

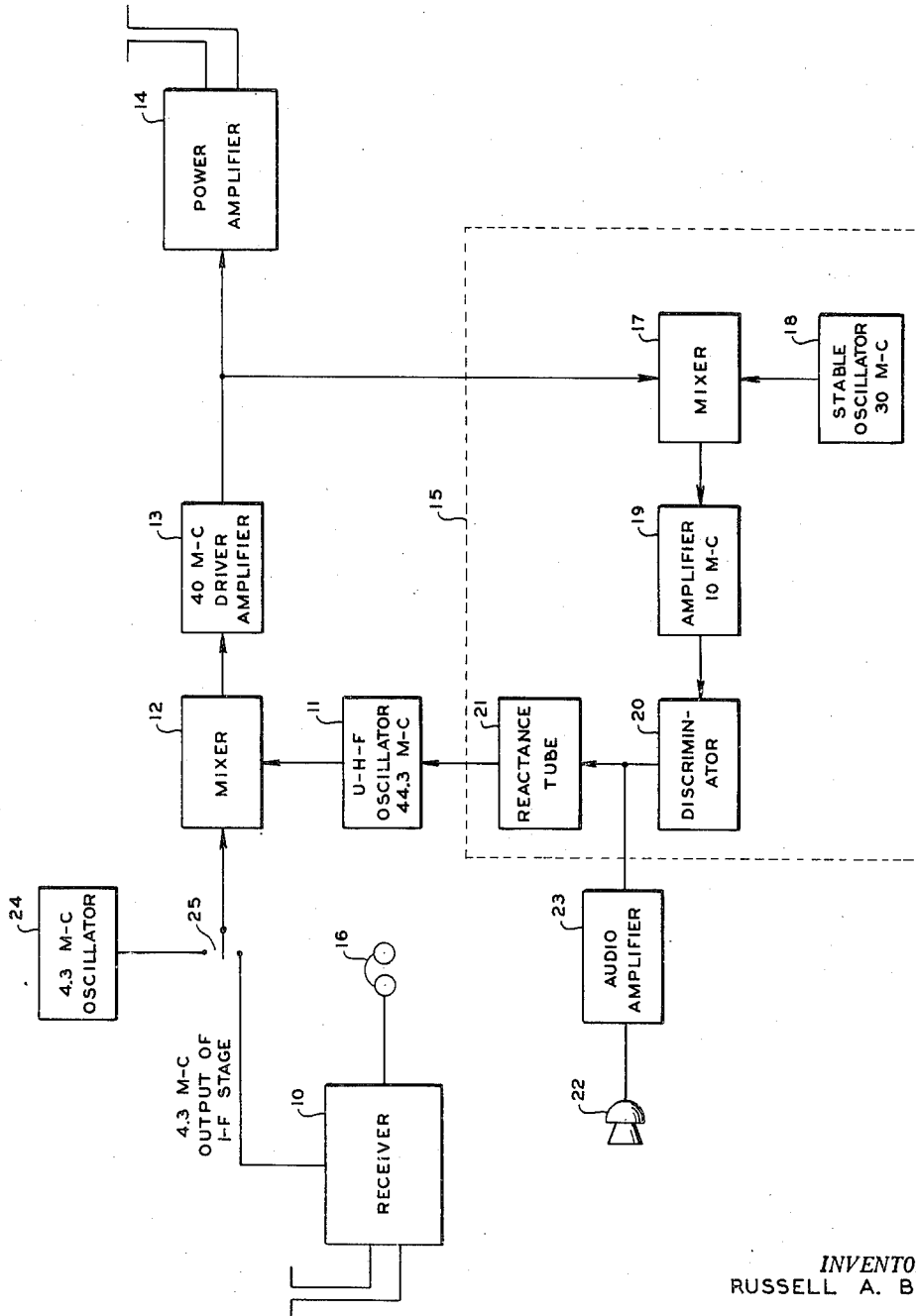
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RADIO RELAY SYSTEM

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RADIO RELAY SYSTEM

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

The present invention relates generally to radio relay systems and more particularly to relays for frequency-modulated wave systems.

In point to point communication utilizing ultra-high frequency bands, it is often desirable to interpose one or more relay stations between the original source of the signals and their final destination. This is not merely for the purpose of maintaining the signal above a predetermined level but is also necessary by reason of the fact that the curvature of the earth precludes direct communication at these high frequencies beyond the line of sight. It is also desirable that such relay stations entail a minimum amount of apparatus which is so constructed and arranged that undesired feed-back and mutual interference effects are avoided.

