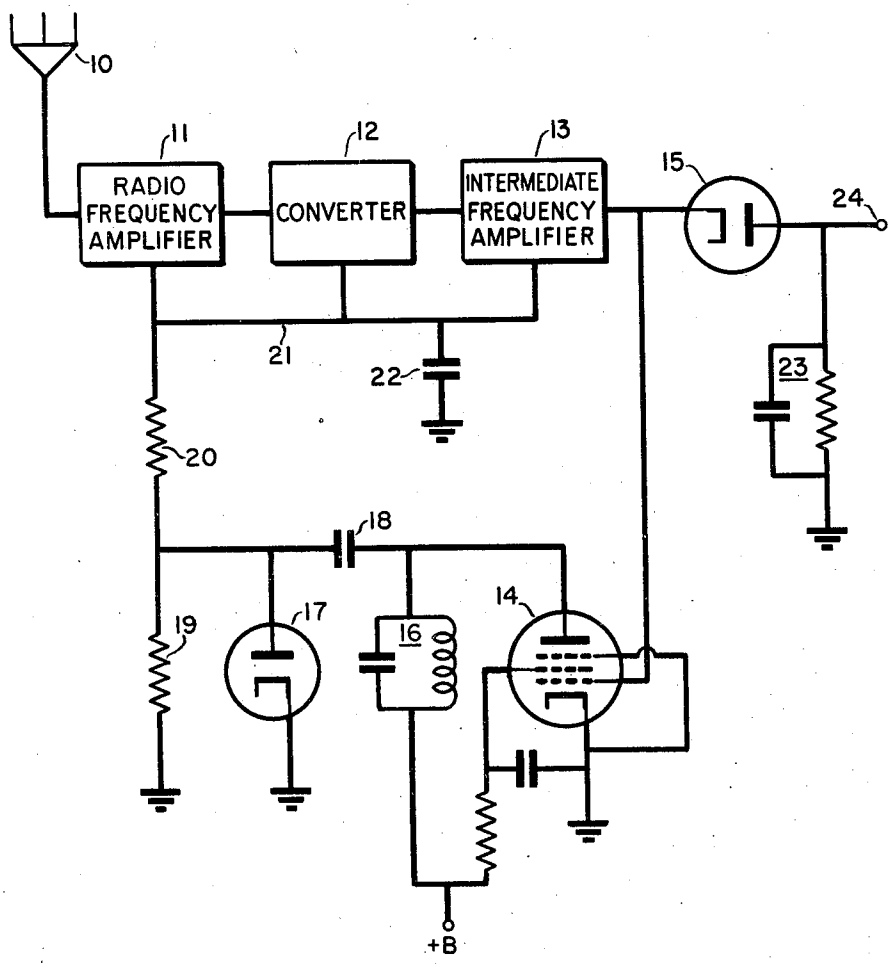
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FREQUENCY AND PHASE MODULATION DETECTOR

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FREQUENCY AND PHASE MODULATION DETECTOR

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11 Claims. (Cl. 250—20)

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This invention is directed to frequency-modulation receivers, and more specifically, it is directed to a novel receiver for the detection of frequency or phase modulated radio signals.

One of the reasons for the wide use of frequency-modulation in radio communication is the fact that it is possible, by the use of amplitude limiters and the like, to eliminate a large proportion of the static and other noise disturbances familiar to all persons who have used the more conventional amplitude-modulation system. One of the features easily incorporated in amplitude-modulation, or AM, systems which is difficult to incorporate in a frequency-modulation, or FM, system, is automatic gain control whereby the gain of the receiver is automatically changed to compensate for variations in the amplitude of the received signals. This automatic gain control, or AVC, is quite desirable in some types of installations, and the use of FM has to some extent been avoided because of this shortcoming.

It is an object of this invention to provide an FM receiver having automatic gain control.

It is a further object of this invention to provide an FM receiver which suppresses amplitude-modulation disturbances without the use of an amplitude limiter.

It is a further object of this invention to eliminate one or more of the shortcomings of the prior art arrangements.

The above and further objects and advantages of this invention are provided by an AM receiver having an AVC characteristic which is proportional to the frequency of the incoming signal.

