Nov. 29, 1938. J. ROBINSON 2,138,746

WIRELESS AND LIKE RECEIVER

Filed Sept. 1, 1934

Fig. 1.

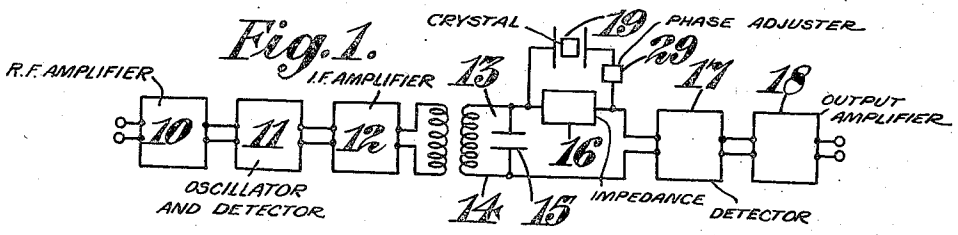


Fig. 2.

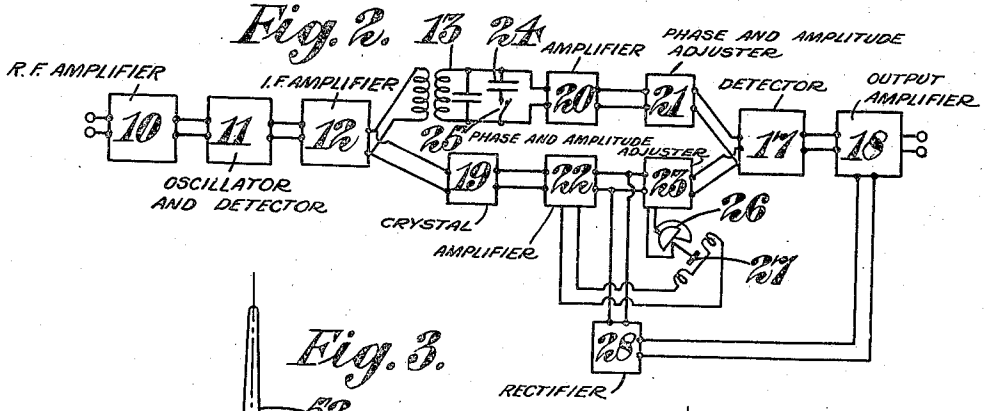


Fig. 3.

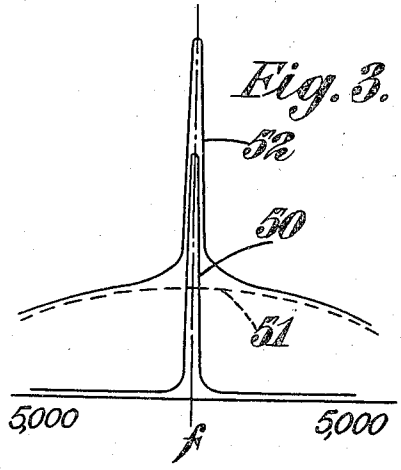


Fig. 4.

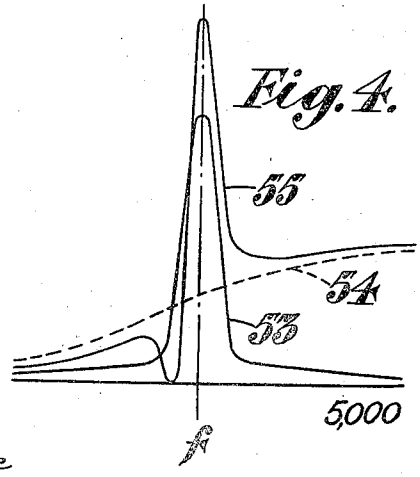
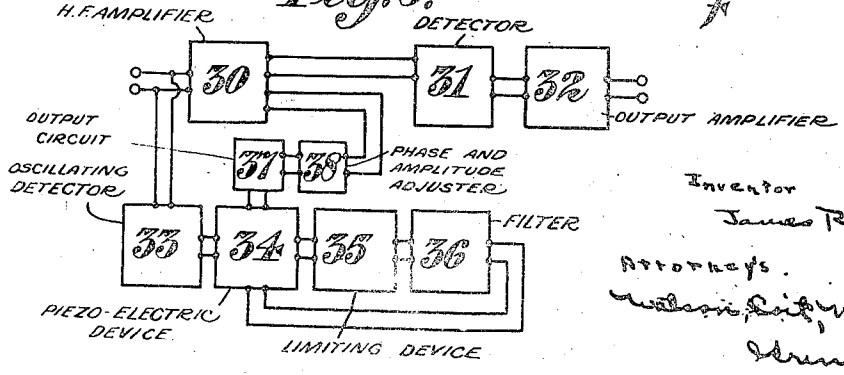


