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RADIO TRANSMISSION SYSTEM

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FIG. 1.

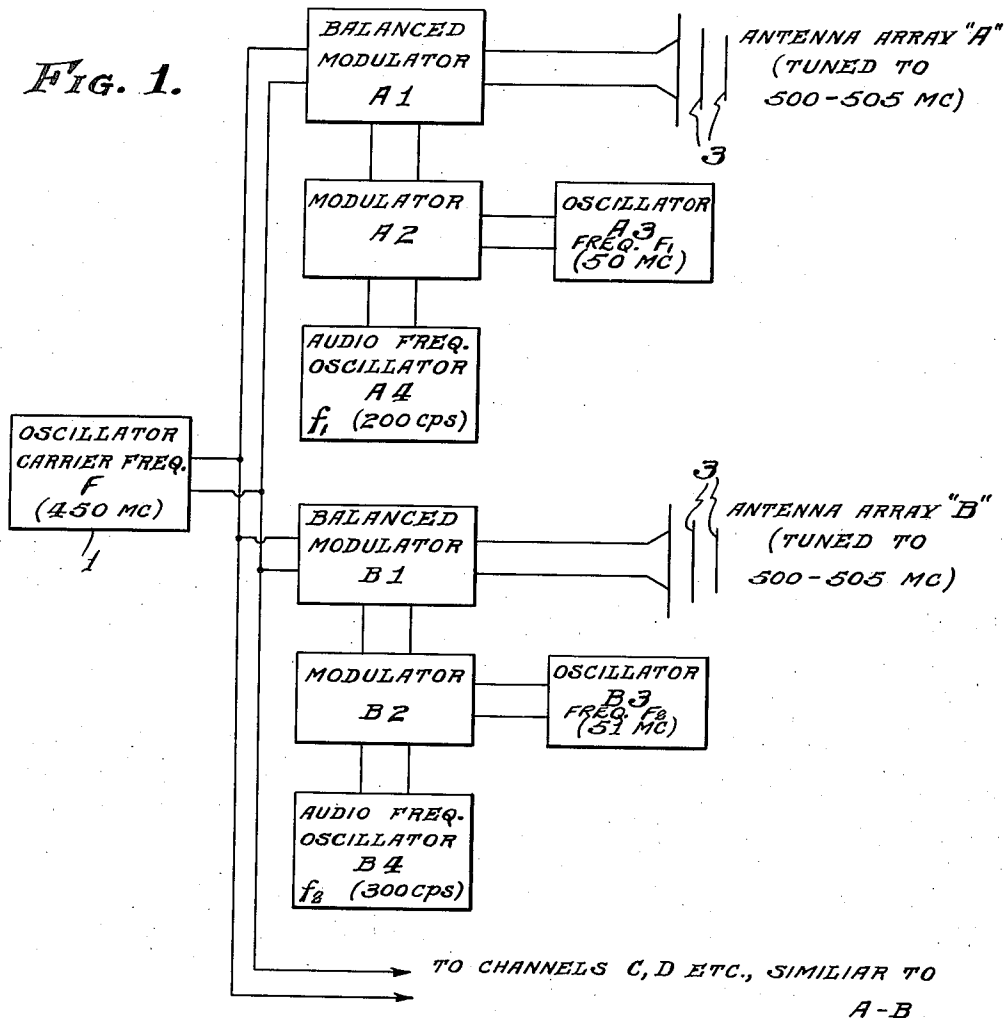
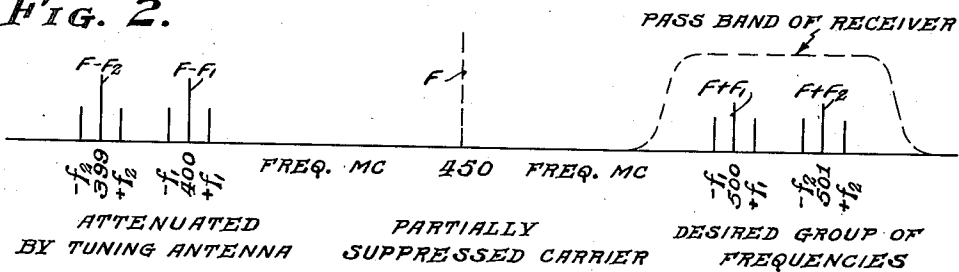


FIG. 2.



