

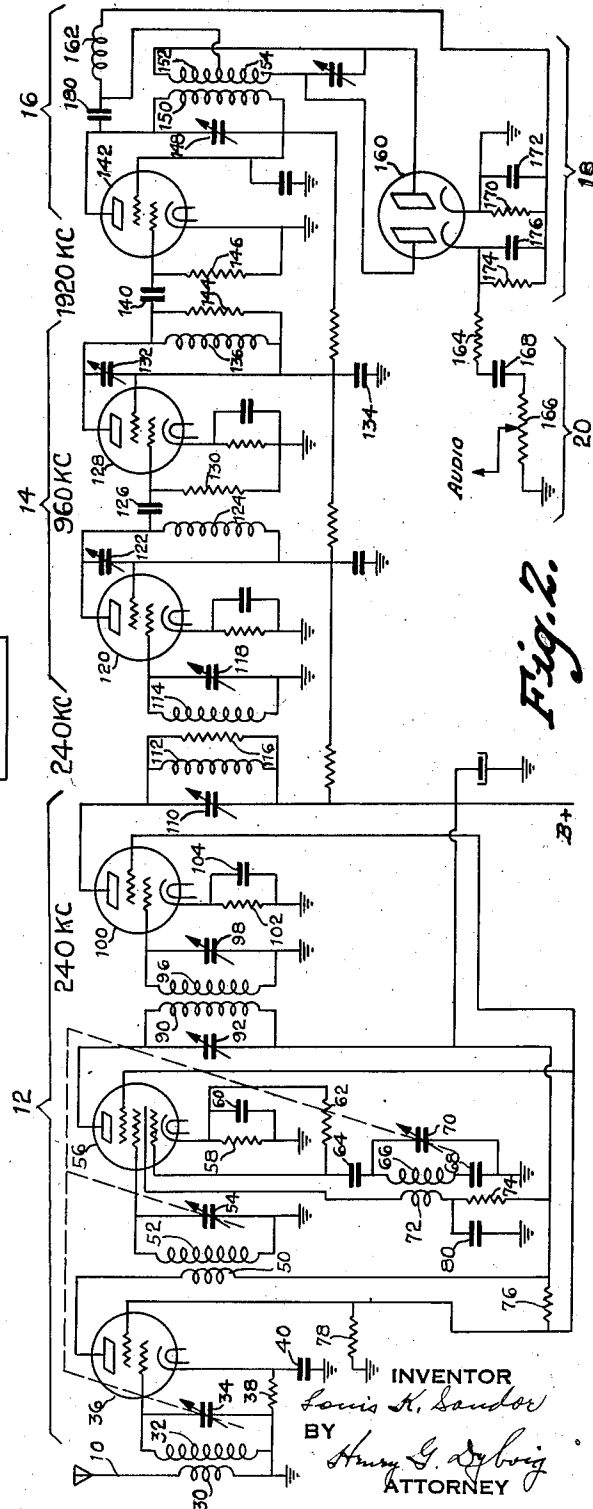
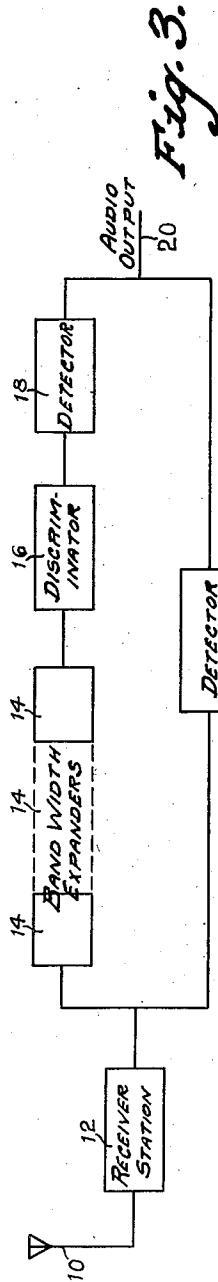
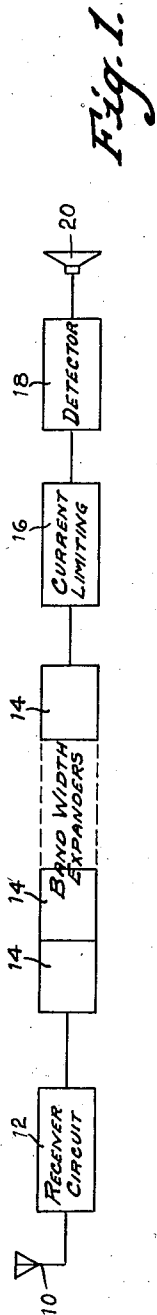
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FREQUENCY MODULATION SYSTEM

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FREQUENCY MODULATION SYSTEM

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5 Claims. (Cl. 250—20)

This invention relates to a frequency modulation broadcasting system and more particularly to a radio receiver for use with frequency modulated broadcasting systems.

