output of one of said oscillators to control the frequency at which the transmitter radiates, and means for utilizing the beat note for controlling the frequency of the local oscillator.

4. In radio apparatus, a transmitter, a receiver including a local source of oscillations for heterodyne purposes, means for producing a beat frequency including a plurality of oscillators, means coupling the local source and one of said plurality of oscillators for controlling the frequency of the local source, and means coupling said beat frequency means and said transmitter whereby the beat frequency produced by the interaction of oscillations generated by said plurality of oscillators is utilized to control the frequency at which the transmitter radiates.

5. In the combination of a transmitter and a superheterodyne receiver, a low frequency source of locally generated oscillations, a high frequency source of locally generated oscillations, means for stabilizing the frequency of oscillations from said high frequency source, a mixer tube for heterodyning said high and low frequencies whereby a second stabilized frequency is generated, and means for impressing one of said stabilized frequencies on said receiver whereby intermediate frequency currents are generated and the other of said stabilized frequencies on said transmitter.

6. In the combination of a transmitter and a superheterodyne receiver, a substantially constant source of locally generated low frequency oscillations, a high frequency source of locally generated oscillations, a piezo electric element, means connecting said element to said high frequency source for stabilizing said high frequency oscillations, means for heterodyning said high and low frequencies whereby a second stabilized frequency is created, and means for impressing one of said stabilized frequencies on said receiver whereby intermediate frequency currents are generated and the other of said stabilized frequencies on said transmitter.

7. In the combination of a transmitter and a superheterodyne receiver including a first detector, a source of locally generated low frequency oscillations, a stable source of locally generated high frequency oscillations, a third source of stable oscillations generated by the heterodyning of oscillations from the first and second sources, means for impressing one of said stable oscillations on said first detector to produce intermediate frequency currents, and means for impressing the other of stable oscillations on said transmitter.

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