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CONTINUOUS WAVE SIGNAL RECEIVING SYSTEM

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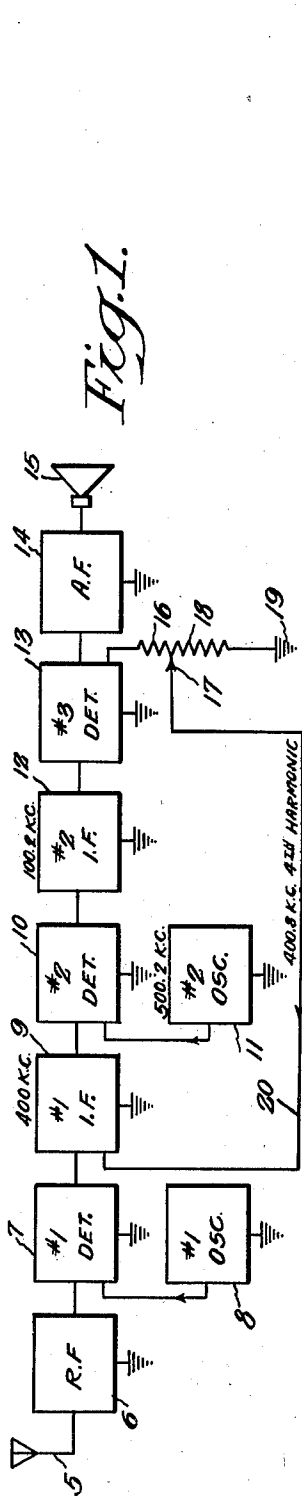


Fig. 1.

