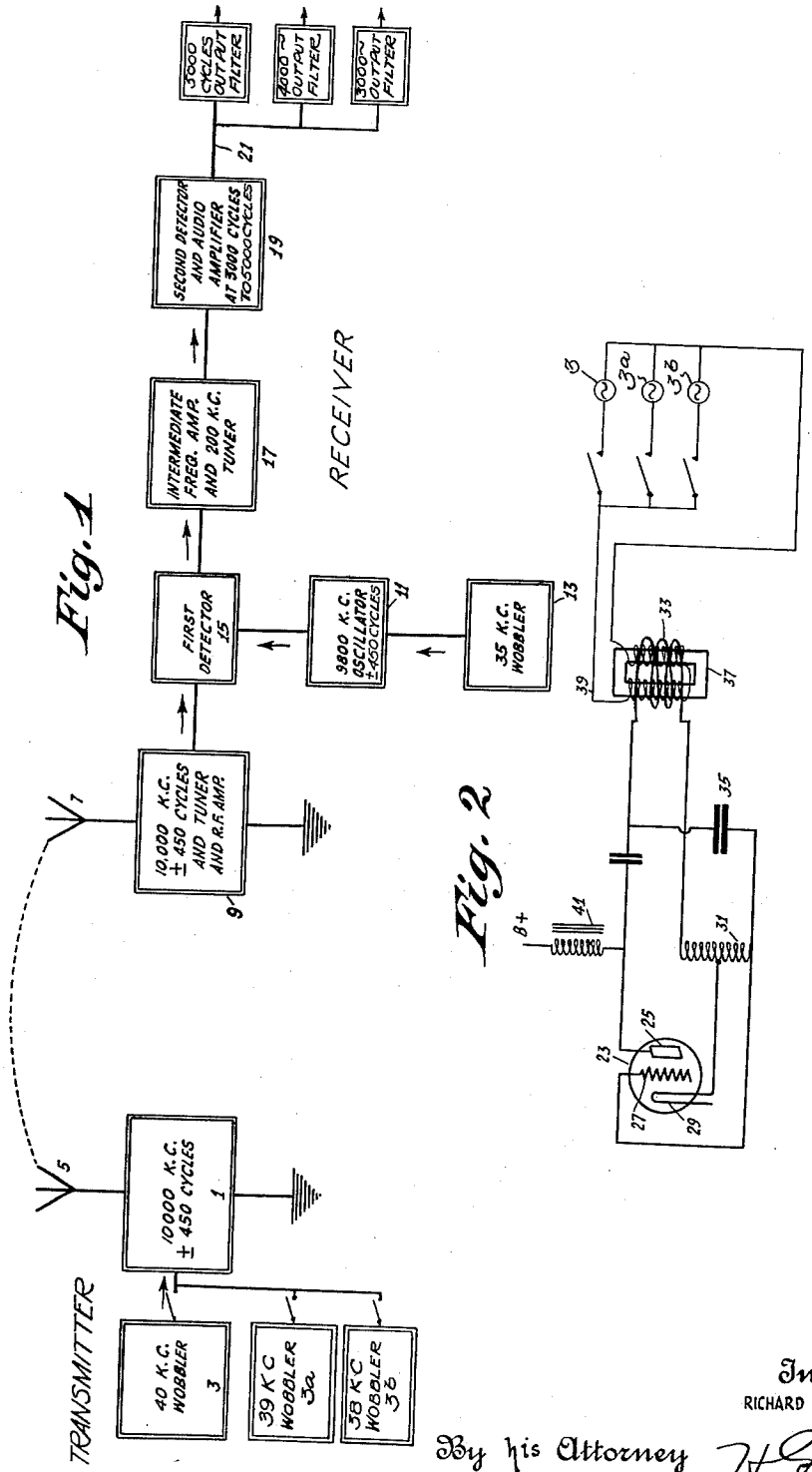
Nov. 3, 1931. R. H. RANGER 1,830,242

WOBBLED FREQUENCY SUPERHETERODYNE SYSTEM

Filed March 22, 1929



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Patented Nov. 3, 1931

1,830,242

UNITED STATES PATENT OFFICE

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WOBBLED FREQUENCY SUPERHETERODYNE SYSTEM

Application filed March 22, 1929. Serial No. 349,075.