In order to produce the wide band width, which virtually is the same as amplitude amplification, it is necessary to expand or multiply the signal a great number of times. These signals are received by radio receivers adapted to discriminate the frequency modulated signal so as to produce an intermediate or audio frequency signal.

An object of the system disclosed herein is to eliminate some of the multiplication of the signal at the broadcasting station and instead, multiply or expand the band width of the signal at the receiving station or in the radio receiver.

Another object of this invention is to provide a radio receiver provided with means for expanding or multiplying the frequency of the incoming signal.

Another object of this invention is to amplify the incoming signal, followed by one or more stages for expanding or multiplying the amplified signal and then passing the expanded signal through a detector circuit.

Another object of this invention is to provide a broadcasting system of modulated frequencies wherein comparatively narrow band widths are transmitted, the band width being broadened or expanded at the radio receiver.

Other objects and advantages reside in the construction of parts, the combination thereof and the mode of operation, as will become more apparent from the following description.

In the drawing, Figure 1 is a schematic showing illustrating the principle incorporated into a radio receiver.

Figure 2 is a wiring diagram of a circuit that has been shown for the purpose of illustration, carrying out the system shown schematically in Figure 1.

Figure 3 discloses another schematic system wherein the same radio receiver may be used for receiving amplitude modulated signals when using one channel and frequency modulated signals when using the other channel.

All successful systems of frequency modulation used up to the present time, so far as known to applicant, have been those which utilize a wide carrier band. The volume or amplitude of the signal is contained in the band width. With a given carrier signal input, the greater the band width, the greater will be the volume output of the detector of the frequency modulation re-

ceiver. Frequency modulation system also has less noise from the tubes of the receiver itself, for the reason that the detector is designed to respond to changes in frequency of constant amplitude and not to changes in amplitude. For example, it has been found that for satisfactory reception, the band width should be equal to five times the highest audio frequency. This width gives a satisfactory ratio of signal to noise level. This wide band width limits the number of broadcasting channels that are available.

If it were possible to transmit frequency modulated signals with a smaller band width without sacrificing the advantages obtained from frequency modulated signals of the broad band width now used, the smaller band width would be very beneficial to our radio broadcasting systems. With that thought in mind, experiments have been conducted to determine the results obtained by using the smaller band width than is now generally used. It has been found that a frequency modulated signal that swings over a band width of ten kilocycles has advantages over amplitude modulated signals, as far as the noise level is concerned. This ten kilocycle band width was received on a conventional frequency modulated receiver, having the output from the modulated receiver amplified, as in the conventional radio receivers now in use. However, instead of receiving the ten kilocycle band width frequency modulated signals on ordinary frequency modulated receivers now in use, it has been found that very satisfactory results have been obtained by passing this ten kilocycle band width frequency modulated signal through a receiver provided with several stages of band expanders or frequency multipliers, such as frequency doublers or frequency quadruplers, connected in series. By this system, the band width is expanded to any desired width, so as to provide satisfactory amplitude in the form of band width for satisfactory detection. For each time that the frequency modulated signal is doubled, the band width is doubled, and consequently, the volume of the detector output is automatically increased proportionately.

This system has been exemplified schematically in Figure 1, where the antenna 10 supplies a signal to a receiver circuit 12, which may include a tuning circuit and one or more stages of radio frequency amplification. It may also include an oscillator detector circuit, having an intermediate frequency output, which may be supplied directly to band expanders or frequency multipliers or

first amplified and then supplied to band expanders or frequency multipliers 14. The number of frequency multipliers is purely a matter of choice, depending upon the desired output. The number of stages of band expanding devices 14 depends in part upon the width of the received band and the desired amplitude of the current output.

Band expanding or frequency multiplication corresponds to amplitude amplification used in conventional radio receivers for receiving an amplitude modulated signal. However, the frequency modulated signal, upon being multiplied, does not suffer from tube distortion and is not affected by tube noises. Furthermore, extraneous disturbances do not have as great a detrimental effect upon frequency multiplication as they do upon amplitude amplification. That being the case, frequency multiplication has substantially all of the advantages of amplitude amplification without the disadvantages caused by extraneous disturbances and defective amplification, tube distortion, tube noises and the like. The signal output from the frequency multipliers or band expanders 14 is supplied to a current limiting device 16 and possibly current filters. This current limiting device is used to energize a detector supplying power to an audio frequency interpreting device 20.