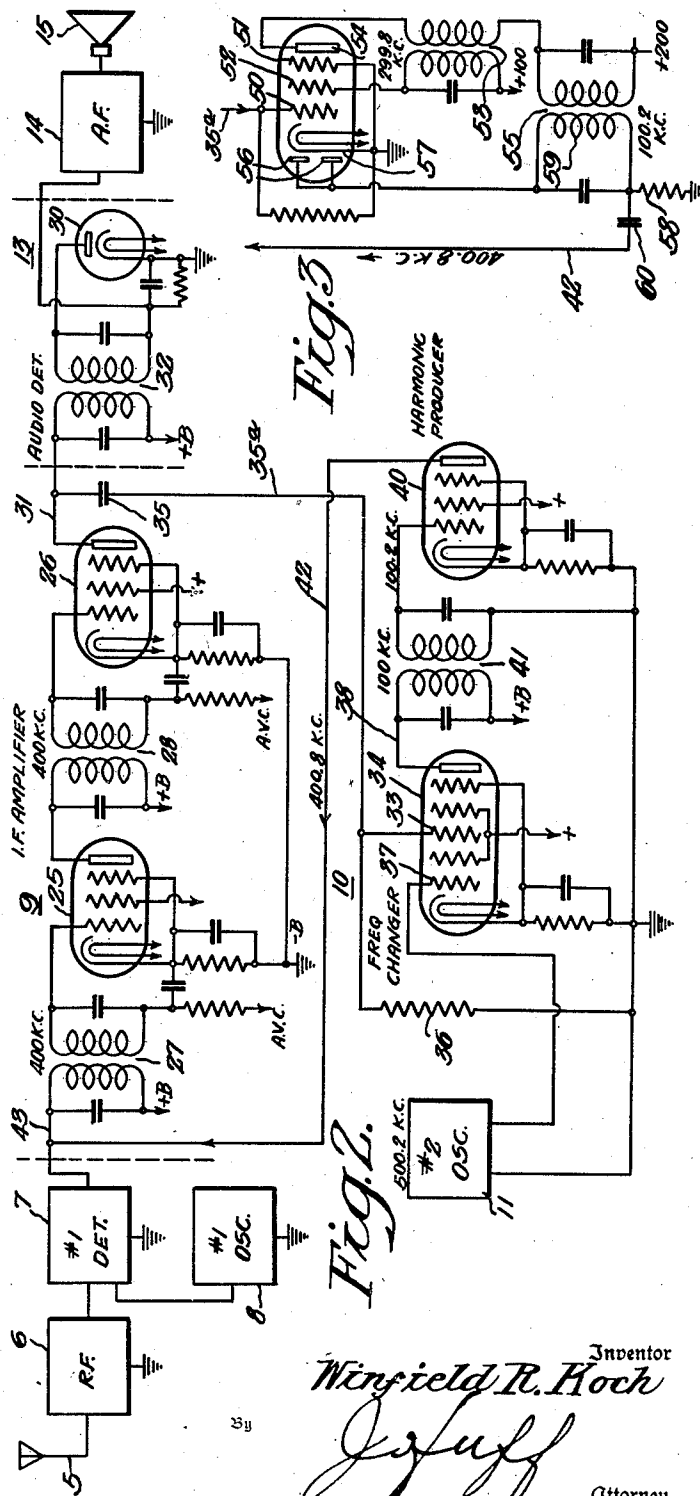


Fig. 2.

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CONTINUOUS WAVE SIGNAL RECEIVING
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8 Claims. (Cl. 250—8)

The present invention relates to a continuous wave signal receiving system and has for its object to provide an improved radio receiving system of that character which permits a wide separation of the signal beat notes from interference beat notes whereby the desired signals may be copied more readily in the presence of interference.

The usual method of producing an audible beat note for copying keyed continuous wave signals is to utilize an oscillator operating at approximately the intermediate frequency and coupled to the intermediate frequency amplifier. This method has several disadvantages, chief of which is the difficulty in preventing the oscillator output from overloading the intermediate frequency amplifier, and the inability of such a system to prevent noise and other interference from being received particularly in the intervals between the dots and dashes of the received signal.

Accordingly, it is a further object of the present invention to provide an improved continuous wave keyed signal receiving system which causes interference and noise to be reduced to a minimum in the interval between signal impulses.

It is also an object of the present invention to provide a keyed continuous wave signal receiving system wherein the signal is caused to heterodyne itself to provide an audible beat note.

The invention will, however, be better understood from the following description when considered in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing, Figure 1 is a block diagram of a continuous wave signal receiving system embodying the invention.

Figure 2 is a modification of the signal receiving system shown in Fig. 1 also embodying the invention and showing certain of the receiving circuits schematically, and

Figure 3 is a further modification of a portion of the circuit of Fig. 2 wherein a single tube is utilized to provide a beat note.

Referring to Fig. 1, a double heterodyne receiving system is shown comprising a signal source such as an antenna 5 which is connected with a radio frequency amplifier 6. The amplified signals from the radio frequency amplifier are applied to a first detector 7 together with signals from a first oscillator 8 to combine in the first detector in a well known manner to provide a desired first intermediate frequency which is amplified in the first intermediate frequency amplifier indicated at 9.

The output of the intermediate frequency amplifier is applied to a second detector or mixer 10 together with signals from a second oscillator 11 and the resulting beat frequency or second intermediate frequency is applied to a second intermediate frequency amplifier 12.

The output of the second intermediate frequency amplifier is applied to a third or audio frequency detector 13 which is coupled with a suitable audible frequency amplifier 14 and a sound producing device or loudspeaker 15, as indicated.

The audio frequency detector is preferably of the type which produces strong harmonics and a harmonic of the second intermediate frequency such as the fourth harmonic, for example, may be derived from the audio frequency detector through a suitable output circuit 16 having a volume control device 17—18 located therein.

In the present example this is of the potentiometer type connected between the output lead 16 and ground or chassis 19 and having a feedback lead 20 connected with the contact 17 and with the input side of the first intermediate frequency amplifier 9.

The first intermediate frequency may be any suitable value which may be a multiple of the second intermediate frequency and the second oscillator frequency is such that signals therefrom may combine with signals at the first intermediate frequency to produce the second intermediate frequency as a sub-multiple of the first intermediate frequency.

The second intermediate frequency is such that a harmonic thereof such as the fourth harmonic, for example, may pass through the tuned circuits of the first intermediate frequency amplifier and, accordingly, the chosen harmonic must lie within the pass band of frequencies of the first intermediate frequency amplifier. In order to eliminate interference, the first intermediate frequency amplifier must be tuned relatively sharply to the selected intermediate frequency.

