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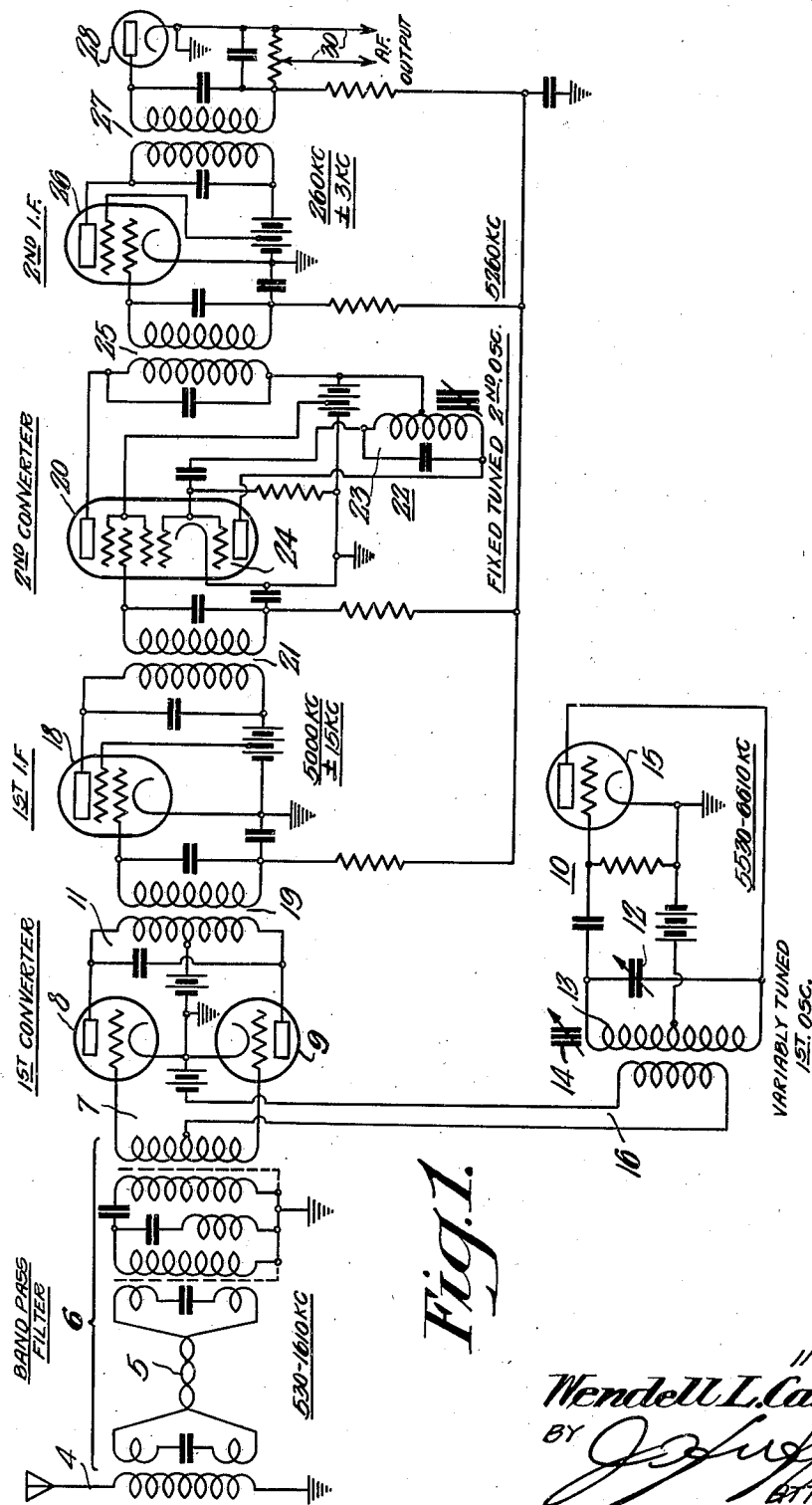
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DOUBLE HETERODYNE SIGNAL RECEIVING SYSTEM