For distances somewhat in excess of the physically possible direct optical path, a single intermediate relay station may suffice. For considerably longer distances a series of relay stations, each of which repeats to the next station, may be employed. The relay stations may be separated from each other and from the terminal stations by distances in the order of 100 miles or less depending upon their respective elevation above sea level and upon the extent to which the intervening terrain may tend to intercept or block the direct optical path.

Heretofore, it has been the practice in relaying frequency-modulated signals to first demodulate the incoming waves and then impart the resultant audio signal as a modulation upon the carrier of a relay transmitter. Consequently, where a plurality of relay stations are used, each contributing a measure of distortion and noise to the signal in the course of detection and remodulation, the overall effect is to seriously reduce the intelligibility of the signal. Moreover, in multi-channel communication systems appreciable amounts of cross talk will be introduced.

Accordingly, it is the principal object of the present invention to provide a relay station for frequency-modulated signals obviating the need for detecting the incoming signals and modulating a relay transmitter.

It is another object of this invention to provide a relay station wherein feed-back between the received and retransmitted signals is substantially eliminated.

Yet another object of this invention is to pro-

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vide a communications instrument which may serve as a receiver, a transmitter or as a relay station.

For a better understanding of the present invention, as well as other objects and features thereof, reference is had to the following description to be read in connection with the accompanying drawing illustrating in block diagram form a preferred embodiment of a relay station in accordance with the invention.

The station comprises a conventional U-H-F frequency modulation receiver 10, preferably of the superheterodyne type and associated with a receiving antenna, a transmitter including an ultra-high-frequency oscillator 11, a mixer stage 12, a driver amplifier 13 and a power amplifier 14, feeding a transmitting radiator, and an automatic frequency control circuit 15.

The signal to be relayed is intercepted by receiver 10 and detected, the audio output signal thereof being fed to a reproducer 16 for monitoring or cuing purposes. The output of the intermediate-frequency stages of receiver 10 is applied to one channel of mixer stage 12, the other channel thereof being associated with ultra-high-frequency oscillator 11. The frequency of oscillator 11 is such that, when heterodyned with the signal yielded by the I-F. stage of receiver 10, the resultant difference beat frequency will fall in the desired relay band. It will be assumed, by way of illustration, that the mean or center frequency of the receiver I-F. stage is 4.3 mc. and that the oscillator 11 is set to operate at 44.3 mc. Hence the difference beat signal derived from the output of mixer 12 will be 40 mc. The 40 mc. frequency-modulated carrier is then applied to the driver amplifier 13 which raises the level thereof to the degree necessary to excite power amplifier 14, the output thereof being fed to the transmitting antenna.

In order to stabilize the operation of oscillator 11 or, if desired, to modulate the transmitter, automatic frequency control circuit 15 is provided comprising a mixer stage 17, an oscillator 18, an amplifier 19, a discriminator 20 and a reactance tube 21. One input channel of mixer 17 is associated with the output of driver amplifier 13, the other channel being connected to oscillator 18, which for the purpose of explanation will be assumed to generate a 30 mc. signal. Oscillator 18 is preferably characterized by a high order of frequency stability. It is evident that the difference beat produced by heterodyning the signal from driver amplifier 13 and oscillator 18 will be an intermediate-frequency of 10 mc.

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The output of mixer 17 is fed to discriminator 20 through amplifier 19 which elevates the signal level to a desired degree. Discriminator 20 develops a D.-C. voltage proportional to the extent that the intermediate-frequency is at variance with the desired value (in this instance 10 mc.), either as a result of the frequency drift of oscillator 11 or of the incoming signal or of the beat oscillator in receiver 10. This D.-C. voltage is used to control reactance tube 21 which is arranged to draw a reactive current having a value dependent upon the control voltage established by discriminator 20.

Reactance tube 21 is shunted across the tuned circuit of oscillator 11 in a manner whereby when the I.-F. applied to the discriminator 20 does not have the desired value there results a control action on the reactance tube 21 which displaces the frequency of oscillator 11 in a direction bringing the intermediate frequency, and hence the radiated frequency, closer to the desired value.