When a signal is received the harmonic frequency derived from the output circuit 16 of the audio frequency detector or harmonic producer is applied at a proper amplitude as adjusted by the device 17—18 to the first intermediate frequency amplifier and produces a predetermined beat note which is the difference between the harmonic frequency supplied to the first intermediate frequency amplifier and the signal at the desired intermediate frequency. In the absence of signals, there are no beat frequencies produced by noise and hiss because of the absence

of the harmonic frequency and unless an interfering signal is present, the receiving system is silent between signal impulses.

In order to show the effect of interfering signals a specific example may be used and definite frequencies assigned to the circuits as follows:

Assuming that the first intermediate frequency is chosen as 400 kc. and a second intermediate frequency is chosen at 100 kc. being therefore a sub-multiple of the first intermediate frequency, the second oscillator 11 may be tuned to produce a frequency of 500.2 kc. With a desired signal of 400 kc. and an undesired signal of 399 kc. in the first intermediate frequency amplifier 9, the desired signal will be heterodyned to 100.2 kc. which will pass easily through the second intermediate frequency amplifier as readily as the desired signal and will thereby be attenuated to an appreciable degree.

Assuming that the fourth harmonic of the second intermediate frequency is fed back to the first intermediate frequency amplifier through the lead 20, the fourth harmonic of the desired signal will be 400.8 kc. and 404.8 for the undesired interference signal.

These harmonic signals applied to the first intermediate frequency amplifier 9 along with the desired and undesired signals will therefore produce a beat note of .8 kc. or 800 cycles for the desired signal. In the absence of the desired signal, the assumed undesired signal of 399 kc. having the harmonic frequency of 404.8 kc. will combine with the incoming interference signal of 399 kc. to produce a beat note of 5.8 kc. or 5800 cycles. This wide separation of 5000 cycles between beat notes makes the signal much easier to copy than the separation of 1,000 cycles which would be produced by the usual heterodyne oscillator method.

Furthermore, the interference will be relatively weak compared with the desired signal because of the selectivity of the intermediate frequency amplifier circuits which will tend to attenuate substantially fully the harmonic frequency of 404.8 kc. since the first intermediate frequency amplifier is tuned to respond to 400 kc. signals.

In accordance with the invention it will be seen that a superheterodyne receiver for continuous wave signal impulses or signals may be provided with the usual input tuning means including the first detector oscillator and radio frequency amplifier and that the intermediate frequency signal is then passed through a first intermediate frequency amplifier, a second frequency changing means and a second intermediate frequency amplifier from the second intermediate frequency amplifier operating in a sub-multiple of the first intermediate frequency and that the selectivity of the first intermediate frequency amplifier is depended upon to attenuate harmonics of the second intermediate frequency for undesired signals and to pass the harmonic of the desired signal which differs from the said desired signal by a frequency in the audio frequency range to produce a desired beat note. Any beat note which may be derived from the undesired signal is then widely separated from the desired signal in a manner which permits the desired signal to be copied in the presence of the undesired signal and further because the undesired signal is appreciably attenuated.

A single heterodyne receiver may be employed and a second intermediate frequency may be used wholly for producing the beat note, as shown in the modification of Fig. 2. In order that

Figs. 1 and 2 may be compared and in order that the modification may more readily be understood, the tubes shown in connection with the schematic circuits bear the same reference numerals as the corresponding elements in the preceding figure.

Referring to Fig. 2, the antenna 5 supplies signals to the radio frequency amplifier 6 and these are combined in the first detector 7 with oscillations from the local oscillator 8 to provide an intermediate frequency output for the first intermediate frequency amplifier 9 of 400 kc., for example.

In the present example, the intermediate frequency amplifier 9 comprises a pair of amplifier tubes 25 and 26 connected in cascade as the first and second stages of the amplifier by suitable tuned coupling transformers 27 and 28, the latter being interposed between the tubes in the form of being interposed between the first detector and the first stage amplifier tube 25.

The audio frequency detector 13 comprises a diode rectifier device 30 which is coupled to the output circuit 31 of the intermediate frequency amplifier through a suitable tuned intermediate frequency coupling transformer 32 and signals derived from the detector circuit are applied to the audio frequency amplifier 14 and the loudspeaker 15 in the usual manner. The intermediate frequency amplifier output circuit 31 is also coupled to a control grid 33 of a frequency changer tube 34 through a coupling capacitor 35 and lead 35a across a grid resistor 36.

