

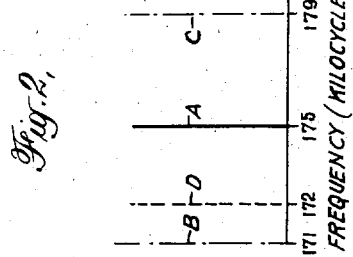
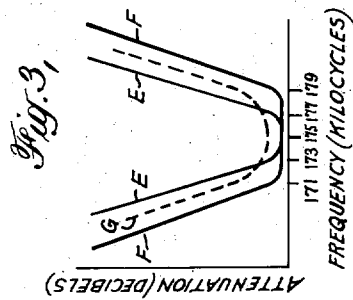
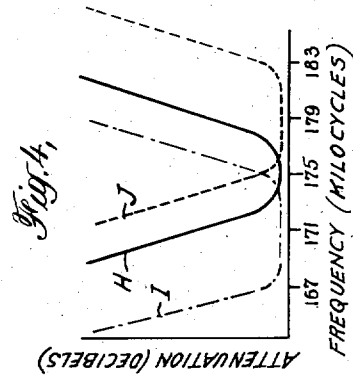
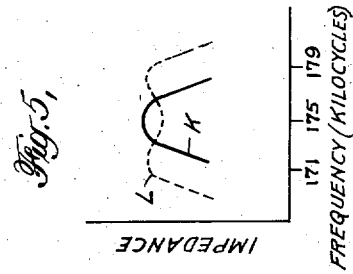
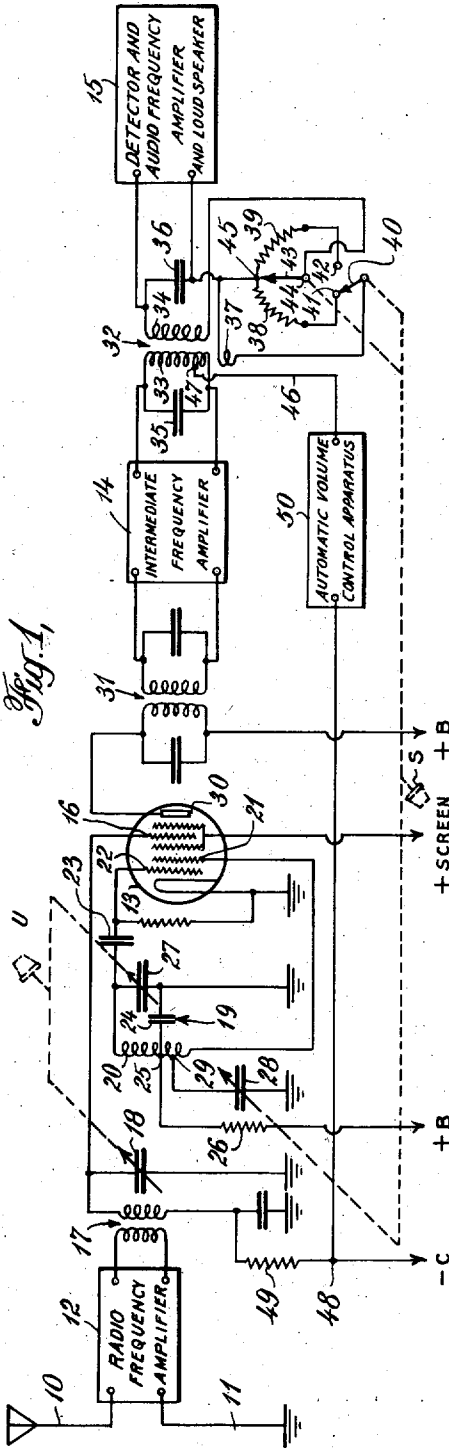
March 9, 1937.

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2,073,344

SUPERHETERODYNE RECEIVER

Filed May 22, 1934



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2,073,344

SUPERHETERODYNE RECEIVER

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Application May 22, 1934, Serial No. 726,931

14 Claims. (Cl. 250—20)

This invention relates to the reception and selection of modulated carrier signals, and has for its principal objects to facilitate the selection of such signals and to improve the fidelity of reception thereof.