The above and further objects and novel features will more fully appear from the following detailed description when the same is read in connection with the accompanying drawing wherein there is illustrated a diagram of a receiver in accordance of the instant invention.

Referring now to the drawing, there is illustrated an antenna 10 connected to the input circuit of a radio frequency amplifier 11. The output of the amplifier 11 is connected through a frequency converter 12 to the input circuit of an intermediate frequency amplifier 13 the output of which is connected to the control electrode of a vacuum tube 14 and to the cathode of a second vacuum tube 15.

The anode of the tube 14 is connected to a source of voltage +B through a circuit 16 comprising the parallel combination of an inductor and a condenser, and to the anode of a tube 17 through a condenser 18. The anode of the tube 17 is connected to ground through a resistor 19, and through a resistor 20 to an AVC bus 21. The AVC bus 21 is connected to ground through a condenser 22.

The cathodes of the tubes 14 and 17 are connected to ground. The anode of the tube 15 is connected to ground through a parallel circuit

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23 comprising a resistor and a condenser, and to an output terminal 24.

The amplification or gain of the R. F. amplifier 11, the converter 12, and the I. F. amplifier 13 is controlled by their connection to the AVC bus 21.

In operation an input signal E_i which is either frequency or phase modulated, and which may also be amplitude modulated by noise or the like, is applied to the input circuit of the amplifier 11 from the antenna 10. For convenience we may lump the gain characteristics of the stages preceding the tube 14 as:

$$(1-be)G(f) \tag{1}$$

where e is the AVC control voltage applied from the bus 21, b is the inverse of the control potential required to reduce the amplifier gain to unity, and G is the maximum available gain in the absence of a signal and in the center of the pass band generally described by the function (f). The tube 17 comprises an AVC detector driven from the output circuit 16, through a coupling condenser 18, and the resistor 19 serves as a load resistor for the tube 17 across which the AVC is developed. The resistor 20 and the condenser 22 serve as a filter to provide the AVC circuit the proper time constant.

The output voltage of the slope-detector-AVC-filter combination e is related to the I. F. signal E_0 fed to the cathode of the tube 15 as follows:

$$e=E_0[d+L(\Delta f)] \tag{2}$$

where

E_0=signal potential at the output of the I. F. amplifier.

$d=e/E_0$ at the mean signal frequency.

$L(\Delta f)$=a function of frequency expressive of the influence of the slope circuit 16 on the ratio e/E_0 as the frequency is varied by an increment Δf from the mean.

Where $L(\Delta f)$ is a function of the deviation of the frequency of E_0 from its center frequency.

The output voltage e of the slope detector varies the gain of the stages preceding the tube 14 in accordance with the product of (1) and (2), and the output signal E_0 at the cathode of the tube 15 is

$$E_0=E_i[1-bE_0(d+L(\Delta f))]G(f) \tag{3}$$

when E_i is sufficiently large,

$$bE_i(d+L[\Delta f](G(f)>>1 \tag{4}$$

and therefore

$$E_0\cong\frac{1}{b(d+L[\Delta f])} \tag{5}$$

Equation 5 shows that the voltage applied to the cathode of the tube 15, which may now be identified as a second detector having a load

circuit 23 and an output terminal 24, is an amplitude modulated signal whose modulation envelope may be a linear function of the frequency deviation. By properly choosing $L(\Delta f)$ this condition may be fulfilled, and the use of a conventional AM second detector 15 is justified.

Since E_i, the input voltage, does not appear in Equation 5 it will be manifest that as long as Equation 4 is satisfied, amplitude modulation components of E_i will be rejected.

What is claimed is:

1. A receiver for the reception of an angle modulated signal comprising: means constituting an amplifying channel having substantially uniform transmission characteristics over a band of frequencies including the frequencies of said signal; a frequency selective automatic gain control system having different transmission characteristics at each frequency in said band; means applying the output of said channel to the input of said system; means applying the output of said system to modulate the gain of said channel as a function of the angle modulation of said signal; and an amplitude responsive detector receiving the output of said channel.

