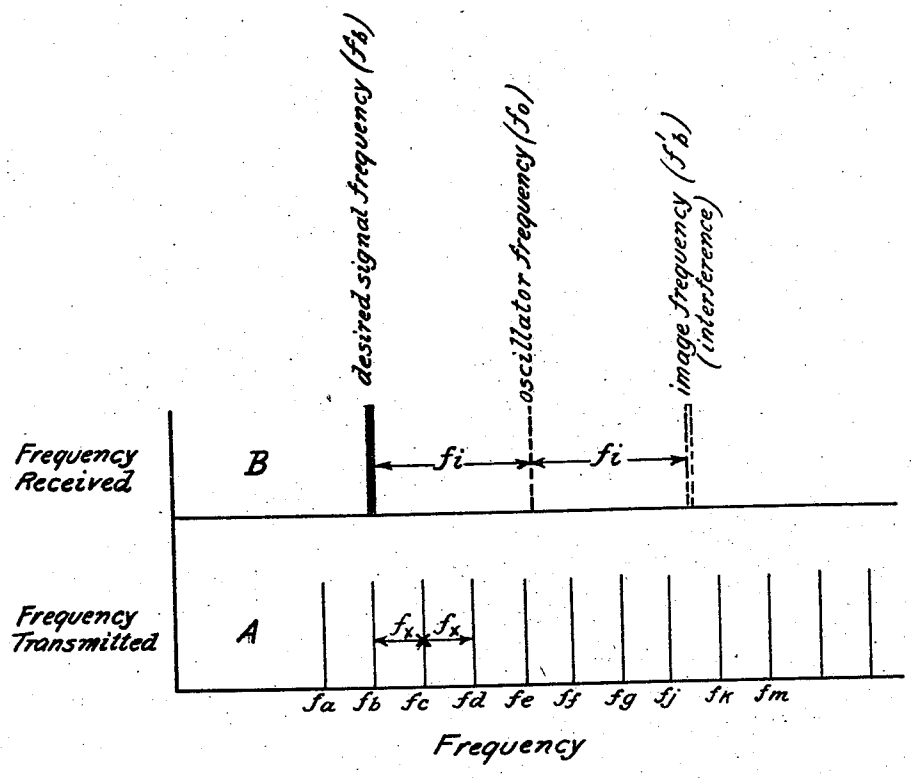
Sept. 20, 1932. H. A. WHEELER 1,878,614

METHOD OF OPERATING SUPERHETERODYNE RECEIVERS

Filed Feb. 24, 1931



INVENTOR
HAROLD A. WHEELER
BY
Dennis, Davis, Mecum & Edmonds,
ATTORNEYS

Patented Sept. 20, 1932 1,878,614

UNITED STATES PATENT OFFICE

HAROLD A. WHEELER, OF GREAT NECK, NEW YORK, ASSIGNOR TO HAZELTINE CORPORATION, A CORPORATION OF DELAWARE

METHOD OF OPERATING SUPERHETERODYNE RECEIVERS

Application filed February 24, 1931. Serial No. 517,742.

The principles of operation of the superheterodyne receiver are well known. The received signal having a certain high radio frequency is applied to a so-called first detector, usually after amplification in a radio-frequency amplifier tuned to the signal frequency. A local oscillator in the receiver, having a frequency slightly different from the signal frequency, is also coupled to the first detector. In this detector a signal is generated having a new frequency which is called the intermediate frequency. This intermediate frequency is equal to the difference between the signal and oscillator frequencies. The oscillator frequency is so chosen relative to the signal frequency that the intermediate frequency has a value above the audible range but substantially lower than the signal frequency. For this reason amplification and a certain amount of selectivity can be accomplished at the intermediate frequency more easily than would be possible at the signal frequency. Therefore an amplifier tuned to the intermediate frequency is connected in the circuit following the first detector. The remainder of the receiver includes the so-called second detector followed by an audio-frequency amplifier which correspond to the detector and audio-frequency amplifier usually employed in any type of receiver for high-frequency signals. While this description applies to a representative superheterodyne receiver it is understood that any number of variations may be employed without departing from the superheterodyne type.

It is also well known that such superheterodyne receivers are responsive to two different carrier frequencies, one of which is equal to the sum of the oscillator and intermediate frequencies and the other of which is equal to the difference between these frequencies. In practice it is customary to select one of these two carrier frequencies by the use of tuned radio-frequency circuits preceding the first detector. In the following description it is assumed that a desired signal is being received on one of these two carrier frequencies and that the tuned radio-frequency circuits preceding the first detector are tuned to this carrier frequency. It is also assumed that it is desired to avoid any interference or interfering effects resulting from signals transmitted upon the other carrier frequency, which will be referred to as the image frequency (this is a logical term because this image frequency and the desired signal frequency are equally distant from the oscillator frequency, one higher and the other lower).