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RADIO TRANSMISSION SYSTEM

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5 Claims. (Cl. 250—11)

This invention relates to a radio system for the transmission of two or more waves which may be superimposed in space without the formation of objectionable standing wave patterns. In one of its applications, the invention relates to the production of two or more radio beams for guiding vehicles without the production of erroneous indications due to standing wave patterns.

Several systems for establishing courses for aircraft and other vehicles by means of radio waves have been proposed. If overlapping radio fields are created, the overlapping portion may be made to coincide with a desired course. The course may be identified by distinctive modulation applied alternately to the carrier. While the general practice has been to radiate the waves alternately, it would be advantageous if the waves could be radiated continuously. One advantage would be the improved signal to noise ratio; another advantage would be found in the simplified apparatus.

However, it has not been practical to radiate an ultra high frequency carrier wave from antenna systems separated by a few wave lengths and modulated by audio signals f_1 , f_2 , etc., because of the formation of an objectionable standing wave pattern about the antenna. It is, therefore, one of the objects of this invention to provide means for eliminating the objectionable standing wave patterns of a radio transmission system. Another object is to provide means for radiating two or more carriers sufficiently close in frequency to be passed by a receiver which reproduces only the desired demodulation products. An additional object is to provide means for radiating two or more carriers each including distinctive modulation and demodulating such carriers in a single receiver which reproduces only the said modulation. A further object is to provide means for transmitting a carrier bearing picture signals and for varying said carrier to eliminate the deleterious effects caused by standing wave patterns produced by reflections.

The invention will be described by referring to the accompanying drawing in which Figure 1 is a schematic circuit diagram of one embodiment of the invention; and Figure 2 is a graphic illustration of the frequency characteristics of the radio transmission and receiving system.

An ultra high frequency oscillator 1 is connected to two or more channels A, B, etc. The first channel includes a balanced modulator A1 which is connected to an antenna array A. The array may include directors 3 and/or reflectors not shown. The antenna is tuned to attenuate the

lower frequency side band currents. The balanced modulator A1 is connected to a modulator A2 which is, in turn, connected to a sub-carrier frequency oscillator A3 and an audio frequency oscillator A4. By way of example, the frequencies of the several oscillators may be as follows: ultra high frequency oscillator—450 megacycles per second (F); sub-carrier oscillator A3—50 megacycles per second (F₁); and audio frequency oscillator A4—200 cycles per second (f_1).

The second channel B includes a balanced modulator B1, a modulator B2, a sub-carrier oscillator B3 and an audio frequency oscillator B4. The balanced modulator is connected to the main carrier frequency oscillator 1, and to the modulator B2. The modulator B2 is connected to the oscillator B3 and to the audio oscillator B4. The oscillators B3 and B4 are operated respectively at 51 megacycles per second (F₂) and 300 cycles per second (f_2), by way of example. In other respects, the channels A and B are similar. It should be understood that other channels, C, D, etc., which have not been shown may be included in the system.

The operation of the system is as follows: The main carrier frequency currents are partially or completely suppressed in the balanced modulators A1, B1, respectively. Currents from the sub-carrier oscillator A3, modulated by the audio frequency f_1 , combine with the carrier frequency currents to form upper and lower side bands corresponding to 500 and 400 megacycles per second. These side band oscillations are modulated by the audio frequency oscillations forming oscillatory currents of 500 mc. and 500 mc. $\pm f_1$ and 400 mc. and 400 mc. $\pm f_1$ (mc. standing for megacycles per second). The currents of the latter frequency are attenuated by tuning the antenna array A to 500—505 mc. The currents of the former frequency (500 mc. and 500 mc. $\pm f_1$) establish waves which are directly radiated by the antenna A.