The details of a circuit arrangement shown for the purpose of illustration have been shown in Figure 2, wherein the receiver circuit includes one stage of radio frequency amplification, a detector-oscillator stage having an intermediate frequency output and one stage of intermediate frequency amplification. The multipliers or band expanding devices include a stage of quadruple multiplication, followed by a doubler. If, for example, the intermediate frequency is selected at 240 kilocycles, the resulting output frequency from the doubler stage would be 1920 kilocycles, resulting in expanding the band eight times. The expanded signal is supplied to a current limiting device that energizes the frequency modulated detector circuit having its output connected to an audio signal perceptible device, such as a loud speaker.

The several stages referred to above will now be more fully described. The antenna is connected in series to ground through a primary winding 30 coupled to a resonant circuit including a secondary winding or coil 32 arranged in parallel with a variable condenser 34 used in tuning the circuit to the desired incoming signal. One terminal of the resonant circuit is connected to the grid of the radio frequency amplifying tube 36, which may be of any suitable type, as for example a 6SK7 tube. The cathode is connected through a resistance 38 to the other terminal of the coil 32. A suitable by-pass condenser 40 grounds the circuit.

The anode or plate circuit of the tube 36 contains the primary coil 50 coupled to a resonant circuit including the secondary winding or coil 52, connected in parallel with a variable condenser 54. The output of this resonant circuit is connected to the oscillator-detector tube 56, which may be any suitable tube, as for example, a tube known in the trade as 6A8. The cathode of this tube is connected through a resistance 58 to ground. This resistance 58 is shunted by a by-pass condenser 60. The cathode of the tube 56 is also connected through a resistance 62 to an electrode of the tube 56 and grounded through a condenser 64 connected in series with the reso-

nant circuit including the elements 66, 68 and the variable condenser 70. The oscillating anode of the tube 56 is coupled to the coil 66 through inductance windings 72, connected in series to ground by a series of resistances 74, 76 and 78. A suitable by-pass condenser 80 connects one terminal of the inductance 72 to ground.

The output frequency of the tube 56 is an intermediate frequency. This intermediate frequency may be selected at will. For the purpose of illustration, 240 kilocycles have been used. The anode of the tube 56 is connected to the resonant circuit including the primary winding 90 connected in parallel with a condenser 92. The primary winding 90 is coupled to a resonant circuit including the secondary coil or winding 96 connected in parallel with the adjustable condenser 98. The output of the resonant circuit including the coil 96 and the condenser 98 is connected to the grid of an amplifying tube 100, which may be a 6SK7 tube, for amplifying the intermediate frequency. The cathode of the tube 100 is connected to ground through a suitable resistance 102 connected in parallel with the by-pass condenser 104.

The output circuit of the tube 100 is connected in series with an adjustable condenser 110 connected in parallel with the primary winding or coil 112, coupled to a resonant circuit including the secondary winding or coil 114 and the adjustable condenser 118. A suitable resistance 116 is connected in parallel with the variable condenser 110 and the primary winding 112, so as to broaden the band width of the resonant circuit, as is well known to those skilled in the art. The output of the resonant circuit including the coil 114 and the condenser 118 is connected to a grid of the tube 120 having an output frequency four times the frequency of the original intermediate frequency. Assuming the intermediate frequency is 240 kilocycles, the output of the tube 120 will then have a frequency of 960 kilocycles. The anode circuit is connected to a resonant circuit including the adjustable condenser 122 and the coil 124. The resonant circuit is connected between the anode and the screen grid of the tube 120. Furthermore, the output circuit of this tube 120 is connected through a condenser 126 to the control electrode of a tube 128, which may be of the 6SJ7 type. The control electrode is grounded through a suitable grid leak 130.

The output of the tube 128 has a frequency twice that of the input, that is, 1920 kilocycles. This output is connected through a pair of condensers 132 and 134 to ground. An inductance 136 is connected in parallel with the adjustable condenser 132, so as to form a resonant circuit, connected by a suitable condenser 140 to the current limiting tube 142. This tube may also be of the 6SJ7 type. A suitable resistance 144 is also connected in parallel with the adjustable condenser 132 and the inductance 136, so as to broaden the band width of this circuit. The cathode of the tube 142 is grounded and the control electrode is connected to ground through a suitable grid leak resistance 146. The output of the tube 142 is connected to a resonant circuit including the adjustable condenser 148 and the primary winding or coil 150.

The output of the current limiting tube 142 is supplied to the detector by the coil 150 being inductively coupled to the secondary windings 152 and 154. The terminal of one winding is connected to one anode of the detector tube 160 and the terminal of the other winding is connected to

the other anode of the detector tube 160. This detector tube may be of the type known as 6H6. The center tap of the secondary windings 152 and 154 is connected through a suitable inductance 162 to the circuits of the cathodes of the tube 160. One of these circuits includes the resistance 170 shunted by a by-pass condenser 172. The cathode in this circuit is grounded. The other of these circuits includes the resistance 174 shunted by a by-pass condenser 176. The cathode in this other circuit is grounded through the resistance 164 and variable resistance 166 connected in series with a condenser 168. The resistance 166 is provided with an adjustable tap for supplying audio signal current to any suitable audio perceptible signal device. The inductance 162 is connected by a condenser 180 back to the anode of the tube 142.