In a broadcast receiver wherein signals must be received over a wide frequency range it is desirable to minimize the number of radio-frequency circuits which must be tuned to the signal frequency. On the other hand it is difficult to secure with a small number of such tuned radio frequency circuits a sufficient amount of discrimination against interfering signals whose frequencies are approximately equal to the image frequency. It is the purpose of this invention to provide a method of operating a superheterodyne receiver, which will under certain conditions reduce the amount of interference from this cause.

It is common practice to allot to broadcast stations in a given section of the country a group of frequencies which are equally spaced 50 kilocycles apart over the broadcast band. The reason for this practice is to minimize interference between different nearby stations, one of which is being received in a broadcast receiver. When a superheterodyne receiver is tuned to the transmitting frequency of one of these nearby stations, the intermediate frequency can be so chosen that the image frequency will lie intermediate the transmitting frequencies of two other nearby stations separated in frequency by 50 kilocycles. In this way the receiver is made responsive to only one nearby station, i. e. the one transmitting at the desired carrier frequency.

The image frequency and the desired carrier frequency are separated by a frequency interval equal to twice the intermediate frequency. If the condition described above is to be realized the difference between the image frequency and the desired signal frequency must be equal also to an odd multiple

of 25 kilocycles which is one-half the frequency separation of the nearby stations in the above example. Therefore the intermediate frequency must equal an odd multiple of 12.5 kilocycles which is one-quarter the frequency separation.

There are other factors which are equally important in the choice of an intermediate frequency but which need not be described in detail. A representative value for the intermediate frequency which would fulfill the above requirements is approximately 312.5 kilocycles. If the desired signal is received on a frequency of 600 kilocycles, for example, the oscillator frequency might be 912.5 kilocycles and the image frequency 1225 kilocycles. According to the preferred practice two other nearby stations would be operating on frequencies of 1200 and 1250 kilocycles respectively. The image frequency would lie midway between 1200 and 1250 kilocycles and the receiver would not be responsive to interference from either of these stations.

The essential elements of this invention are therefore as follows: A number of nearby stations are equally spaced in the broadcast band with a certain frequency separation. The intermediate frequency is chosen to be an odd multiple of one-quarter the frequency separation. It is thereby assured that the image frequency will not correspond to the frequency of an undesired nearby signal. Interference at the image frequency is thereby reduced to minimum.

The single figure illustrates graphically the method here intended. Graph A depicts at f_a, f_b, f_c, etc. the several transmitting frequencies of nearby radio-broadcasting stations. These transmitting frequencies are successively displaced by a constant frequency interval of f_x which in the example given above amounts to 50 kilocycles.

In graph B the heavy line designates the receiver as being tuned to a desired transmitting frequency, in this instance f_b. Designating the oscillator frequency by f_o and the image frequency of f_b by f_b', then in order to ensure that the image frequency of f_b will not coincide with any of the remaining transmitting frequencies f_j, f_k, f_m, etc. the following relation should exist between the frequency spacings:

$$f_i = (2n+1)\frac{f_x}{4}$$

where n is an integral number and f_i is the difference between the selected carrier and the oscillator frequencies. With this condition fulfilled the image frequency f_b' corresponding to the tuned frequency f_b will be situated, as shown in the figure, midway between the transmitting frequencies f_i and f_k of two other broadcast stations, while the oscillator frequency is displaced from the transmitting frequency f_o by the interval

$$\frac{f_x}{4}.$$

What I claim is:

1. The method of operating a superheterodyne receiver to receive any one of a number of stations equally spaced in the frequency spectrum, comprising the choice of an intermediate frequency substantially equal to an odd multiple of one-quarter the frequency separation of successive stations in said spectrum, whereby the image frequency falls midway between two undesired station frequencies when the desired one of said stations is being received.

2. The method of operating a superheterodyne receiver to receive any one of a number of broadcast stations spaced 50 kilocycles apart in the broadcast band, comprising the choice of an intermediate frequency substantially equal to an odd multiple of 12.5 kilocycles, whereby the image frequency falls midway between two undesired station frequencies when the desired one of said broadcast stations is being received.

In testimony whereof I affix my signature.

HAROLD A. WHEELER.