A radio broadcast signal is ordinarily transmitted on a carrier wave having two sidebands of modulation frequencies, which are of about 6 kilocycles in width on either side of the carrier. Under present broadcasting conditions, the different carrier frequencies are allocated at various positions throughout the broadcast range, usually 10 kilocycles apart, and in many instances the sideband frequencies of one signal channel either overlap those of an adjacent signal channel or else closely encroach upon them. In either case, it is difficult, when tuning a radio broadcast receiver to a desired signal in one such channel, to eliminate interference due to signals in the adjacent channels, particularly when such interfering signals are received with a strength comparable to that of the desired signal.

Operation without interference in such cases ordinarily requires that the selecting system shall pass a considerably narrowed band of frequencies so that passage of the interfering signals is substantially prevented. Narrowing the selected band in this manner ordinarily impairs the fidelity of reception of the signals, since the sideband frequencies corresponding to the higher audio frequencies of modulation are suppressed.

It is well known that in the operation of superheterodyne receivers, there is produced an intermediate carrier frequency which is equal to the difference between the signal carrier frequency and the local oscillator frequency. This intermediate, or difference, frequency is ordinarily maintained constant over the tuning range of the signals by operating the signal selecting circuits and the oscillator frequency-determining circuit by a uni-control device to maintain the constant difference. The two sidebands of modulation which extend on either side of the signal carrier frequency likewise extend on either side of the intermediate carrier frequency. It is the usual practice in the case of superheterodyne receivers to locate the principal band width determining circuits in the intermediate frequency portion. Hence, the narrowed band width mentioned above is passed by a highly selective intermediate frequency selective system.

According to one of the features of this invention, it is proposed to improve the fidelity of reception and yet maintain the narrowed band selective characteristic of the selective circuits.

This is accomplished in accordance with this invention by utilizing in a superheterodyne type of receiver a local oscillator system provided with means for shifting the oscillator frequency relative to the signal frequency.

A particular feature is the association of a variable reactive element with the frequency-determining circuit of the oscillator in such a manner that equal movements of the reactive element produce substantially equal shifts in oscillator frequency for all frequencies of the tuning range.

When the local oscillator frequency is shifted relative to the signal frequency, as explained above, the intermediate carrier frequency is also altered by a like amount. Since the band selected by the intermediate-frequency selecting system remains fixed, this shifting of the intermediate carrier frequency results in further "cutting out" the extreme frequencies of one sideband and of simultaneously admitting more of the extreme frequencies of the other sideband. Finally, when the intermediate carrier frequency is shifted all the way to one extreme or the other of the selected band, only a single sideband is passed, this having a width equal to the entire selected band width. The direction in which the intermediate carrier frequency should be shifted to produce the greatest freedom from interfering signals is in the direction away from such interfering signal.

According to another feature of this invention, there is provided a selective system which is adjustable to pass any band width between a moderately selective width and a more highly selective width. The adjustable feature is provided by varying the coupling between a pair of coupled tuned circuits, and simultaneously varying the resistance introduced into at least one of these tuned circuits. Since a change of resistance in a tuned circuit also changes the gain, or transmission efficiency, the varying coupling is arranged to automatically maintain the transmission efficiency substantially constant while the resistance is being changed.

Another feature of the invention resides in a cooperation between the two foregoing features, in accordance with which means is provided for simultaneously shifting the local oscillator frequency and varying the selectivity of the tuned selecting system.

Fig. 1 illustrates a superheterodyne radio receiver embodying all the features of this invention;

Fig. 2 shows graphically how the local oscillator

frequency is shifted according to the invention; Fig. 3 illustrates graphically the expansion of the band selected by a tuned coupling system according to the invention;

Fig. 4 illustrates graphically the combined effect of shifting the local oscillator frequency and of expanding the band selected by a tuned coupling system; and

Fig. 5 shows the impedance variation of one of the circuits of the tuned coupling system in passing to the expanded condition.

Fig. 1 illustrates a superheterodyne receiver comprising in tandem in the order named: an antenna 10 and ground 11; a radio-frequency amplifier 12; an oscillator-modulator tube 13; an intermediate-frequency amplifier 14; and a detector and audio-frequency amplifier, and loud-speaker 15. The devices 12, 14, and 15 are indicated only in generalized block form since they constitute no part of this invention.

The oscillator-modulator tube 13 is of the hexode type and may take the form disclosed in the copending application of Harold A. Wheeler, Serial No. 654,327, filed January 30, 1933, Patent No. 2,015,327, September 24, 1935. The tube contains a signal input grid 16 coupled to the radio-frequency amplifier 12 through a radio-frequency transformer 17, the secondary coil of which is tunable to signal channels of the broadcast range by a variable condenser 18.