Fig. 6.



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WIRELESS AND LIKE RECEIVER

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In Great Britain September 9, 1933

4 Claims. (Cl. 250—20)

This invention relates to wireless and like receivers for modulated, e. g. interrupted, carrier-wave signals, and one object of the invention is to determine the relationship between the amplitude of the carrier-wave and the amplitude of the side-band frequencies used in the receiver for reproduction of the signals.

In one well-known form of receiving apparatus there is provided a selective system providing a response which is substantially uniform over a band of frequencies which includes the carrier frequency and also the essential side bands of the transmission and providing a low response outside this band in order to minimize interference. Such a receiver is usually referred to as one with "band-pass" selectivity.

In another form of receiver there is employed a resonator of low damping or high selectivity tuned to the carrier frequency of the signals to be received and providing a high response at this frequency as compared with the response at adjacent frequencies including the essential side-band frequencies. In this case additional benefits are obtained as regards overall selectivity by reason of the comparatively high value of the received carrier frequency, although it is necessary to correct the distortion that is obtained of the modulation signals as a result of the high selectivity. Certain different technique is required for this latter type of receiver, for instance, in some cases to provide rather more amplification than with other forms of receivers owing to the small amplitude at which the side band frequencies are received as compared with the amplitude of the response of the carrier frequency.

Another object of the present invention is to provide a receiver in which the advantages of both the forms of receiver mentioned above are obtained. That is to say, it is an object of this invention to provide a receiver by means of which the side-bands are received at such volume that a normal amount of amplification is sufficient for ordinary purposes and at the same time a comparatively large response for the carrier frequency is obtained in order to secure the advantages in the effective selectivity of the apparatus.

The present invention comprises a wireless or like receiver for modulated carrier-wave-transmissions in which there is provided signal-selective means comprising the combination of a resonant device of low damping, such as a piezoelectric crystal tuned to the frequency of the carrier-wave of the signals to be received (or frequency conversions thereof), a comparatively broadly-tuned resonant device for receiving at least one side-band of the signals at substantially uniform amplitude, means for applying the incoming signals to both of these resonant devices, and a rectifier for the signals to which the combined output of the two resonators is applied. The resonant device of low damping provides a response of very large amplitude for the carrier frequency as compared with the response for the side-band frequencies. The broadly-tuned resonant device, on the other hand, provides a larger response for the frequencies of at least one side-band. Thus, by the combination of the outputs of these two resonant devices, any interference is reduced in intensity due to the high amplitude of the carrier frequency and also the wanted modulation frequencies may be reproduced without a high degree of low frequency amplification being necessary. By a resonant device of low damping is meant one having less than normal damping in wireless receivers and including zero or even negative damping.

In one form of the invention the signal output of the resonant device of low damping is provided by a portion of the output of the broadly-tuned resonant device. In another form the incoming signals are fed separately to both of the resonant devices which thus constitute parallel paths for the signals in the receiver.

According to a feature of the invention, means is provided for adjusting the relative phase and/or amplitude of the signals which are combined from the outputs of the two resonant devices. In this manner proper phase relation of the two outputs may be ensured.

In the receiver according to this invention the side-band frequencies of the signals are received mainly by the broadly-tuned resonant device and the carrier-wave component is to a large extent isolated and separately received by the resonant device of low damping. By rotating the phase of the carrier with respect to both side-bands, a variation in the total output may be obtained. Also, in cases where only one side-band is received, the carrier component received by the resonant device of low damping may be more or less opposed to the carrier component received by the broadly-tuned resonant device to control the total volume of the output signals. Thus, by adjusting the phase relation of output of the resonant device of low damping with respect to the output of the broadly-tuned resonant device, a control of the total output of the receiver is obtained and a further feature of this invention consists in providing means to control this phase relationship automatically according to the

strength of the received signals. Furthermore, additional means, such as a limiting device, may be provided for obtaining a more thorough isolation of the carrier component.