Frequency expanding device or frequency expanding stages have been used to describe a system for expanding the band width in a receiver, which in some respects is the equivalent of frequency multipliers in transmitting devices. However, the final signal supplied to the detector need not necessarily be higher than the signal input of the receiver. That being the case, the ultimate signal supplied to the detector may not be as high, and if so, is not a multiple of the signal input into the receiver. Therefore, band width expanding device, or frequency expanding device, has been used herein to designate any suitable device for widening the band width, whether or not the ultimate signal supplied to the detector is a multiple of, lower than or higher than the input signal that is picked up at the antenna.

In the modification disclosed in Figure 3, a dual purpose radio receiver has been shown. When the input signal is a frequency modulated signal, it passes through the upper branch of the circuit through the frequency expanding devices, through the detector to the output. If the incoming signal is an amplitude modulated signal, it is passed through the lower branch of the receiver, which may be a conventional super-heterodyne or a tuned radio frequency receiver, or any other suitable receiver for receiving amplitude modulated signal, amplifying the same and converting this signal either directly or indirectly into an audio perceptible signal through any suitable medium. The upper branch may consist of a circuit similar to that described in connection with Figure 2, or any other circuit for expanding the band widths of the frequency modulated incoming signal. Thus, the same receiver may function as the receiver for frequency modulated incoming signals converted into audio perceptible signals through the band expanding device, or for converting the incoming amplitude modulated signal into an audio perceptible signal through the use of a conventional amplitude modulated signal receiving circuit.

Although the preferred modification of the device has been described, it will be understood that within the purview of this invention various changes may be made in the form, details, proportion and arrangement of parts, the combination thereof and mode of operation, which generally stated consist in a device capable of carrying out the objects set forth, as disclosed and defined in the appended claims.

Having thus described my invention, I claim:

1. A super-heterodyne radio receiver including means for selecting a radio frequency signal, means including an oscillator-detector circuit for

converting the selected signal into an intermediate frequency signal, a selected circuit selected from a pair of parallel circuits, one for expanding the band width of a frequency modulated signal and the other for amplifying an amplitude modulated signal, and means for converting the signal output of the selected circuit into perceptible signals.

2. In a radio receiver for use either with a frequency modulated signal or an amplitude modulated signal, said receiver having a pair of parallel circuits, one for use with a frequency modulated signal and the other for use with the amplitude modulated signal, said radio receiver including a circuit network including a by-pass band filter for selecting a broadcast signal, means including an oscillator-detector circuit for converting the selected signal into an intermediate frequency signal, a circuit selected from a pair of circuits, one for expanding the band width of the frequency modulated signal, the other for amplifying an amplitude modulated signal, and a detector circuit for converting the current output of the selected circuit into perceptible signals.

3. A super-heterodyne radio receiver including means for selecting a radio frequency signal, which signal may be either a frequency modulated signal or an amplitude modulated signal, means including an oscillator-detector circuit for converting the selected signal into an intermediate frequency signal, a selected circuit selected from a pair of parallel circuits, one of which circuits includes means for expanding the band width of the selected signal, and current limiting circuit means having a substantially constant amplitude current output and the other circuit for amplifying an amplitude modulated signal, and means for converting the signal output of the selected circuit into perceptible signals.

4. A super-heterodyne radio receiver including means for selecting a radio frequency signal, which signal may be either a frequency modulated signal or an amplitude modulated signal, said means including a resonant circuit for selecting the signal, means including an oscillator-detector circuit for converting the selected signal into an intermediate frequency signal, a selected circuit selected from a pair of parallel circuits, one of which circuits includes means for expanding the band width of the intermediate frequency signal, current limiting means having a substantially constant amplitude signal current output, and a detector for translating the intermediate frequency expanded band width into perceptible signals.

5. In a radio receiver for use either with a frequency modulated signal or an amplitude modulated signal, said receiver having a pair of parallel circuits, one for use with a frequency modulated signal and the other for use with the amplitude modulated signal, said radio receiver including a circuit network including a by-pass band filter for selecting a broadcast signal, means including an oscillator-detector circuit for converting the selected signal into an intermediate frequency signal, a circuit selected from a pair of circuits, one for expanding the band width of the frequency modulated signal, said one including current limiting means having a substantially constant amplitude signal current output, the other for amplifying an amplitude modulated signal, and a detector circuit for converting the current output of the selected circuit into perceptible signals.

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