There is associated with tube 13 a local oscillator system 19 which includes a coil 20 connected from an inner screen 21 to an inner grid 22 through a condenser 23. A condenser 24 is connected between ground and an intermediate point 25 of the coil. A source of positive operating voltage, designated +B, is connected through a resistor 26 to the point 25 for supplying a proper direct voltage to the screen 21. A variable condenser 27 is connected between ground and the upper end of coil 20. The condensers 24 and 27 and the portion of coil 20 above point 25 constitute a resonant circuit which determines the frequency of the oscillatory system, this oscillator frequency being variable by means of condenser 27. The oscillator-modulator circuit just described is similar to those which are more fully described in the copending application of Harold A. Wheeler, Serial No. 654,326, filed January 30, 1933, Patent No. 1,958,027, May 8, 1934.

In accordance with a feature of this invention, there is connected a relatively small variable condenser 28 between ground and a second intermediate point 29 of the coil 20 which is outside the resonant frequency-determining circuit. By reason of its connection to ground, condenser 28 is connected across condenser 24 and a portion of coil 20 which is outside the resonant circuit. The function and operation of condenser 28 will be more fully explained subsequently.

Modulation occurs between the received signal frequency impressed on grid 16 and the local oscillator frequency in a manner which is fully described in the above-mentioned application, Serial No. 654,326, Patent No. 1,958,027, May 8, 1934. The products of modulation at the circuit of anode 30 include the intermediate-frequency band which is the difference between the local oscillator frequency and the frequencies of the received signal channel. For the purpose of maintaining a constant frequency difference and therefore a constant intermediate carrier frequency, the variable condensers 18 and 27 are ganged together for simultaneous operation by

means of a uni-control device indicated generally by U.

A coupling system 31 connected between the anode 30 of tube 13 and the input of intermediate-frequency amplifier 14 is tuned to pass a fixed intermediate-frequency band.

The frequency band selected and passed by the tuned coupling system 31 is shown graphically in Fig. 2. In Fig. 2, the intermediate carrier frequency is represented by the vertical line A which is taken as 175 kilocycles in this case. The coupling system is adjusted to select and pass an intermediate-frequency channel band 8 kilocycles wide, from 171 to 179 kilocycles, these two edges of the selected band being indicated by the broken lines B and C, respectively.

The function of the condenser 28 associated with the oscillator circuit is to shift the oscillator frequency in either direction by any desired amount up to the width of a sideband, without altering the radio-frequency channel selected. Since the sideband width for the case under consideration is 4 kilocycles, this should be the limit of frequency shift due to condenser 28. If the oscillator frequency is higher than the received signal frequency, as is usually the case, any decrease in the oscillator frequency without an attendant change in the selected radio frequency, will shift the intermediate carrier frequency downward by a like amount, and vice versa. In the example under consideration, therefore, the oscillator frequency will be considered to be 175 kilocycles higher than the selected signal frequency, when condenser 28 is in its neutral or normal position. The dotted line D in Fig. 2 shows the location of the intermediate carrier frequency when the oscillator frequency is shifted downward by 3 kilocycles from normal. It is contemplated that the intermediate frequency represented by line D may be shifted at will to any position between the limits of lines B and C.

Since the position of the selected intermediate-frequency band remains fixed, such a shift of the intermediate carrier frequency has the effect of cutting off the outer frequencies of one sideband and of adding on to the outer frequencies of the other sideband by a like amount. For the amount of shift illustrated in Fig. 2, there remains in the lower sideband only the frequencies between 171 and 172 kilocycles, corresponding to audio frequencies from 0 to 1000 cycles. The lower intermediate-frequency sideband frequencies corresponding to audio frequencies of 1 to 4 kilocycles have not been selected. The upper intermediate-frequency sideband, however, is now 7, instead of 4, kilocycles wide; for it now extends from 172 to 179 kilocycles. Hence, instead of transmitting only frequencies corresponding to 0 to 4 kilocycles of audio frequency, the selecting system now transmits frequencies corresponding to 0 to 7 kilocycles of audio frequency.

In the manner just described, the audio-frequency fidelity is improved without increasing the transmitted band width; although it should be noted that at the same time frequencies corresponding to low audio frequencies (0 to 1000 in this case) are transmitted with better efficiency than the frequencies corresponding to higher audio frequencies. The reason for this is that frequencies corresponding to low audio frequencies are transmitted by both sidebands. This inequality of transmission can be compensated to a considerable extent by a properly designed equalizing network in the audio-frequency amplifier.