When it is required for cuing or other purposes to originate intelligence at the relaying station, frequency modulation of the transmitter is accomplished by applying the output of a microphone 22 through a suitable audio amplifier 23 to the input of reactance tube 21, thereby effecting a frequency modulation of oscillator 11 in accordance with intelligence. In the absence of an incoming carrier when it is desired to operate the station as a self-sufficient transmitter, an oscillator 24, in this instance generating a 4.3 mc. signal, is fed into one channel of mixer 12 through a single-pole, double-throw switch 25 enabling the operator to select between the I.-F. stage of receiver 10 or oscillator 24.

The various elements of the relay system may be of any conventional design performing the required functions, the invention residing in the new and useful combination of these elements. By retransmitting the incoming signal at a different frequency, feed-back between the transmitter and receiver is minimized. Since with the present invention it is not necessary to detect and remodulate the incoming signal, the employment of a plurality of relay stations is feasible without the introduction of excessive noise and distortion. The automatic frequency control feature is of especial value where a plurality of relay stations are employed in chain fashion, inasmuch as frequency deviation in any link of the chain would upset the proper functioning of the entire system.

While there has been described what is at present considered a preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention.

What is claimed is:

1. The combination in a relay station adapted for relaying a frequency-modulation signal of predetermined wavelength on a different wavelength, comprising a superheterodyne receiver for receiving the incoming wave and converting it to an intermediate frequency, a first high-frequency oscillator, a second high-frequency oscillator tuned to said intermediate frequency, means for mixing selectively either the intermediate-frequency output of said receiver or the output of said second oscillator with the output of said first oscillator to produce a beat signal having a mean frequency at the desired relay

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wavelength, means for amplifying and radiating said beat signal, a reactance tube shunted across the tuned circuit of said first oscillator, means for modulating said reactance tube with intelligence, thereby frequency-modulating said first oscillator, means for developing a direct-current proportional to the displacement of the mean frequency of said beat signal from the desired relay wavelength, and means for applying said direct-current to said reactance tube in a manner whereby a reactive current is drawn effecting a displacement in the operating frequency of said first oscillator to an extent restoring said mean frequency of said beat signal to the desired relay wavelengths.

2. The combination in a relay station adapted for relaying a frequency-modulation signal of predetermined wavelength on a different wavelength, comprising a superheterodyne receiver for receiving the incoming wave and converting it to an intermediate frequency, a signal reproducer associated with the output of said receiver, a first high-frequency oscillator, a second high-frequency oscillator tuned to said intermediate frequency, means for mixing selectively either the intermediate-frequency output of said receiver or the output of said second oscillator with the output of said first oscillator to produce a beat signal having a mean frequency at the desired relay wavelength, means for amplifying and radiating said beat signal, a reactance tube shunted across the tuned circuit of said first oscillator, means for modulating said reactance tube with intelligence thereby frequency-modulating said first oscillator, a discriminator circuit for developing a direct current proportional to the displacement of the mean frequency of said beat signal from the desired relay wavelength, and means for applying the output of said discriminator to said reactance tube in a manner whereby a reactive current is drawn effecting a displacement in the operating frequency of said first oscillator to an extent restoring the mean frequency of said beat signal to the desired relay wavelength.

3. In combination with a receiver for receiving a frequency-modulated carrier wave of predetermined mean frequency, said receiver having means for deriving a sensory presentation of the modulation component of said carrier wave; means for extracting a portion of the energy in a carrier frequency circuit of said receiver, a first high-frequency oscillator, a second high-frequency oscillator tuned to the same frequency as said carrier frequency circuit, means for mixing selectively either said extracted energy or the output of said second oscillator with the output of said first oscillator to produce a beat signal having a mean frequency different from said predetermined mean frequency, means for frequency modulating said first oscillator when the output of said second oscillator is utilized, and means to radiate the beat signal.

4. In combination with a superheterodyne receiver for receiving a frequency-modulated carrier wave of predetermined mean frequency and for converting it to an intermediate-frequency, said receiver having means for deriving a sensory presentation of the modulation component of said wave; means for extracting energy at said intermediate-frequency from said receiver, a first high-frequency oscillator, a second high-frequency oscillator tuned to said intermediate-frequency, means for mixing selectively either said extracted energy or the output of said second

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oscillator with the output of said first oscillator to produce a beat signal having a mean frequency different from said predetermined mean frequency, means for frequency-modulating said first oscillator when the output of said second oscillator is utilized and means to radiate said beat signal.

5. In the combination as set forth in claim 4, means responsive to mean frequency variations in said beat signal for the automatic frequency control of said first oscillator to compensate for said variations.

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