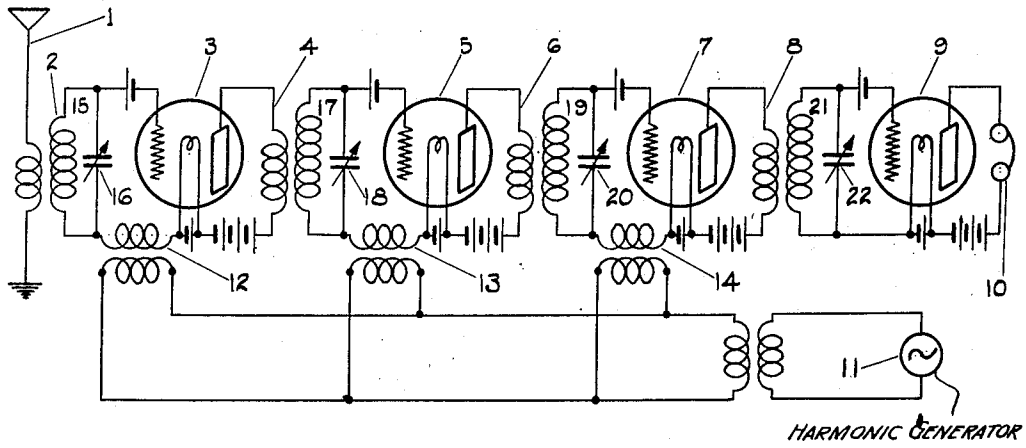
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HETERODYNE RECEIVING SYSTEM

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HETERODYNE RECEIVING SYSTEM.

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This invention relates to a method of and means for receiving radio signals, and more particularly to a heterodyne method of reception in which the principle of successive detection is utilized.

It has been suggested heretofore to employ the heterodyne principle in two or more stages in a receiving system. One of these successive detection systems requires a series of separate oscillators coupled at different points to the receiving circuits. Each oscillator of the series obviously may be and preferably is arranged to supply a frequency differing from that of others in the series, the frequency of any given oscillator being of the order of magnitude of the frequency with which it beats in the receiving circuit.

Another suggested system of the successive detection type comprises, instead of a series of oscillators, a single oscillator arranged to be coupled to the single receiving system at two or more points. Systems of this latter type are open to the objection that the same frequency is supplied for all the successive points at which the oscillator is coupled to the receiving system. Otherwise stated, the oscillator frequency does not vary, preferably in decreasing order of magnitude, as it does from first to last step in the case of the multiple oscillator system above cited, but is fixed at the same value for all frequencies with which it beats in the receiving circuit. The oscillator frequency is, consequently, not of a preferred value for all steps in the successive detection process. For example, an oscillator frequency of the proper value to beat with the receiver circuit frequency at the last heterodyning step in the series will be lower than desired for beating with the incoming signal frequency in the first step of the series.

The object of the present invention is to provide a method of and means for heterodyne reception comprising successive detection whereby a single oscillator supplies the frequencies which beat with the frequencies in the receiving circuits in the successive steps of detection, and, further, whereby the frequency supplied by this single oscillator at each point of coupling to the receiving circuits is of a preferred order of magnitude relative to the frequency with which it beats. As compared with the system heretofore suggested comprising a plurality of separate oscillators, the system herein described permits the employment of a plurality of oscillator frequencies of differing orders of magnitude, but without the complication involved in the provision of a separate oscillator for each stage of detection. As compared with the single oscillator systems above cited, the system herein described retains the simplicity in apparatus and operation inherent in the employment of the single oscillator instead of a series of oscillators, but at the same time permits the employment of a different heterodyning frequency at each stage, thereby avoiding the serious objection involved in the use of the same frequency for all stages of detection.