The present invention relates to radio transmitting and receiving systems, and is particularly directed to transmitting and receiving systems of the heterodyne type.

Great interest has been taken recently in wobbled frequency transmission systems, and the present invention is particularly directed to the development of a transmitting and receiving system, especially adapted to wobbled frequency transmission, which merely means that the transmission of the radio wave from the transmitting station is continually wobbled back and forth between two limiting frequencies to accomplish the signalling, or, in other words, the wobble is the characteristic upon which the signalling is accomplished.

In telephonic transmission, for example, the frequency may be wobbled between two wave lengths to a greater or lesser extent, and the usual receiver is set or adjusted to one side of the frequency shift so that, as the frequency is wobbled back and forth, the receiver will respond to a greater or a lesser extent as the frequency comes nearer or further from the frequency to which the receiver is set.

A system of this type has been found to have certain drawbacks unless other steps are to be taken, which, for example, may be given by the following statement:

The wobbled frequency does not seem to carry through fading conditions as well as the more usual method of modulation, and this is probably due to the fact that there are less side bands which will carry through on one side or the other of the basic carrier when the other side is out, and another reason is, that a wobbled frequency transmission is not readily adapted to heterodyne reception.

As a principal object of the present invention, I have, therefore, sought to develop a novel method and means by which the use of a wobbled frequency transmission system may be taken advantage of to the fullest extent. so that the system may be readily applicable to heterodyne reception, such as is highly desirable in many instances.

As a further object of my invention, I have sought to develop a method and means by which it is possible to utilize a wobbled frequency transmission system in heterodyne reception in which it is unnecessary to maintain a constant frequency and phase relationship between the local wobbling oscillators of the transmitting and receiving systems.

As a further object of my invention, I have sought to develop a system wherein it is possible to utilize local oscillators in connection with wobbled frequency heterodyne receiving and transmitting systems in which the local oscillators at the transmitter and receiver are spaced apart from each other by any predetermined and desirable values or amounts.

As a still further object of my invention, I have sought to develop a method and means by which the wobbled frequency heterodyne transmitting and receiving system may be readily adapted to multiplex transmission and reception, and in which the local oscillators of the transmitter and receiver may be wobbled back and forth between two limiting frequencies at a number of different rates corresponding to the number of channels included in the multiplex communication system.

As a still further object of my invention, I have sought to develop a wobbled frequency transmission and reception system in which the detrimental effects of fading have been substantially overcome and avoided.

A still further object of my invention is to provide a wobbled frequency transmitting and receiving system which is simple in its construction and arrangement of parts, a system which is compact, easily operated, convenient to install, efficient in its use, substantially fool-proof, and which may be readily arranged and set up by merely making simple changes to the already existing types of heterodyne transmitting and receiving systems.

Still other and ancillary objects of my invention will become apparent to those skilled in the art to which the invention relates by reading the following specification in connection with the accompanying drawings, wherein Fig. 1 thereof illustrates diagram-

matically one form which the invention may assume, and Fig. 2 illustrates a suitable means by which the basic frequency of one oscillator may be wobbled, although it is to be understood that the above named illustrations are merely given by way of example, and that other forms of the invention will at once suggest themselves to those skilled in the art to which the invention has been directed.

For the purpose of more clearly describing my invention, I have chosen to illustrate the same as applicable to certain frequency values which have been found to be especially suited to the purposes and objects of the invention, but it should be borne in mind that other frequency values may readily be substituted for those given by way of illustration, and the invention should therefore be considered as basically covering all frequencies and not restricted to the specific examples illustrated.

Now referring particularly to Fig. 1 of the accompanying drawings, let it be assumed, for example, that a thirty meter wave length, or a ten thousand kilocycle frequency is being used. As shown on the drawings, the transmitter 1 containing a local oscillator generating the ten thousand kilocycle frequency may then be wobbled back and forth from this basic frequency by any suitable and desired amount, for example, by an amount of four hundred and fifty cycles or over a band nine hundred cycles wide. As shown, this wobbling may be produced by means of a forty kilocycle wobbler 3. The wobbled carried may then be transmitted from any desired type of transmitting antenna system 5 and projected or directed out through the ether as any ordinary radio wave.