Simultaneously, the ultra high frequency carrier is modulated in channel B by currents from the sub-carrier oscillator B3, modulated by the audio frequency currents B4, the resultant waves corresponding to 399 mc. and 399 mc. $\pm f_2$ and 501 mc. and 501 mc. $\pm f_2$. The former are attenuated by the tuning of the antenna array B; the latter are radiated from the antenna. The ultra high frequency carrier is partially or completely suppressed by the balanced modulator B1.

The waves from the two antenna arrays may be overlapped to form a desired course. The receiver used to guide the vehicle along the course is designed to have a pass band, which will ac-

commodate the upper side bands 500 mc. and 500 mc. $\pm f_1$, 501 mc. and 501 mc. $\pm f_2$, etc. These waves are received, demodulated and filtered so that the resultant signals correspond to f_1 and f_2 only. The currents of frequencies f_1 and f_2 , after filtering, may be applied to any suitable indicator.

In the foregoing operation, the sub-carriers of 500 mc. and 501 mc., being at different frequencies, do not establish undesirable standing wave patterns notwithstanding their being radiated from sources spaced within several wave lengths of the carrier wave. Such wave interference effects as may exist are varying at such a high frequency that they have no objectionable effect upon the demodulator of the receiver. The currents of the several frequencies are so chosen that only the desired demodulation signals are produced.

The system lends itself to ultra high frequency carriers which bear complex signals, such as picture signals. It has been found that a conventional television transmitter, operating at an ultra high frequency, may produce undesired images. These images are caused by standing waves, which are produced by the interference between a direct and a reflected wave. In the application of the invention to television, the picture or video signal would be applied to the modulators A2, B2 simultaneously. The difference between the frequencies of the oscillators A3, B3 should be chosen to prevent any undesired beating frequency which would come within the picture frequency range.

Thus the system has been described as one in which carrier waves of two different frequencies are radiated simultaneously from adjacent antennas to avoid troublesome standing wave patterns. The sub-carriers are distinctively modulated and are differently directed to form an overlapping region coinciding with a desired course. The receiver pass band is designed to pass both sub-carriers which are demodulated to produce the distinctive modulation only. The system may be applied to television to eliminate double images caused by interference between direct and reflected waves. It should be understood that the described method of eliminating undesired standing waves may be practiced by oscillators operating at different frequencies and by audio oscillators generating currents of any desired signal frequency. Likewise, different antenna arrays may be used. Furthermore, the receiver may be a tunable radio frequency device, or superheterodyne provided it passes the desired frequency band.

I claim as my invention:

1. A radio transmitter including an ultra high frequency oscillator, a pair of balanced modulators connected to said ultra high frequency oscillator, a pair of oscillators for generating radio frequency sub-carrier currents of different frequencies, said different frequencies and said ultra high frequency being so related that the resultant pair of upper side bands lie in substantially adjacent radio frequency channels, a pair of oscillators for generating currents of different modulation frequencies, a pair of modulators for combining said sub-carrier currents and said currents of different modulation frequencies, respectively, means for applying said combined currents respectively to said balanced modulators, a pair of antennas each connected to said balanced modulators and tuned to pass currents corresponding respectively to the currents of one of the side band frequencies developed in said

balanced modulators and to partially suppress currents corresponding to the other side band frequency and separated by a distance of the order of the wave lengths of the applied currents, and arranged to radiate modulated waves having carriers in substantially adjacent radio frequency channels susceptible of reception in a single receiver as a single carrier to eliminate thereby standing waves, and means for directing the waves from said pair of antennas along overlapping paths to form a desired course free from undesirable standing waves.