In accordance with the invention, a single local source of heterodyning frequencies is provided, preferably an oscillator of the vacuum tube type, which is arranged to function as a harmonic generator. The method of the invention consists essentially in combining an incoming radio or other signal frequency in a detector with a harmonic frequency from the local source of heterodyning frequencies, selecting the desired component from the detector in a tuned circuit, combining this component with another harmonic frequency in a second detector, selecting the desired component from the second detector in a second tuned circuit, and repeating this process of detection and selection the desired number of times.

The invention will be clearly understood and further advantages thereof will be made apparent by reference to the following description and to the accompanying drawing, which shows schematically a radio receiving system embodying the invention.

In the drawing, 1 designates a receiving antenna circuit, associated through a transformer 2 with a detector 3. A transformer 4 couples detector 3 to a second detector 5, a transformer 6 couples detector 5 to a third detector 7, and a transformer 8 couples detector 7 to a fourth detector 9. The output circuit of the last detector 9 comprises indicating means as telephones 10.

A local source of heterodyning frequencies, which may be a harmonic generator of any preferred type such as a vacuum tube oscillator, is designated by 11. The harmonic

generator is coupled in any appropriate manner to detectors 3, 5 and 7, as through transformers 12, 13, and 14 respectively which may be associated with the input circuits of the detectors.

The input circuit 15 of the first detector 3 comprises tuning means such as a variable condenser 16 connected in the usual manner with relation to transformer 2. Circuit 15 is linked through detector tube 3 and transformer 4 with the tuned input circuit 17 of the detector 5, the circuit being tuned by variable condenser 18. In like manner circuit 17 is linked through detector tube 5 and transformer 6 with the input circuit 19, tuned by condenser 20, of detector 7, and circuit 19 is linked through tube 7 and transformer 8 with the input circuit 21, tuned by condenser 22, of detector 9.

In operation, a high frequency signal wave such as a speech modulated carrier wave in the antenna circuit 1 is impressed upon input circuit 15 of detector 3. The input circuit is tuned to the incoming radio frequency carrier by variable condenser 16. A locally generated frequency supplied by the harmonic generator 11 is also impressed upon the circuit 15 thru transformer 12. This locally generated wave is a harmonic of the fundamental generated by oscillator 11, and its frequency is preferably of an order of magnitude that of the incoming signal carrier wave. The intermediate frequency which results from combining by detector 3 the incoming radio frequency with the harmonic from oscillator 11 is selected out by the tuned circuit 17. A second locally generated frequency supplied by the harmonic generator is impressed upon the circuit 17 through transformer 13, this second frequency being another harmonic of the fundamental generated by oscillator 11. The second intermediate frequency resulting from combining by detector 5 the first intermediate frequency from detector 3 and the harmonic supplied through transformer 13 is selected out by the tuned circuit 19. This second intermediate frequency is, in like manner, combined with another harmonic through transformer 14, detected by tube 7 and selected out by tuned circuit 21. The third and final intermediate frequency resulting from the combination of the second intermediate frequency with the harmonic supplied through transformer 14 is detected by tube 9 and passed to the indicating means represented by telephones 10.

As an example, a frequency value for the incoming carrier wave may be assumed as 1,000,000 cycles per second, with the fundamental of the harmonic generator 67,500 cycles per second, and the harmonics supplied to circuits 19, 17 and 15 respectively the 2nd, 4th, and 8th harmonics of the fundamental. In this case, the first intermediate frequency to which the selector circuit 17 is tuned, is the difference frequency, 1000000−(8) (67500) or 460000; the second intermediate frequency, to which selector circuit 19 is tuned, is the difference frequency 460000−(4) (67500) or 190000; the third intermediate frequency, to which the selector circuit 21 is tuned, is the difference frequency, 190000−(2) (67500), or 55000. If the incoming carrier frequency changes from 1000000 to a higher value, for example, 1500000, the fundamental frequency of the oscillator may be raised in the same ratio and the 2nd, 4th and 8th harmonics used as before, in which case the intermediate frequencies become 690000, 285000 and 82500 respectively. If, on the other hand, the incoming carrier frequency changes from 1000000 to some lower value, for example, to 600000, the fundamental frequency of the oscillator may be lowered in the same ratio, and the 2nd, 4th and 8th harmonics again used. In this latter case the intermediate frequencies become 276000, 114000, and 33000 respectively. In general it is seen that, in the system herein described as one embodiment of the invention, for a given change in the frequency of the incoming signal carrier, the frequency of the oscillator and also the frequency of each intermediate circuit may be caused to change in the same ratio. As a consequence, the tuning of even several stages as herein illustrated in the successive detection process is easily accomplished by such well known means as variable condensers or other variable elements, either separately calibrated and controlled, or interconnected for simultaneous control.