The wobbled carrier is then picked up by a receiving antenna system 7 of any desired and preferred type located at the receiving point. At the receiver, a normal type of pick-up system has been shown, and this may be tuned, for example, to a frequency of ten thousand kilocycles and provided with one or two stages of radio frequency amplification at this particular frequency, as has been illustrated by the tuning system and amplifying system 9.

For detection, a different form of detector than is customarily used with the usual form of superheterodyne receiving system has been provided. I have arranged this detector 15 in combination with a local oscillator 11 which is wobbled at a slightly different rate than the incoming signal energy, and may be wobbled, for example, by a wobbler 13 at a thirty-five kilocycle rate. For example, let it be supposed that the frequency of the local oscillator 11 has been chosen as nine thousand eight hundred kilocycles, then, if neither the incoming signal energy nor the local oscillator of nine thousand eight hundred kilocycles were wobbled, this would produce, as an output of the detector system 15, a superaudible frequency of two hundred kilocycles, which is equal to the difference between the carrier frequency from the transmitter system and the frequency of the local oscillator. Intermediate tuning of the system in this case would be done at this two hundred kilocycle rate.

However, let us now assume that a wobbling action is to be produced upon the transmitted signal energy by means of the forty kilocycle wobbler 3. The two hundred kilocycle tuning will then be quite sharp and the nine hundred cycles will shift in this wobbled frequency. However, it has been found that the wobbled frequency will still come through. Let it now be supposed, however, that the local oscillator 11 generating a frequency of nine thousand eight hundred kilocycles is made to wobble to an amount equal to the nine hundred cycle shift of the transmitter but at a rate slightly different from the wobble rate of the incoming signal energy, for example, at a rate of thirty-five kilocycles. The local wobble will, therefore, fall in and out of step with the incoming signal energy at a rate of five thousand times a second. When the local wobble is in step with the received wobbled frequency energy, the resultant beat in the intermediate frequency will be steady, or, in other words, two hundred kilocycles exactly, and therefore the intermediate frequency amplifier system 17 has been shown, for the purpose of a concrete illustration, as being set sharply to this two hundred kilocycle tone.

However, when the local oscillator is out of phase with the incoming wobble, the intermediate frequency will be wobbling back and forth at a very high rate, namely, forty kilocycles, and over an eighteen hundred cycle band, and, at this time, the intermediate frequency tuning prevents the intermediate frequency amplifier from picking up energy to any considerable or observable extent, and, at any rate, the pick-up is considerably less than when the two wobblers are in step so that the net result will be that the intermediate frequency will respond most effectively a number of times per second corresponding to the frequency difference in the two wobblers, which was assumed in this case to be five thousand cycles.

The detection of this intermediate frequency takes place in the second detector system 19, which may be of any well known type, and will therefore give a five thousand cycle note to which the output may again be tuned to give the opportunity to gain further selectivity.

The energy at the transmitter may be wobbled at more than one rate by coupling different wobblers to the transmitter, for example, by keying wobblers 3*a* and 3*b* with the transmitter in addition to wobbler 3. These energies will come through the receiver to

give the different rate outputs so that the system may easily be multiplexed. For example, the wobbling rates may be respectively at the rate of forty thousand cycles as above for wobbler 3, thirty-nine thousand cycles for wobbler 3*a* and thirty-eight thousand cycles for wobbler 3*b*, presupposing that there are to be three channels in the multiplex system. Then the final outputs of the second detector system 19, appearing in the output circuit 21, will be respectively five thousand cycles, four thousand cycles, and three thousand cycles, which may then, by the aid of well known and suitably designed filter systems such as filters 23, 23*a* and 23*b* tuned to 5000, 4000, and 3000 cycles respectively, be arranged to filter the independent signals for actuating several output systems.

As a means of wobbling the basic frequency of an oscillator such as, for example, the 10,000 kilocycle oscillator 1 of the transmitter, or the 9,800 kilocycle oscillator 11 of the receiver, one of several methods may be used. For example, a magnetic amplifier circuit such as is used in the Alexanderson alternator equipment, and which is well known in the art, may be used. Such a magnetic amplifier consists of a high frequency winding, and a low frequency control winding, as has been illustrated by Fig. 2 of the accompanying drawings.