Several specific forms of wireless receiver according to the invention are shown by way of examples in the accompanying drawing, in which:—

Figure 1 is a diagrammatical representation of one form of receiver in which the resonant device of low damping is connected to the output of the other resonant device.

Figure 2 is a similar view of another form of receiver in which the resonant devices are separately fed by the incoming signals.

Figures 3 and 4 show resonance curves of typical forms of the receivers shown in Figures 1 and 2, and

Figure 5 diagrammatically represents a further form of receiver with additional means for isolating the carrier component of the signals.

Referring to Figure 1 of the drawing, there is shown diagrammatically a receiver of the superheterodyne type comprising an initial amplifier 10 for the incoming signals, an oscillator and detector 11 for converting the signals to a constant intermediate frequency and an amplifier 12 for the intermediate frequency signals. The intermediate frequency amplifier 12 comprises a circuit 13, comprising an inductance 14 and a capacity 15, broadly tuned to the intermediate frequency of the signals. This broadly-tuned circuit 13 is coupled through an impedance 16 to a detector 17 which is in turn coupled to an output amplifier 18 for the modulation frequency output. Connected in parallel with the impedance 16 there is provided a piezo-electric device 19 which is in tune with the tuned circuit 13. The impedance 16 may comprise a resistance or a condenser or an inductance and in the latter case it may form, with the residual capacity of the piezo-electric device 19, a tuned circuit which may appropriately be used for rejecting a specific frequency other than that of the converted carrier frequency of the signals.

In this receiver the broadly-tuned circuit 13 provides a substantially uniform response for the band of frequencies to be received. The piezo-electric crystal 19 provides a response for the converted carrier-wave of the signal output from the tuned circuit 13 which must be made considerably greater than the response at other frequencies, for instance, by means of independent amplification or different couplings. The combined response of the tuned circuit 13 and the piezo-electric crystal 19 as applied to the detector 17 is thus constituted by a substantially uniform response for the side-band frequencies of the signals together with a considerably greater response for the converted carrier frequency of the signals. Phase-adjusting means, for instance as indicated at 29, may be provided to ensure the appropriate phase relationship between the output of the piezo-electric device 19 and that of the tuned circuit 13 as combined at the detector 17.

In Figure 3 there is shown at 50 the resonance curve of the piezo-electric device 19 tuned to a frequency f corresponding to the carrier-wave of the intermediate frequency signals. At 51 there is indicated the resonance curve of the broadly-tuned circuit 13 and at 52 there is shown the resultant resonance curve of the system showing the large response for side-band frequencies together with the greater response at the intermediate carrier frequency whereby the known beneficial effects for minimizing interference are obtained at the detector 17 of the receiver.

In Figure 2 of the drawing there is also shown a receiver of the super-heterodyne type comprising an initial amplifier 10, an oscillator and detector 11 and an intermediate frequency amplifier 12. This intermediate frequency amplifier comprises a broadly-tuned circuit 13 feeding a detector 17 through an amplifier 20 and if desired a phase and amplitude-adjusting device 21 of known form comprising, for instance, a circuit containing variable inductance, capacity and resistance. Connected in parallel with the devices 13, 20 and 21 there are provided a piezo-electric crystal 19 also feeding the detector 17 through an amplifier 22 and a phase and amplitude adjusting device 23. In this form of receiver the piezo-electric crystal is tuned to the converted or intermediate carrier frequency of the signals and provides an output applied to the detector 17 which is considerably greater at the resonant frequency than at other frequencies. The broadly-tuned resonant device 13 provides a large response for the side-band frequencies which is applied to the detector 17 and combined with the output of the piezo-electric crystal 19.