Filed Feb. 29, 1940

2 Sheets-Sheet 1



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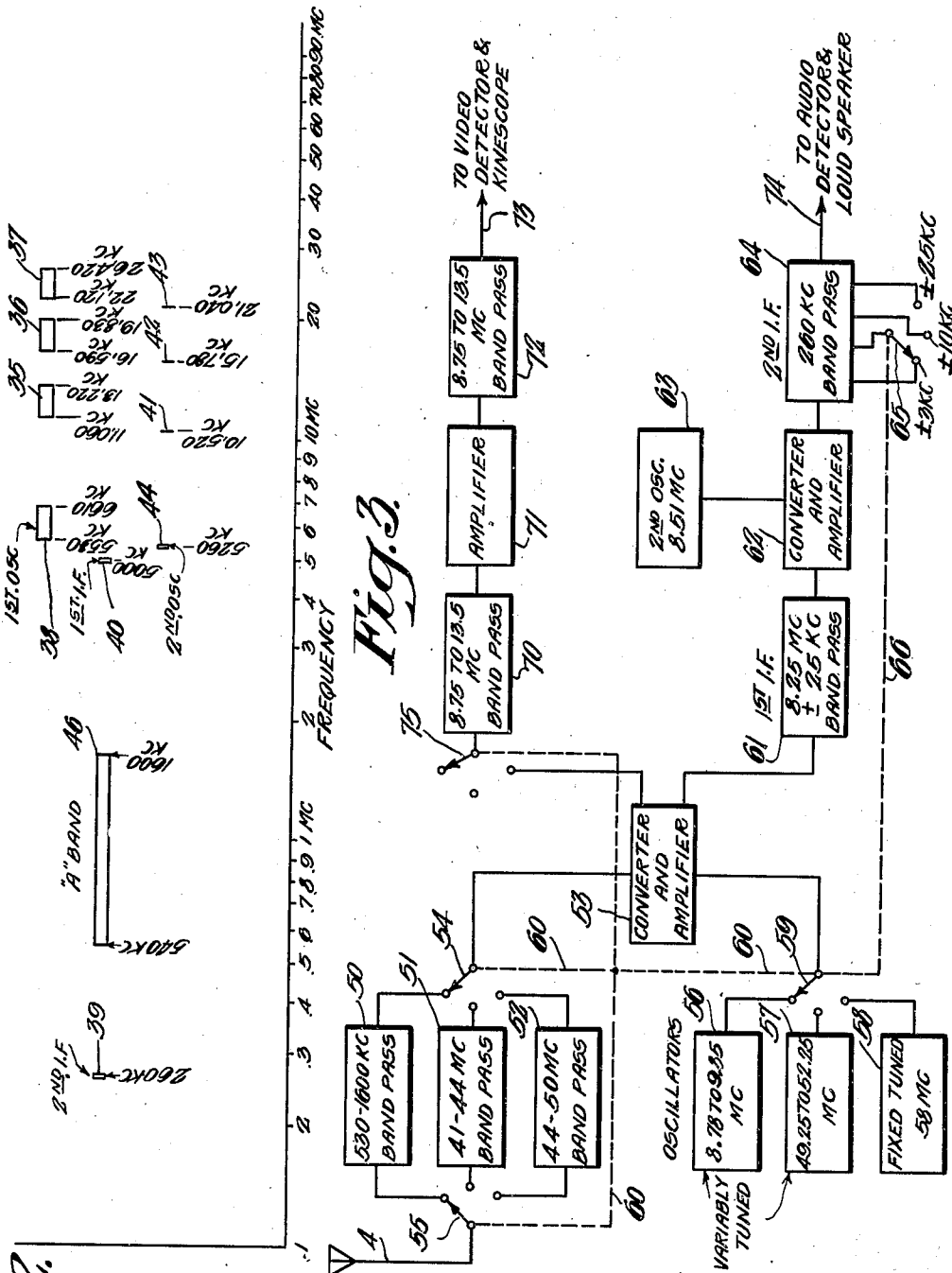
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2 Sheets-Sheet 2



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DOUBLE HETERODYNE SIGNAL RECEIVING SYSTEM

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7 Claims. (Cl. 250—20)

This invention relates to double heterodyne signal receiving systems, and has for its primary object to provide an improved receiving system of the character referred to wherein fundamental and harmonic beat frequency interference from the oscillator frequencies is minimized or prevented without extensive electrical shielding of the various circuits.

It is also an object of the present invention to provide, in a double heterodyne signal receiving system, an improved relation between the operating frequencies of the first and second oscillators and the harmonics thereof with respect to the selected pass bands of the first and second intermediate frequency amplifiers so that a minimum of variably tuned circuits are required to be adjusted when tuning the receiver to different stations.

It is a still further object of the present invention to provide a system of the character referred to wherein the first oscillator may be tuned variably through a frequency range effective to provide a relatively high first intermediate frequency permitting an appreciable drift in the oscillator frequency without introducing distortion or detuning of a received signal. For this purpose, a relatively high first intermediate frequency is preferable, with a wider pass band characteristic than the second intermediate frequency amplifier which operates at a relatively low frequency. The second oscillator tends to correct the effect of the frequency drift of the first oscillator.