It is to be understood that the method of heterodyne reception of signals which forms the subject of the present invention is not limited to the specific means described and illustrated. It is obvious that the method is not limited in its application to a specific number of successive detections. It is further obvious that a wide range of harmonics from a single local source of oscillations may be used, and that the intermediate frequencies at any of the successive stages of detection may be the sum frequencies of the two frequencies which are combined, instead of the difference frequencies as in the embodiment described. Amplification means may also be provided between stages of successive detection, or before the first detection, and audio frequency amplification may be provided between the last detector and the indicating means. These and other changes and modifications in embodiments of the invention may be made without departing from the spirit thereof as defined in the appended claims.

What is claimed is:

1. The method of heterodyne reception of a wide range of signal modulated radio car-

rier frequencies which comprises reducing in frequency any given one of said range of carrier frequencies in two or more detection stages, the beating frequencies for said stages being supplied from a local source of variable fundamental and harmonic frequencies, detecting the signal from the last resultant frequency of the series of stages, and repeating such process of successive detection for any or all other received frequencies within the range of received frequencies, the beating frequency from the local source, in each stage of detection, varying in the same ratio that the received frequency varies, the varying of the plurality of beating frequencies which act in the successive stages of detection being effected simultaneously by varying the fundamental frequency of the local source.

2. The method of heterodyne reception of a wide range of signal modulated radio carrier frequencies which comprises reducing in frequency any given one of said range of carrier frequencies in two or more detection stages, the beating frequencies for said stages being supplied from a local source of variable fundamental and harmonic frequencies, detecting the signal from the last resultant frequency of the series of stages, and repeating such process of successive detection for any or all other received frequencies within the range of received frequencies, the beating frequency from the local source, in each stage of detection, varying in the same ratio that the received frequency varies, the varying of the plurality of beating frequencies which act in the successive stages of detection being effected simultaneously by varying the fundamental frequency of the local source, the resultant frequencies, in the successive stages of detection, also varying in the same ratio that the received frequency varies.

3. The method of heterodyne reception of a wide range of signal modulated radio carrier frequencies which comprises reducing in frequency any given one of said range of carrier frequencies in two or more detection stages, the beating frequencies for said stages being supplied from a local source of variable harmonic frequencies, detecting the signal from the last resultant frequency of the series of stages, and repeating such process of successive detection for any or all other received frequencies within the range of received frequencies, the beating harmonic frequency from the local source, in each stage of detection, varying in the same ratio that the received frequency varies, the varying of the plurality of beating harmonics which act in the successive stages of detection being effected simultaneously by varying the frequency of the local source.

4. The method of heterodyne reception of a wide range of signal modulated radio carrier frequencies which comprises reducing in frequency any given one of said range of carrier frequencies in two or more detection stages, the beating frequencies for said stages being supplied from a local source of variable harmonic frequencies, detecting the signal from the last resultant frequency of the series of stages, and repeating such process of successive detection for any or all other received frequencies within the range of received frequencies, the beating harmonic frequency from the local source, in each stage of detection, varying in the same ratio that the received frequency varies, the varying of the plurality of beating harmonics which act in the successive stages of detection being effected simultaneously by varying the frequency of the local source, the resultant frequencies, in the successive stages of detection, also varying in the same ratio that the received frequency varies.

In witness whereof, I have hereunto signed my name.

WILLIAM F. COTTER.