It is noted that the location of condenser 28 is particularly advantageous. By reason of its connection across at least some of the capacity of the frequency-determining circuit and across inductance which is outside the frequency-determining circuit, equal motions or variations of the capacity of 28 produce equal frequency shifts at all frequencies of the tuning range. Such would not be the case if condenser 28 were connected across inductance alone or capacity alone.

Since the intermediate carrier frequency may be shifted in either direction, the direction chosen for the shift will ordinarily be opposite that in which an interfering signal may happen to be present. Such a shift will tune out such an interfering signal at the same time that the fidelity is being improved.

There is arranged according to this invention a second intermediate-frequency coupling system 32, connected between the output of intermediate-frequency amplifier 14 and the detector and audio-frequency amplifier, and loudspeaker 15. Means is associated with this coupling system to permit the width of the band transmitted thereby to be varied to change the selectivity and fidelity. This means augments, and may be used in conjunction with the oscillator frequency-shifting arrangement. The coupling system 32 comprises a primary coil 33 electromagnetically coupled to a secondary coil 34. The coil 33 is tuned to the intermediate carrier frequency by a condenser 35, and coil 34 is likewise tuned to the intermediate carrier frequency by a condenser 36.

There is arranged in series between the lower ends (the low potential ends) of coil 34 and condenser 36 an arrangement of a coil 37 and a potentiometer comprising two resistors 38 and 39. A switch 40 is provided to connect coil 37 across either resistor 38 or 39 according to whether switch 40 makes contact with switch-point 41 or switch-point 42. The coil 37 is electromagnetically coupled to primary coil 33. The potentiometer contact arm 43 is connected to a point 44, and when in the neutral position makes contact with the neutral point 45 between the two resistors. In this position, the low potential ends of coil 34 and condenser 36 are directly connected. The switch 40 is correlated to potentiometer arm 43 so that when the arm 43 is operating on resistor 38, switch 40 makes contact with point 41; but when arm 43 is operating on resistor 39, switch 40 makes contact with point 42.

As arm 43 is moved in either direction from the neutral position, along resistor 38 or resistor 39, more voltage is introduced into the secondary circuit from the coupling between coils 37 and 33, since the voltage across coil 37 also appears across the potentiometer resistance. At the same time, more resistance is introduced in the secondary circuit from the potentiometer. The amount of coupling and resistance increase in the resonant secondary circuit depends upon how far the arm 43 is moved from neutral.

It is well known that when the coupling between a pair of coupled tuned circuits is small, the resonance characteristic of the system is sharp. But when the coupling is increased above the "optimum" value, the system becomes characterized by two resonances which become spread apart, thus increasing the selected band width. The term "optimum" coupling means that degree of coupling between the two tuned circuits which produces the maximum amplification, at but a single resonant frequency.

In this manner, then, the selected band is

expanded by movement of the arm 43. The secondary circuit would be characterized by two pronounced resonant peaks, when in the expanded condition, if it were not for the resistance which is introduced. The effect of simultaneously introducing resistance and increasing the coupling is to expand the band without producing objectionable resonance peaks in the secondary circuit.

The double-tuned coupling system 32 is adjusted so that when arm 43 is in the neutral position (no resistance being introduced), the selectivity is quite sharp. A typical selectivity curve for this condition is curve E of Fig. 3, which is a graph of attenuation plotted against frequency. In the example illustrated, the intermediate carrier frequency is 175 kilocycles. The selectivity represented by curve E is such as to pass a band about 4 kilocycles in width; that is, each sideband passed is 2 kilocycles in width, for a carrier frequency of 175 kilocycles.

While the characteristic represented by curve E provides high selectivity, the fidelity is poor. To improve the fidelity then, the potentiometer arm 43 is moved from the neutral position to increase the coupling and to introduce resistance into the tuned circuit, as explained above. When the arm 43 is rotated the maximum distance in one direction or the other, the transmission characteristic takes the form of curve F in Fig. 3. According to curve F, coupling system 32 selects a band about 8 kilocycles in width, from 171 to 179 kilocycles, which is approximately the same characteristic provided by coupling system 31.