It is also a further object of the present invention to provide an improved radio signal receiving system of the double heterodyne type for receiving signals in a plurality of differing input signal bands such, for example, as a standard broadcast band, a high frequency broadcast band, and a television signal also in a high frequency band, and in which the fundamental frequency and harmonics of the oscillators are prevented from introducing interference into the receiving circuits, with minimum electrical shielding.

A further object of the invention is the provision of a double heterodyne signal receiving system wherein a predetermined relation between the oscillator, intermediate and signal frequencies is effected whereby objectionable heterodyne beat frequency signals are largely avoided, and wherein the effect of frequency drift of the oscillators is substantially cancelled.

The invention will be further understood from the following description when considered in

connection with the accompanying drawings, and its scope is pointed out in the appended claims.

In the drawings,

Figure 1 is a schematic circuit diagram of a double heterodyne radio signal receiving system embodying the invention,

Figure 2 is a diagram showing the relation of the signal, oscillator, oscillator harmonics, and intermediate frequencies in the frequency spectrum in which the system operates, and

Figure 3 is a schematic block diagram of a modification of the circuit of Fig. 1 adapted for signalling reception in a plurality of signal bands including television signals.

Referring to Fig. 1, input signals from a suitable source such as a collector or antenna 4 are applied through a tuned filter 6 to the input circuit 7 of a first converter provided by a balanced detector comprising tubes 8 and 9. The input system may include also a low impedance transmission line 5 coupling two parts of the filter 6 remote from each other. The converter may include a pair of triodes as shown, and the circuit arrangement is such that the noise-to-signal ratio and cross-modulation are reduced, while the oscillator voltage applied to the input circuit from an oscillator 10 is prevented from passing through the output circuit 11 of the first detector to the following portions of the receiving system to cause objectionable heterodyne beat signals at the second converter or detector, hereinafter referred to.

The oscillator may be of any suitable type variably tunable as by a variable capacitor 12 or a variable inductance 13 having a movable iron or other suitable core indicated at 14. Likewise, variable push-button tuning may be provided for the oscillator in any suitable and well-known manner, if desired. In the present example, the oscillator is of the Hartley type comprising an oscillator tube 15, the output circuit of which is indicated at 16, connected with the input circuit 7 of the first converter 8—9, as shown.

The output circuit 11 of the first converter is coupled to a first intermediate frequency amplifier comprising a tube 18 through a tuned input transformer 19, and this is followed by a second converter 20 coupled to a tuned output transformer 21 of the first intermediate frequency amplifier. The second converter includes an oscillator 22 having a fixed tuned oscillator circuit 23 and oscillator tube elements 24 included in the present example, in the same envelope with the second converter 20.

The output of the second converter is coupled

through a tuned input transformer 25 to a second intermediate frequency amplifier comprising a tube 26, which in turn is coupled through a tuned output transformer 27 with the second detector 28. The latter may be provided with a suitable output circuit 30 for conveying the modulation output to the usual audio frequency amplifier and loudspeaker device which, for the sake of simplifying the drawings, are not shown.

In one embodiment of the invention employing a circuit in accordance with Fig. 1 for broadcast reception, the input system 4, 5, 6 is tuned to a pass band of substantially 530-1610 kcs. and the oscillator 10 is arranged for variable tuning through a frequency range of 5530-6610 kcs., thereby providing a first intermediate frequency of 5000 kcs., to which the transformers 19 and 21 are tuned. The second oscillator 22 is fixed tuned at 5260 kcs., thereby producing a second intermediate frequency of 260 kcs. to which the transformers 25 and 27 are tuned.

The frequency stability of a high frequency oscillator is ordinarily less than that of an oscillator operating at a lower frequency. However, in accordance with the present invention, the first I. F. circuits pass a wider than normal frequency band and the second oscillator will tend to drift in the same direction as the first oscillator and in the same direction as the resulting first I. F. frequency thereby tending to hold the second I. F. frequency constant. Thus, if the first oscillator frequency tends to drift to a higher frequency, this raises the first I. F. frequency a corresponding amount but will not cause detuning for the reason that the first I. F. circuits are provided with a pass band of the order of 5 to 10 times that of the second I. F. amplifier. The normal tendency of the second oscillator is to drift in the same direction as the first oscillator which is in the direction to hold the second intermediate frequency constant for impressing on the narrow band second I. F. amplifier. In the present example, the first I. F. amplifier may have a pass band of substantially plus and minus 15 kcs., while the second I. F. amplifier may have a pass band of plus or minus 3 kcs.