By Fig. 2 of the accompanying drawings, the usual type of vacuum tube oscillator 23, having the usual plate, grid and filament members 25, 27 and 29 respectively, may be connected as an oscillator according to the general fashion disclosed by U. S. Patent to Hartley, No. 1,356,763, and in the circuit thereof is included an inductance 31 connected between the plate and grid members of a vacuum tube. The inductance is shunted by a capacity element 35. In such a type oscillator, the filament member of the vacuum tube should be connected to any predetermined and suitable point on the inductance 31 connecting the plate and grid members of the vacuum tube.

As has been shown in connection with Fig. 2 of the drawings, the inductance 31 is divided so that a portion 33 thereof surrounds a magnetic core 37 of a magnetic modulating system. Also carried by the core 37 and wound inside of the winding 33 is preferably arranged a second winding 39 which is differentially wound with respect to the outside winding 33, so that each half of the inner winding has no direct inductive action on the other, but the control winding is capable of saturating the iron core about which both windings are placed, and thus serve to reduce materially the inductance effect in the high frequency winding, which, in the case illustrated, is the winding 33 forming a portion of the oscillator circuit of the oscillator 23.

As has been shown by Fig. 2, plate potential is applied to the plate 25 of the oscillator 23 from a source +B through a choke coil 41 to block high frequency currents from the direct current source. For simplicity of illustration, a source of filament current for the filament 29 has not been shown, although the same may consist of the usual filament battery or alternating current supplied through any desired type of available resistor.

In addition to the method herein shown for wobbling a basic frequency, recourse may be had to a system of the general type disclosed by copending application of Clarence W. Hansell, Serial No. 264,102, filed March 23, 1928, in which two master tuned circuits of different periods are provided, and coupling to each of these two circuits is accomplished in an alternate manner.

On very high frequencies, it is impossible to get a good frequency shift suitable for wobbling the basic carrier by merely changing the plate potential on the oscillator in a cyclical manner so as to periodically wobble the output thereof. Likewise, when using screen grid tubes, the voltage impressed upon the screen grid of the tube may be varied to cause a similar frequency shift.

For the purpose of transmitting simultaneously on two completely different wave lengths so as to promote further effectiveness through fading conditions, a complete duplicate of the operation may be made on two or more separate and independent transmission systems. This means that when a signal is desired to be sent out, the transmitter frequency will be wobbled on each of the separate transmitters by the same wobbler control so that the wobbles will be exac ly in phase. This may easily be accomplished by arranging a single wobbler so as to control simultaneously a plurality of transmitting stations. For receiving purposes, a similar number of receivers will be set up, and similarly to the separate transmitters, the same wobbler is arranged to control the frequency shift of the local oscillators on each of the receivers so that these also will be exactly in phase. The final outputs from each of the receivers will then produce beat notes between the wobblers at the transmitting and receiving stations which will be exactly in phase and may be combined just as they are, and utilized in the manner above disclosed for the single transmitting and receiving systems. As an illustration of the general type of transmitting and receiving systems which may be provided for transmitting and receiving over a plurality of separate and individual communication channels so as to avoid fading effects, reference may herein be made to copending applications filed jointly by Harold H. Beverage and Harold O. Peterson, on March 15th, 1928, as Serial Numbers 261,736, 261,737, 261,738, covering

respectively, a system for combining rectified currents, an antenna switcher system, wherein a plurality of separate antenna systems are cyclically used to energize the same receiver, and a system wherein individual beat notes have been combined. The above named applications have been merely referred to by way of example, and not in a limiting sense, and other modifications will at once suggest themselves to those skilled in the art to which the invention has been directed.

Having now described my invention, what I claim and desire to secure by Letters Patent is the following:

1. In a signalling system, a transmitting station, means for producing a carrier frequency for transmission, and means for independently wobbling the said carrier frequency of the said transmitter between predetermined frequency values at a plurality of different predetermined rates corresponding in number to the independent signals transmitted.

2. In a multiplex communication system, a transmitting station, means for generating a carrier frequency for transmission from said station, means for impressing a plurality of different signals upon said transmitter and modulating said transmitter thereby, and means for wobbling the carrier frequency of said transmitter at a plurality of different rates corresponding in number to the number of different signals impressed upon said transmitter.