If it were attempted to expand the band by the addition of resistance alone, the characteristic would take a form somewhat like curve G of Fig. 3. Curve G shows greater attenuation than curve E within the band, this being due to the reduction of transmission efficiency because of the added resistance. Curve F, however, shows less attenuation than curve G, and shows about the same attenuation as curve E. The difference in attenuation between curves G and F is made up by the additional coupling due to coil 37. Thus the gain due to coupling coil 37 compensates the loss due to the resistance.

It has been found very satisfactory to operate the frequency shifting condenser 28 and the potentiometer arm 43 (as well as the switch 40) simultaneously by means of a single mechanical control device indicated generally by the dotted lines and knob S. The device S is so connected as to hold condenser 28 and arm 43 both in the neutral position to produce the minimum band width, which will be that of curve E in Fig. 3. To broaden the band, knob S is turned in either one direction or the other. Movement in one direction causes arm 43 to move along resistor 38 and simultaneously causes condenser 28 to shift the intermediate carrier frequency in one direction. Movement of the knob in the other direction causes switch 40 to move to contact point 42, causes the arm 43 to operate on resistor 39, and causes the condenser 28 to shift the intermediate carrier frequency in the other direction.

The adjustment should preferably cause the maximum frequency shift to coincide with the maximum band width (curve F).

Fig. 4 shows the overall effect of operating the knob S to shift both the oscillator frequency and to expand the band width of system 32. Curve H corresponds to curve E of Fig. 3 and shows the overall characteristic in the highly selective con-

dition, which is the condition for tuning. Curve I shows the overall selective characteristic when the knob S is turned to fully expand the band width in the direction of the lower sideband. Curve I is seen to be of substantially the same width as curve F in Fig. 3 except that it is displaced downwardly. Curve J similarly shows the effect of the full expansion in the direction of the upper sideband.

It should be understood that the arrangement of the invention is readily susceptible to many variations from the specific embodiment described. For example, if it be found that the primary circuit 33, 35 can stand being loaded by both resistors 38 and 39 in parallel, the switch 40 may be dispensed with and a permanent connection may be made between points 41 and 42 and the point to which the switch is shown connected.

There is associated with the receiver a system of automatic volume control. This system comprises a path 46 between a point 47 of coil 33 and a point 48 which is connected through resistor 49 to the signal grid circuit of tube 13. There is included in the path 46 automatic volume control apparatus designated generally by the block 50. This automatic volume control apparatus may be of any conventional form which ordinarily includes a rectifier for developing a uni-directional voltage which biases the grid 16 of tube 13 inversely with any change of the intermediate-frequency voltage at coil 33.

This arrangement, in addition to automatically controlling the volume output, produces the desirable effect of maintaining a substantially uniform output with expansion. This effect is due to the manner in which the impedance of the primary circuit 33, 35 changes in shifting from the contracted to the expanded condition of coupling system 32.

Impedance characteristics of the primary circuit 33, 35 are illustrated in Fig. 5 in which the impedance is plotted against the intermediate frequency. Curve K illustrates the relatively sharp impedance curve obtained when the band passed by the coupling system is contracted by placing the arm 43 in the neutral position. When the band passed by the coupling system is expanded, as by moving the arm 43 in either direction, and the coupling between the primary and secondary circuits of the coupling system thereby increased, the impedance at the primary circuit becomes characterized by the double resonance effect due to over-optimum coupling. The impedance of the primary circuit under the expanded condition is shown by curve L from which it is observed that there are two pronounced resonant peaks and a dip between them at the carrier frequency. The reason for the pronounced peaks at the primary circuit while such peaks are absent at the secondary circuits lies in the fact that no additional resistance is introduced into the primary circuit when the coupling is increased.

Since the voltage applied to the automatic volume control apparatus is taken from the primary circuit, the automatic volume control effect is caused to relax when the band width selected by coupling system 32 is expanded. The reason for this is that the intermediate carrier frequency lies within the dip in curve L. In consequence the volume output rises somewhat when the band width is expanded; or in other words, the sensitivity would be somewhat less in any except the expanded condition.

This counteracts the tendency for the volume to drop due to the moving of the carrier to one side of the sloping resonance characteristic and thus decreasing in amplitude as the band is expanded. This also compensates for the net drop in output which results from the cutting off of a large portion of one of the sidebands.

If the receiver is tuned in the expanded condition, this primary impedance characteristic produces a noise suppression and sharp tuning effect. On either side of the exact resonance frequency the voltage actuating the automatic volume control is abnormally high, thus decreasing the receiver gain, while at exact resonance the automatic volume control voltage is abnormally low. This condition produces a rapid and easily distinguished output volume rise when tuning through resonance, which indicates the exact point at which the receiver is correctly tuned.