Referring now to Fig. 2 along with Fig. 1 the relative positions of the various frequencies employed are shown in a frequency spectrum in which the system operates, the scale being drawn to cover the spectrum between 100 kcs. and 90 mcs. It will be noted that the first, second and third harmonic frequencies 35, 36 and 37, of the variable first oscillator frequency 38 do not conflict to produce objectionable I. F. or A. F. beat interference signals at either intermediate frequency, indicated at 39 and 40, such as 260 kcs. and 5000 kcs. or at audio frequencies. Furthermore, the higher order harmonics than indicated are relatively weak and do not cause interference even though their beat frequencies may fall within one of the pass bands.

The second I. F. frequency is chosen preferably to lie below the signal receiving band, as shown. The first and second oscillator frequencies are above the first I. F. frequency. Thus, with the system arranged in this manner, a minimum degree of shielding of the electrical circuits is necessary.

Furthermore, it will be noted that the harmonics of both oscillators are above the signal receiving bands of both the R. F. and first and second I. F. amplifiers, and that the harmonics 41, 42, 43 of the second oscillator frequency 44 fall between the harmonics of the first oscillator.

Among the advantages derived from the system as shown is that no variable input radio frequency selectivity is employed. The circuit largely avoids interference due to image signal frequencies, sum or difference signal frequencies, and signal frequencies at the intermediate frequencies. Furthermore, the first oscillator is required to cover only a 1 to 1.2 frequency range to receive the 540 to 1600 kcs. broadcast band.

The circuit shown in Fig. 1 may be employed for relatively high frequency signal reception as shown, for example, in Fig. 3, to which attention is now directed.

Referring to Fig. 3, the double heterodyne receiving system of Fig. 1 is shown in its application for the reception of signals in a plurality of differing frequency bands, for example, the reception of sound signals on the 530-1600 kcs. band and the 41-44 mc. band, and for the reception of a television channel, both sound and picture signal, at 44-50 mc.

The input circuit comprises three band pass filters 50, 51, and 52 for the R. F. signals in the three receiving bands each of which may be of the type shown in Fig. 1 and precede the first converter 53, to which they are selectively connected by suitable selector switching means 54, the input circuit from the signal source 4 being similarly controlled by selector switch means 55, so that signals from the source may be selected in a predetermined band and applied to the first converter 53.

Three first oscillators indicated at 56, 57 and 58 are likewise provided for the first converter and connected therewith through selector switch means 59 conjointly operable with switch means 54 and 55 as indicated by the dotted connections 60.

It should be understood that the three input band pass filters may, if desired, include amplification and variable tuning and, likewise, the first oscillators, preferably 56 and 57, and variably tunable, as indicated. The third oscillator 58 may be adjusted to a predetermined fixed frequency such as 58 mcs., for the reception of the single television channel.

In the present example, the first intermediate frequency amplifier indicated at 61 is tuned to a slightly higher frequency than in the preceding example and may have a mean pass band frequency of 8.25 mcs., as indicated, the pass band being plus or minus 25 kcs. for the purpose of permitting oscillator drift, as hereinbefore described.

For this intermediate frequency, the variably tunable first oscillator 56 for the broadcast band may tune through a range of 8.73 to 9.85 mcs., while, for the 41-44 mc. receiving range, the oscillator 57 is tunable, as indicated, between 49.25 and 52.25 mcs.

The second converter is indicated at 62 and may include amplification, and is coupled to a second oscillator 63 providing a fixed output frequency of 8.51 mcs. to derive from the first I. F. signal the same 260 kcs. second I. F. signal for the second I. F. amplifier 64 as in the circuit of Fig. 1. The band pass characteristic of the second I. F. amplifier or filter 64 is preferably adjustable with change in wave band as indicated by the selector switch means 65 which is coupled with selector switch means 59, 55 and 54, as indicated by the dotted connection 66, for adjusting the selectivity or pass band characteristic as indicated, in a range of 6 kcs. to 50 kcs. for the three receiving bands shown. It will thus be seen that for receiv-

ing signals in the higher frequency ranges, the selectivity or band pass characteristic of the second I. F. amplifier is changed to more nearly equal the width of the pass band of the first I. F. amplifier for the reason that the wider band is desirable for high fidelity reception in the ultra high frequency broadcast band.

From the first converter 53, the second amplifier channel is provided for the video signal and comprises a band pass filter or amplifier 70 which may be an intermediate frequency amplifier of which the amplifier portion is indicated at 71 followed by a second band pass filter 72 in the output circuit indicated at 73 for the video signal, corresponding to the output circuit 74 for the audio frequency detector and usual amplifying circuits of the usual sound channel. The video channel is controlled by selective switching means 75 conjointly controllable with the switching means previously referred to, to provide a connection with the first converter when the band change switching means is moved to receive signals in the television channel.