3. In a multiplex communication system having the transmitted carrier frequency wobbled at a plurality of different rates corresponding in number to the number of separate signal channels forming the multiplex system, a receiving system, an oscillator at said receiver of a frequency different from the carrier frequency transmitted, means for wobbling said receiver oscillator at a rate different from each wobble rate of the incoming carrier, and a plurality of receivers for receiving signals produced by the heterodyne action of said receiver wobbled frequency and said incoming wobbled frequency energy.

4. A system for transmitting and receiving energy which includes a transmitting station, means for wobbling the carrier frequency of the said transmitter between predetermined frequency values at a predetermined rate, means for receiving the wobbled frequency energy transmitted from said transmitting system, an oscillator at the receiving station of a frequency different from that of the said transmitting station, means for wobbling the frequency of said receiving oscillator at said receiver by an amount equal to the wobble of the said transmitting station and at a rate different from that of said transmitting station, means for producing beat notes of a frequency equal to the difference between the wobble rates of the said local oscillators of the said transmitter and the receiver, and means for utilizing the resultant amplified energy of said beat notes.

5. A system for transmitting and receiving energy which includes a transmitting station, means for wobbling the carrier frequency of the said transmitter between predetermined frequency values at a predetermined rate, means for receiving the wobbled frequency energy transmitted from said transmitting system, an oscillator at the receiving station of a frequency removed from the transmitter carrier by a predetermined amount, means for wobbling the frequency of said receiving oscillator at said receiver by an amount equal to the wobble of the said transmitting station and at a rate different from the wobble rate of said transmitting station, and means for receiving the signals produced by the heterodyning action of said two wobbled frequencies.

6. In a multiplex communication system, the method of heterodyne transmission and reception of radio frequency energy which includes generating a carrier frequency at a transmitting station, wobbling the said carrier over a predetermined frequency band, controlling the rate of wobble of said transmitter carrier at a plurality of predetermined and chosen rates, receiving the wobbled transmitted carrier, generating at the receiver a local frequency different from that of the locally generated carrier of the transmitter, wobbling the locally generated frequency of the receiver over a frequency band equal to that of the wobble of the transmitted carrier, producing from the incoming and locally generated frequencies beat notes of a frequency equal to the difference between the various wobble rates of the transmitter and receiver, amplifying the resultant beat notes, and utilizing the said amplified beat notes for producing indications of a plurality of transmitted signals.

7. The method of heterodyne transmission and reception of radio frequency energy in a multiplex communication system which includes generating a carrier frequency at a transmitting station, wobbling the said carrier over a predetermined frequency band, controlling the rate of wobble of said transmitter carrier at a plurality of predetermined chosen rates, receiving said wobbled transmitted carrier, generating at the receiver a local frequency different from that of the locally generated carrier of the transmitter, wobbling the locally generated frequency of the receiver over a frequency band equal in width to that of the wobble of the transmitted carrier, producing a heterodyne action at the receiver between the received and locally generated wobbled frequency energy, and converting the heterodyne beat notes into a plurality of different signals.

8. The method of heterodyne transmission and reception of radio frequency energy which includes generating a carrier frequency at a transmitting station, wobbling the said carrier over a predetermined frequency band, controlling the rate of wobble of said transmitter carrier at a predetermined chosen rate, receiving said wobbled transmitted carrier, generating at the receiver a local frequency different from the generated carrier of the transmitter, wobbling the locally generated frequency of the receiver over a frequency band equal in width to the wobble of the transmitted carrier, controlling the rate of wobble of the locally generated frequency at the receiver at a rate different from that of the wobble rate of the transmitter, producing beat notes of a frequency equal to the difference between the wobble rates of the transmitter and receiver, amplifying the resultant beat notes, and utilizing the said amplified beat notes for producing indications of the transmitted signal energy.

9. In a multiplex communication system, the method of transmission of radio frequency energy which includes generating a carrier frequency at a transmitting station, wobbling the said carrier over a predetermined frequency band, controlling the rate of wobble of said transmitter carrier at a plurality of predetermined and chosen rates corresponding in number to the number of signals transmitted simultaneously.

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