Signals from a second oscillator 11 are also applied to a second control grid 37 in the frequency changer tube 34 and the combined oscillations of each frequency are derived from the output circuit 38 of the frequency changer tube. The frequency changer device 34 is designated generally by the reference numeral 10 to indicate that it corresponds with the second detector or frequency changer of the circuit of Fig. 1 and the output therefrom is passed through an amplifier tube 40 which is suitably biased to produce harmonics. The coupling between the harmonic producer 40 and the frequency changer 10 may be provided by tuned intermediate frequency circuits from which in the present example amplifiers have been omitted for the purpose of simplifying the drawing. In this case the tubes are shown as being coupled by a single intermediate frequency coupling transformer 41 which is tuned to the second intermediate frequency of 100 kc., for example, and the harmonics output from the tube 40 is applied through an output lead 42 to the input circuit 43 of the intermediate frequency amplifier.

Assuming the second oscillator to operate at 500.2 kc. and with an incoming signal of 400 kc., the frequency changer 10 will produce an output signal of 100.2 kc. as before, the fourth harmonic of which is 400.8 kc., and combining in the intermediate frequency amplifier 9 with the incoming signal produces an audio frequency beat in the audio frequency detector 13 of .8 kc. or 800 cycles as in the preceding example.

Since the interference signals must pass through the tuned circuits of the intermediate frequency amplifier and also through the tuned circuit of the beat producing frequency changer and harmonic producer such as provided by the tuned transformer 41 interference signals are appreciably attenuated and their resulting beat notes are widely separated from the desired beat

note produced by the signal as described in connection with Fig. 1.

The circuit of Fig. 2 may be modified as shown in Fig. 3 to provide the harmonics and a combined oscillator and frequency changer for the beat notes in one tube.

Referring to Fig. 3, signals derived through the lead 35a from the first intermediate frequency amplifier are applied to a signal grid 50 of a combined oscillator and rectifier tube 51 and oscillations are applied to a second control grid 52 by feed-back coupling through suitable transformer means 53 connected with the output anode 54. The beat frequency resulting in the output anode circuit or second intermediate frequency is derived from a second coupling means in the anode output circuit provided by a tuned intermediate coupling transformer 55 which supplies the intermediate frequency signals to rectifier anode electrodes 56 associated with the cathode 57 of the device 51 and the harmonic signals are derived from the rectifier across an output resistor 58 connected between the transformer secondary 59 and the cathode 57. The harmonic frequency is then applied to the output lead 42 through a coupling capacitor 60, otherwise the system of Fig. 3 is the same as shown in Fig. 2 and further description is believed to be unnecessary. In this case, however, the oscillator circuit provided by the coupling means 53 may operate at 299.8 kc. instead of 500.2 to produce the same difference frequency of 100.2 kc. with an incoming signal of 400 kc., as before.

From the foregoing description it will be seen that in a system embodying the invention a continuous wave signal is caused to produce its own beat note and that the beat note of interference signals are widely separated therefrom and appreciably attenuated, whereby desired signal impulses or keyed continuous wave signals may more readily be received through interference.

Between signal simpulses the receiving system will be silent unless there is an interfering signal present and this will produce such widely differing tone and amplitude that the desired signal impulses will be clearly distinguishable therefrom.

I claim as my invention:

1. A receiving system for continuous wave signal impulses comprising, in combination, means for producing an intermediate frequency signal in response to received high frequency continuous wave signals, means connected with said first named means for receiving and heterodyning said intermediate frequency signals to produce a second intermediate frequency signal which has a frequency which is slightly different from that of a sub-multiple of the first intermediate frequency signal, means including a detector connected with said second named means for deriving a harmonic of the second intermediate frequency, means providing a signal amplifying channel for said receiving system including an intermediate frequency amplifier tuned to said first intermediate frequency and said harmonic frequency, and means for deriving a beat note from said harmonic frequency and first intermediate frequency signals.