I claim:

1. In a superheterodyne receiver comprising means for receiving modulated carrier signals, means including means for generating oscillations for deriving from said received signals modulated intermediate carrier-frequency signals and a selecting circuit for selecting a band of frequencies including said intermediate carrier-frequency, means for varying the effective width of an intermediate frequency modulation sideband passed by said selecting circuit comprising means for shifting said oscillator frequency relative to the frequency of said signals.

2. In a superheterodyne receiver comprising means for receiving modulated radio-frequency signals, means including means for generating oscillations for deriving from said received signals intermediate carrier-frequency signals, said latter means including a resonant frequency-determining circuit having inductance shunted by capacity and a selecting circuit for selecting a band of frequencies including the intermediate carrier-frequency, means for varying the effective width of an intermediate frequency modulation sideband passed by said selecting circuit comprising a condenser connected across at least part of said capacity and coupled to said inductance, whereby the frequency of said oscillations may be shifted relative to said radio-frequency signal frequency.

3. In a superheterodyne receiver comprising a modulator, means for impressing modulated carrier-frequency signals on said modulator, a local oscillator system for producing oscillations to modulate said signal, said oscillator system having a frequency-determining circuit provided with adjustable means for causing said oscillator frequency to vary with the signal frequency, whereby a substantially constant intermediate frequency is produced at the output of said modulator and a selecting circuit for selecting a band of frequencies including said intermediate frequency, means for varying the effective width of an intermediate frequency modulation sideband passed by said selecting circuit comprising a variable reactive element associated with said frequency-determining circuit and operable independently of said adjustable means for shifting said oscillator frequency relative to the frequency of said signals, whereby the intermediate carrier-frequency may be shifted within said band.

4. In a superheterodyne receiver, a tunable radio frequency signal receiving circuit, means including means for generating oscillations for deriving from received signals intermediate carrier frequency signals, said latter means includ-

ing a tunable frequency determining circuit and a selecting circuit for selecting a band of frequencies including the intermediate carrier frequency, means for varying the effective width of an intermediate frequency modulation sideband passed by said selecting circuit comprising an adjustable reactance element coupled to one of said tunable circuits and so related thereto that equal adjustments of said reactance element produce substantially equal adjustments in said intermediate frequency throughout the tuning range of the receiver.

5. In a superheterodyne receiver comprising means for receiving modulated radio frequency signals, means including means for generating oscillations for deriving from said received signals intermediate carrier frequency signals, said latter means including a resonant frequency determining circuit and a selecting circuit for selecting a band of frequencies including the intermediate carrier frequency, means for varying the effective width of an intermediate frequency modulation sideband passed by said selecting circuit comprising an adjustable reactance element included in said frequency determining circuit for shifting said oscillator frequency in either direction relative to said signal frequency, said reactance element being so connected to said frequency determining circuit that equal adjustments thereof produce substantially equal frequency shifts at all frequencies in the tuning range.

6. In a superheterodyne receiver comprising a signal-selecting circuit tunable over a range in frequency, an oscillator-modulator tube upon which the selected signals are impressed, said tube having associated therewith an inductance and a capacity included in a tunable local oscillator circuit associated with said tube and a selecting circuit coupled to the output of said tube responsive to the intermediate-frequency band of frequencies, means for varying the effective width of an intermediate frequency modulation sideband passed by said selecting circuit comprising a variable condenser operable independently of the tuning of said oscillator circuit and connected across part of said inductance and at least part of said capacity for shifting the oscillator frequency relative to said signal frequency, equal movements of said variable condenser producing substantially equal frequency shifts at all frequencies of said range.

7. In a superheterodyne receiver comprising a signal-selecting system, means including means for generating oscillations for deriving from said selected signals an intermediate carrier-frequency and associated sidebands, a selecting circuit for selecting a band of frequencies including said intermediate carrier-frequency, said oscillation-generating means comprising a resonant oscillation frequency-determining circuit including an inductance and a capacity connected across two points of said inductance, means for varying the effective width of an intermediate frequency modulation sideband passed by said selecting circuit comprising an auxiliary variable condenser connected between a third point of said inductance and a point of said capacity.