2. A radio transmission system including an ultra high frequency oscillator, a pair of balanced modulators connected to said ultra high frequency oscillator, means for applying to each of said balanced modulators a radio frequency carrier wave of a different frequency, said ultra high frequency and said different frequencies being so related that resultant pairs of upper and lower side bands, respectively, lie in substantially adjacent radio frequency channels, means for transmitting one set of the side bands produced by said ultra high frequency carrier and said carrier waves of different frequencies, and for at least partially suppressing the other set of side bands so that the transmitted waves are in substantially adjacent radio frequency channels and may be received as a single carrier, means for radiating said adjacent channel carrier waves from points separated in space by a distance of the order of the wave lengths of said adjacent channel carrier waves whereby undesired standing wave patterns are eliminated, and means for applying currents of single frequency to each of the radio frequency carrier waves of different frequencies.

3. A radio system for direction finding including an ultra high frequency oscillator, a pair of balanced modulators connected to said ultra high frequency oscillator, a pair of oscillators for generating radio frequency sub-carrier currents of different frequencies, the frequencies of said ultra high frequency oscillator and said radio frequency sub-carriers being so related that the upper radio frequency side bands produced by their combination lie in substantially adjacent radio frequency channels, a pair of oscillators for generating currents of different modulation frequencies, a pair of modulators for combining said sub-carrier currents and said currents of different modulation frequencies, respectively, means for applying said combined currents respectively to said balanced modulators, a pair of antennas each connected to said balanced modulators and tuned to pass currents corresponding respectively to the currents of one of the side band frequencies developed in said balanced modulators and to partially suppress currents corresponding to the other side band frequency and spaced apart by a distance of the order of a wave length of the applied currents, means for directing the waves from said pair of antennas along overlapping paths to form a desired course free from undesirable standing waves, a receiver having a response band including the unsuppressed pair of radio frequency carriers in each of said overlapping fields, and means for demodulating and indicating said side bands.

4. The method of suppressing undesired standing wave effects in a directional radio system including the steps of generating a main carrier wave of frequency F, generating a pair of sub-carrier waves of radio frequency F_1 and F_2 , re-

lating F , F_1 and F_2 so that $F+F_1$ and $F+F_2$ are in substantially adjacent radio frequency channels and have a frequency difference greater than the desired signal frequency, modulating said sub-carrier waves to produce modulated sub-carrier waves of frequency $F_1 \pm f_1$ and $F_2 \pm f_2$, modulating said main carrier wave with said modulated sub-carrier waves, suppressing at least partially said main carrier wave to establish waves having frequencies $F \pm F_1 \pm f_1$ and $F \pm F_2 \pm f_2$, attenuating one set of the side bands generated by said modulation of the main carrier, for example, $F - F_1 \pm f_1$ and $F - F_2 \pm f_2$, and directly radiating the other set of side bands, for example, $F + F_1 \pm f_1$ and $F + F_2 \pm f_2$ from points separated by a distance of the order of the length of the radiated waves and along overlapping paths so that each of said paths includes a carrier of different frequency and side bands corresponding to the desired signal modulation.

5. The method of suppressing undesired standing wave effects in a directional radio system including the steps of generating a main carrier wave of ultra high frequency F , generating sub-

carrier waves of radio frequencies F_1 and F_2 and in which F_1 and F_2 are less than F and in which $F+F_1$ and $F+F_2$ differ in frequency by an amount greater than the desired signal frequencies and in which $F+F_1$ and $F+F_2$ are located in substantially adjacent radio frequency channels, modulating said sub-carrier waves with distinctive radio frequencies f_1 and f_2 , modulating said main carrier with said distinctively modulated sub-carrier waves to form F , $F \pm F_1 \pm f_1$, and $F \pm F_2 \pm f_2$, suppressing at least partially said main carrier F , attenuating one set of the side bands generated by modulating said main carrier, for example, $F - F_1 \pm f_1$ and $F - F_2 \pm f_2$, and directly radiating the other set of side bands, for example, $F + F_1 \pm f_1$ and $F + F_2 \pm f_2$ from points spaced by a distance of the order of the length of the radiated waves and along overlapping paths so that each of said paths includes a carrier of a frequency corresponding to either the sum or difference frequencies of the main carrier and sub-carriers and the said distinctive audio frequency modulation.

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