2. In a superheterodyne receiver having an intermediate frequency amplifier and an audio frequency detector connected therewith, said amplifier having circuits tuned to a predetermined intermediate frequency, of frequency changer means for deriving a signal which is slightly different from that of a sub-multiple intermediate frequency signal, said frequency changer means

being coupled to said first named intermediate frequency amplifier to receive signals therefrom, said frequency changer means being coupled with said audio frequency detector to apply signals thereto, means including said audio frequency detector for deriving a harmonic frequency signal from said second intermediate frequency signal within the frequency response range of the first named intermediate frequency amplifier, and means providing a feed-back connection from said detector to said intermediate frequency amplifier for applying said harmonic frequency signal through said intermediate frequency amplifier to the audio frequency detector connected therewith.

3. A superheterodyne receiving system in accordance with claim 2, further characterized by the fact that tuned circuits are provided for the intermediate frequency and second intermediate frequency signals for attenuating accompanying interference signals transmitted therethrough, and that the frequency changer means includes an oscillator tuned to a frequency which is outside the response range of the said tuned circuits.

4. A superheterodyne receiving system in accordance with claim 2, further characterized by the fact that the frequency changer means includes an oscillator circuit, and that the change in frequency, the generation of said oscillations and the production of harmonic frequencies are provided by a single electric discharge device.

5. In a superheterodyne receive having a frequency changer device for received signals to provide a predetermined intermediate frequency signal therefrom and an intermediate frequency amplifier therefor, the combination of a second intermediate frequency amplifier tuned to a frequency which is slightly different from a sub-multiple of the frequency to which the intermediate frequency amplifier is responsive, means interconnecting said first and second intermediate frequency amplifiers for producing a second intermediate frequency for said second intermediate frequency amplifier at said second intermediate frequency in response to received signals, and means connected with the second intermediate frequency amplifier for producing a harmonic of the produced second intermediate frequency and feeding back said harmonic to the first named intermediate frequency amplifier, said last named means including an audio frequency detector of a type which produces strong harmonics and having a harmonic output circuit connected with the first intermediate frequency amplifier for providing said feed back, thereby to produce a beat note between an incoming intermediate frequency signal and said harmonic of the second intermediate frequency in said first intermediate frequency amplifier.

6. The combination with an intermediate frequency amplifier for a radio signal receiving system, and an audio frequency detector connected therewith, of means for applying oscillations to said intermediate frequency amplifier to derive therefrom a second intermediate frequency signal which is slightly different from a sub-multiple of the intermediate frequency to which said amplifier is tuned, means connected with said detector for deriving a harmonic of the second intermediate frequency, and means providing a connection between said last named means and said intermediate frequency amplifier for applying said harmonic signal to the input end of said intermediate frequency amplifier to produce a predetermined beat frequency at the audio fre-

quency detector, said intermediate frequency amplifier comprising tuned circuits responsive to the intermediate frequency and for attenuating interference signals.

- 5 7. The method of receiving continuous wave signal impulses which comprises generating an intermediate frequency signal in response to received signal impulses, heterodyning said intermediate frequency signal to provide an intermediate frequency signal which is at a frequency
10 slightly different from the frequency of a harmonic of the first intermediate frequency signal, deriving a harmonic of said second intermediate frequency signal and applying said first intermediate frequency signal and said harmonic signal
15 to an intermediate frequency amplifying channel and deriving a beat frequency therefrom by detection at the output of said channel.

8. In a superheterodyne receiver, the combination with an intermediate frequency amplifier
20 tuned to respond to signals in a relatively narrow pass band including a predetermined mean

intermediate frequency, of means connected with the output end of said intermediate frequency amplifier for receiving desired and interference signals therefrom, a frequency changer in said receiving means for converting the frequencies
5 of said signals within the pass band of said amplifier to frequencies slightly different from a sub-multiple of the mean intermediate frequency, means connected with said frequency changer for deriving therefrom a harmonic of
10 said converted frequency, means providing a connection between said last named means and the input end of said intermediate frequency amplifier for applying the harmonic of said converted frequency to said amplifier with an in-
15 coming signal, and an audio frequency detector for deriving beat notes from desired and interference signals having a relatively wide frequency difference, said audio frequency detector being coupled to said intermediate frequency
20 amplifier.

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