In the arrangement indicated in Figure 2 the broadly-tuned resonant device 13 may be tuned to the intermediate carrier frequency of the signals as described with reference to Figure 1 in which case the total response is of the form indicated in Figure 3. Alternatively, this broadly-tuned resonant device 13 may be tuned to a frequency displaced from the intermediate carrier frequency, for instance by an amount equal to the highest wanted modulation frequency, for instance, 5000 to 6000 cycles per second for telephony so that this resonant device is responsive mainly to one side-band of the signals. Thus, as shown in Figure 4, the curve 53 represents the response of the piezo-electric device 19, the curve 54 the response of the broadly-tuned circuit 13 and the curve 55 indicates the resultant corresponding to the total signals fed to the detector 17. It will be understood that the resultant curves shown in Figures 3 and 4 are qualitative only to indicate generally the form of the response of receivers according to the invention and that the actual quantitative form will depend upon the phase relationship of the combned signals in each particular case.

In the form of receiver indicated in Figure 2 it is preferable to provide means to change the tuning of the circuit 13 for one or the other side bands of the signals for the purpose of minimizing interference. Thus, the resonant circuit 13 may normally be tuned for the lower side-band and a condenser 24 in series with a switch 25 may be provided in parallel with the circuit 13 for changing the tuning to the other side-band.

It will be understood that the broadly-tuned circuit 13 may be of any form, either a simple circuit as shown or a complex circuit such as a band-pass circuit, the width of the band being such as to include both or only one of the side-bands of the signals. Alternatively, separate tuned circuits may be employed with a switch to introduce either one for operation. When employing a tuned system of the band-pass type for a single side-band, the band-pass range of frequencies may include the frequency of the intermediate carrier-wave or alternatively this frequency may be outside the range of the band-

pass system, especially in circumstances where the modulation of the signals to be received is in the super-sonic range.

By the use of a broadly-tuned resonant device, tuned to a frequency other than the carrier frequency of the signals, the response to the modulation frequencies may be non-uniform and, if desired, means may be provided, for example in the low frequency part of the receiver, for correcting the distortion thus produced.

Referring again to Figure 2 of the drawing, the amplifiers 20 and 22 are provided for separately amplifying the signals passed through the piezo-electric device 19 and the broadly-tuned circuit 13. It is preferable to amplify the output of the piezo-electric device by a higher factor than the amplification of the response of the broadly-tuned circuit 13 in order to provide a maximum amplitude for the former which is considerably greater than that of the broadly-tuned circuit, for example ten times greater.

Referring again to Figure 2 of the drawing, the volume output of the receiver may be controlled by relative adjustment of the phase-controlling devices 21 and 23 since by rotating the phase of the carrier-wave as obtained from the piezo-electric device 19 with respect to the side-bands which are received mainly by the broadly-tuned resonant device 13, a variation in resulting modulation signal strength is obtained. This control by phase variation may be effected automatically by means such as a variable condenser 26 forming part of the phase-controlling means 23 and operated automatically by an electro-magnetic device 27 controlled by a portion of the signal output derived for instance from the amplifier 22 for the output of the piezo-electric crystal.

Alternatively, a portion of the output of the piezo-electric crystal 19 or preferably the output of the following amplifier 22 may be utilized for controlling automatically in the well-known manner the amplification of the receiver according to the volume output by providing a biasing potential for one or more amplifying valves of the receiver.

The output of the piezo-electric crystal or the amplifier 22 may also be utilized in the known manner to suppress the output of the receiver when no carrier-wave signals are being received or when off tune, for example by providing, by means of a rectifier 28, a bias for suppressing operation of a valve or valves of the output amplifier 18 and consequently the output of the receiver when the signals are received are below a minimum value.

It is preferable in cases where the output of the piezo-electric crystal is to be varied as regards phase with respect to the output of the broadly-tuned resonant device for the purpose of volume control to have the output of the piezo-electric device as free as possible of modulation signal components and in such circumstances additional devices may be employed for this purpose.