I claim as my invention:

1. In a double heterodyne signal receiving system, the combination of band pass signal receiving circuits responsive to signals in a predetermined frequency band, a first converter coupled thereto, a first oscillator for said converter tunable in a predetermined frequency range, a second oscillator tuned to a frequency outside of and relatively close to said first oscillator frequency range, and signal amplifying and converting means including a second converter and a first intermediate frequency amplifier coupled between said converters having a predetermined pass band in a range below the frequencies of said oscillators, said means providing a second intermediate frequency signal of substantially constant frequency in response to drift in the frequencies of said oscillators.

2. In a double heterodyne signal receiving system, the combination of a first converter of the balanced type, a first oscillator coupled thereto and tunable in a predetermined frequency range above said band, a second oscillator tuned above said band to a frequency outside of and relatively close to said first oscillator frequency range, signal amplifying and converting means including a first intermediate frequency amplifier coupled between said converters having a predetermined pass band in a range below the frequencies of said oscillators and above the signal receiving band, providing a second intermediate frequency signal of substantially constant frequency in response to drift in the frequencies of said oscillators, and a second intermediate frequency amplifier for said last-named signal tuned for response thereto in a relatively narrow pass band.

3. In a double heterodyne signal receiving system, the combination of a full wave first converter, a variably tunable first oscillator, a first intermediate frequency amplifier, a second converter and a second intermediate frequency amplifier following said first converter in the order named, a second oscillator coupled to said second converter, means for tuning said first and second oscillators to provide higher oscillation frequencies than the first intermediate frequency and harmonics above the first and second intermediate frequencies, thereby to minimize beat frequency interference, and said tuning means providing oscillator frequencies so spaced

in the frequency spectrum that the harmonics of the second oscillator fall between the harmonics of the first oscillator, thereby further minimizing beat frequency interference in said system.

4. In a double heterodyne signal receiving system, the combination of a first oscillator variably tunable through a frequency range providing a relatively high first intermediate frequency signal, a first intermediate frequency amplifier for said signal having a relatively wide band pass characteristic, a second oscillator, a converter coupled to said second oscillator and to said first intermediate frequency amplifier providing a relatively low second intermediate frequency signal, said second oscillator being tuned to a fixed frequency adjacent to the operating frequency range of the first oscillator whereby, as the oscillator frequencies drift in operation, the second intermediate frequency is held substantially constant, a second intermediate frequency amplifier connected with said converter and having a relatively narrow pass band characteristic, and means for determining the oscillator frequencies such that the lower harmonics thereof fall outside the pass bands of said first and second intermediate frequency amplifiers and the lower harmonics of the second oscillator fall between the lower harmonics of the first oscillator, thereby to provide minimum beat frequency interference with minimum shielding.

5. A multiple channel double heterodyne signal receiving system comprising in combination, a first converter, a first band pass signal channel, a second band pass signal channel, a plurality of band pass filters preceding said first converter, means for selectively applying signals to said converter through each of said band pass channels, means providing a plurality of differing oscillator signals for said first converter, means for selectively applying said signals to said first converter to establish a predetermined intermediate frequency for said first signal channel and for said second signal channel selectively, a second oscillator for said first signal channel and a second converter coupled thereto and operative at a predetermined frequency to provide a relatively low second intermediate frequency, and means coupled to said second converter providing an adjustable band pass filter for said second intermediate frequency, the operating frequencies of said oscillator means being higher than the first intermediate frequency and such that the lower harmonics thereof fall outside the pass bands of said first and second signal channels, and the harmonics of the second oscillator fall between the lower harmonics of the first-named oscillators.

6. In a multiple channel double heterodyne signal receiving system, the combination of a plurality of selectable band pass input filters, and a plurality of selectable tuned oscillators, said oscillators having operating frequencies above the pass bands of the respective band pass filters, a first converter selectively connected with said oscillators and band pass filters to provide relatively high intermediate frequency signals, band pass filter means for said signals, and means for converting said intermediate first signal to a relatively low intermediate frequency below the bands of said band pass input filters.

7. In a double heterodyne signal receiving system, the combination of means providing a band pass signal input circuit, a band pass first intermediate frequency amplifier, a band pass sec-

ond intermediate frequency amplifier, a variably tunable first oscillator, the first oscillator being tunable through a frequency range providing a relatively high first intermediate frequency and a second oscillator tuned to provide a relatively low second intermediate frequency, and means

for controlling the frequency of both oscillators such that the harmonics thereof are outside of the frequency ranges established for the signal and intermediate frequencies, whereby interference beat frequencies are minimized.

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