2. A receiver for the reception of an angle modulated signal comprising: an amplifier having substantially uniform transmission characteristics over a band of frequencies including the frequencies of said signal; a frequency selective automatic gain control system having incorporated as a transmission path therein a circuit resonant at one of the limits of said band; means applying the output of said amplifier to the input of said system and means applying the output of said system to modulate the gain of said amplifier as a function of the angle modulation of said signal; and an amplitude responsive detector receiving the output of said amplifier.

3. A receiver for the reception of an angle modulated signal comprising: an amplifier having substantially uniform transmission characteristics over a band of frequencies including the frequencies of said signal; a frequency selective automatic gain control system having incorporated as a transmission path therein a circuit resonant outside of, but adjacent to, one of the limits of said band; means applying the output of said amplifier to the input of said system, means applying the output of said system to modulate the gain of said amplifier as a function of the angle modulation of said signal; and an amplitude responsive detector receiving the output of said amplifier.

4. A receiver for the reception of an angle modulated signal comprising: means constituting an amplifying channel having substantially uniform transmission characteristics over a band of frequencies including the frequencies of said signal; an amplifier having an output circuit resonant at a frequency adjacent said band of frequencies; means applying the output of said channel to the input of said amplifier; means for the amplitude detection of the output of said amplifier; means applying the output of said detector to modulate the gain of said channel; and an amplitude responsive detector receiving the output of said channel.

5. A receiver for the reception of an angle modulated signal comprising: means constituting an amplifying channel having substantially uniform transmission characteristics over a band of frequencies including the frequencies of said signal; means varying the gain of said amplifying means as a function of the angle modulation of said signal; and means recovering the envelope of the resulting amplitude modulated signal.

6. A receiver for the reception of an angle modulated signal comprising: means constituting an amplifying channel having substantially uniform transmission characteristics over a band of frequencies including the frequencies of said signal; means varying the gain of said amplifying means as a function of the angle modulation of said signal and inversely with variations of the amplitude of said signal; and means recovering the envelope of the resulting amplitude modulated signal.

7. The method of receiving an angle modulated signal which comprises: submitting the said signal to amplification uniformly over the range of frequencies encompassed thereby; submitting said amplified signal to frequency selective amplification which varies linearly through said range of frequencies; utilizing said frequency selectively amplified signal to modulate the said uniform amplification as a function of the frequency of said signal; and recovering the envelope of the resulting amplitude modulated signal.

8. The method of receiving an angle modulated signal which comprises: submitting the said signal to amplification uniformly over the range of frequencies encompassed thereby; submitting said amplified signal to amplification which varies as a function of the frequency thereof; utilizing the product of said frequency varied amplification to modulate the said uniform amplification; and recovering the envelope of the resulting amplitude modulated signal.

9. The method of receiving an angle modulated signal which comprises: submitting the said signal to amplification uniformly over the range of frequencies encompassed thereby; submitting said amplified signal to frequency detection; applying the product of said frequency detection to modulate the said uniform amplification and recovering the envelope of the resulting amplitude modulated signal.

10. The method of receiving an angle modulated signal which comprises: submitting the said signal to amplification uniformly over the range of frequencies encompassed thereby; recovering from said signal so amplified a voltage varying in amplitude with said angle modulation and varying inversely with amplitude variations of said signal; modulating said uniform amplification with said voltage; and recovering the envelope of the resulting amplitude modulated signal.

11. The method receiving an angle modulated signal which comprises: submitting the said signal to amplification uniformly over the range of frequencies encompassed thereby; submitting said amplified signal to amplification which varies as a function of the frequency thereof; recovering the envelope of the product of said frequency varied amplification; modulating said uniform amplification with said envelope; and recovering the envelope of the resulting amplitude modulated signal.

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Disclaimer

2,483,195.—*Harold Goldberg*, Towson, Md. FREQUENCY AND PHASE MODULATION DETECTOR. Patent dated Sept. 27, 1949. Disclaimer filed June 6, 1951, by the assignee, *Bendix Aviation Corporation.*

Hereby enters this disclaimer to claims 1, 5, 6, 7, 8, 9, 10, and 11 of said patent.

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