In Figure 5 there is shown a receiver comprising a high-frequency amplifier 30, a detector 31 and an output amplifier 32. In this case a portion of the input signal energy is applied to an oscillating detector 33 to convert the signals to an intermediate frequency which is constant for a range of incoming signals. The output from this oscillating detector is applied to a piezo-electric device 34 tuned to the intermediate frequency and by reason of the low damping of this piezo-electric device the output therefrom comprises a carrier component which is at a high value compared with the modulation components of the signals. This carrier component is further isolated by means of a limiting device 35 followed by a filter 36 tuned to the intermediate frequency. This isolated carrier of intermediate frequency is fed back to the detector-oscillator which is provided with an output circuit 37 tuned to the original carrier frequency from which there is obtained the carrier component of the original frequency. The carrier component of the signals thus isolated is fed through phase and amplitude adjusting means 38 to a high-frequency circuit of the normal receiver and provides an effect of increased selectivity, as hereinbefore described. Alternatively, the isolated carrier at low frequency may be combined with a portion of the oscillator output, and rectified separately, the resulting output at the original carrier frequency being fed to the receiving circuit.

The phase and amplitude controlling means indicated at 38 is preferably provided for controlling the volume output of the receiver for example automatically according to the input signals as hereinbefore described with reference to Figure 2.

Modification may be made in the specific forms of receiver hereinbefore described. For instance, the outputs of the resonant device of low damping and the broadly-tuned resonant device may be combined either in the assisting sense or in the opposed sense. Further, the impedance 16 in Figure 1 may be constituted by the electrode capacity of the piezo-electric device and in this case any phase adjustment if necessary may be effected by slightly detuning the piezo-electric device.

I claim:—

1. In a wireless or like receiver for modulated carrier-wave signals, signal-selective means comprising the combination of a broadly-tuned resonant device for receiving at least one side-band of the signals at substantially uniform amplitude, means for applying the signals to said broadly-tuned resonant device, means for converting the frequency of the signals to a frequency that is constant for a range of different signals, a resonant device of low damping tuned to the converted frequency of the signals, means for applying the converted signals to said resonant device of low damping, means for reconverting the output of said resonant device of low damping to the original signal frequency, means for combining said converted output with the output of the broadly-tuned resonant device, a rectifier for the signals and means for applying the combined output to the said rectifier.

2. In a wireless or like receiver for modulated carrier-wave transmission, signal-selective means comprising the combination of a broadly-tuned resonant device for receiving at least one side-band of the signals at substantially uniform amplitude, means for applying the incoming signals to said broadly-tuned resonant device, means for converting the frequency of the incoming signals to a frequency which is constant for a range of received signals, a piezo-electric device tuned to said frequency, means for applying said converted signals to said piezo-electric device, limiting means for further isolating the carrier-wave output of the piezo-electric device, means for reconverting the output of said limiting device to the original signal frequency, means for com-

bining said converted output to the output of the broadly-tuned resonant device, a rectifier for the signals and means for applying the combined output of the resonant devices to the said rectifier.

3. In a wireless or like receiver for modulated carrier-wave signals, signal-selective means comprising the combination of a broadly-tuned resonant device for receiving at least one side-band of the signals at substantially uniform amplitude, means for applying the signals to said broadly-tuned resonant device, means for converting the frequency of the signals to a frequency that is constant for a range of different signals, a resonant device of low damping tuned to the converted signal frequency, means for applying the converted signals to said resonant device of low damping, means for reconverting the output of said resonant device of low damping to the original signal frequency, means for adjusting the relative phase of the converted output of the resonant device of low damping and the output of the broadly-tuned resonant device, means for combining said converted output with the output of the broadly-tuned resonant device, a rectifier for the signals and means for applying the combined output to the said rectifier.

4. In a wireless or like receiver for modulated carrier-wave transmission, signal-selective means comprising the combination of a broadly-tuned resonant device for receiving at least one side-band of the signals at substantially uniform amplitude, means for applying the incoming signals to said broadly-tuned resonant device, means for converting the frequency of the incoming signals to a frequency which is constant for a range of received signals, a piezo-electric device tuned to said frequency, means for applying said converted signals to said piezo-electric device, limiting means for further isolating the carrier-wave output of the piezo-electric device, means for reconverting the output of said limiting device to the original signal frequency, means for adjusting the relative phase of the reconverted output and the output of the broadly tuned resonant device, means for combining said reconverted output with the output of the broadly-tuned resonant device, a rectifier for the signals and means for applying the combined output of the resonant devices to the said rectifier.

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