8. In a superheterodyne receiver comprising a signal-selecting system, means including means for generating oscillations for deriving from said selected signals an intermediate carrier-frequency and associated sidebands and a selecting circuit for selecting a band of frequencies including said intermediate carrier-frequency, said

oscillation-generating means comprising a resonant oscillation frequency-determining circuit including part of an inductance and a variable capacity effectively connected across said part, means for varying the effective width of an intermediate frequency modulation sideband passed by said selecting circuit comprising an auxiliary adjustable condenser connected across at least a portion of said capacity and at least a portion of said inductance which is outside said part, whereby equal movements of said auxiliary condenser produce substantially equal frequency shifts at any frequency within said range, and thereby produce equal shifts of said intermediate carrier-frequency.

9. In a superheterodyne receiver comprising means for receiving radio-frequency signals, means including means for generating oscillations for deriving from said received signals intermediate carrier-frequency signals, means for varying the effective width of an intermediate frequency modulation sideband passed by the receiver comprising a selecting circuit for selecting a band of frequencies including said intermediate carrier-frequency, means for shifting said oscillator frequency relative to the frequency of said signals whereby the intermediate carrier frequency may be shifted, and means for adjusting the width of the band selected by said selecting circuit while said intermediate carrier-frequency is being shifted.

10. Apparatus according to claim 9 in which a single mechanical control device serves to shift the frequency of said oscillations and to increase the band width selected by said selector.

11. In a superheterodyne receiver comprising means for receiving modulated carrier-frequency signals, means including means for generating oscillations for deriving from said received signals intermediate carrier-frequency signals, said latter means including a resonant frequency-determining circuit having inductance shunted by capacity, a selecting circuit for selecting a band of frequencies including the intermediate carrier-frequency means for varying the effective width of an intermediate frequency modulation sideband passed by said selecting circuit comprising a variable condenser connected across at least part of said capacity and a portion of said inductance, said variable condenser being normally in a neutral position but being movable in either direction from said neutral position, a selecting circuit for selecting a band of frequencies including the intermediate carrier-frequency, said selecting circuit being provided with movable means for varying the selected band width, said band width being least when said movable means is in a neutral position, and a mechanical control device for simultaneously moving said variable condenser and said movable means away from their neutral positions to improve the fidelity of reception.

12. In a superheterodyne receiver comprising a tunable input circuit for carrier signals, means including oscillation generating means for deriving from said signals modulated intermediate frequency signals, said latter means including a tunable frequency determining circuit, and means for simultaneously tuning said input circuit and said frequency determining circuit and maintaining a substantially constant frequency difference therebetween, means for adjusting said frequency difference by a constant value throughout the respective tuning ranges of said circuits comprising an additional adjustable tuning reactance element coupled to one of said circuits.

13. In a superheterodyne receiver comprising a tunable input circuit for carrier signals, means including oscillation generating means for deriving from said signals modulated intermediate frequency signals, said latter means including a tunable frequency determining circuit, and means for simultaneously tuning said input circuit and said frequency determining circuit and maintaining a substantially constant frequency difference therebetween, means for adjusting said frequency difference by a constant value throughout the respective tuning ranges of said circuits comprising a fixed reactance element external to one of said tunable circuits but coupled thereto and an additional adjustable tuning reactance element connected across said fixed reactance element and at least a portion of its associated tunable circuit.
14. In a superheterodyne receiver comprising a tunable input circuit for carrier signals, means including oscillation generating means for deriving from said signals modulated intermediate frequency signals, said latter means including a tunable frequency determining circuit, and means for simultaneously tuning said input circuit and said frequency determining circuit and maintaining a substantially constant frequency difference therebetween, means for adjusting said frequency difference by a constant value throughout the respective tuning ranges of said circuits comprising a fixed inductance element external to said frequency determining circuit but coupled thereto, and an additional adjustable tuning condenser connected across said inductance and a capacitive portion of said frequency determining circuit.

JOHN KELLY JOHNSON.

CERTIFICATE OF CORRECTION.

Patent No. 2,073,344.

March 9, 1937.

JOHN KELLY JOHNSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 54, strike out the word "the"; page 3, first column, line 27, for "conjuiction" read conjunction; page 5, first column, line 57, claim 7, strike out the comma after "sidebands"; second column, line 44, claim 11, insert a comma after "frequency" and lines 51-53, strike out the words and comma "a selecting circuit for selecting a band of frequencies including the intermediate carrier-frequency,"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of June, A. D. 1937.

(Seal)

Henry Van Arsdale
Acting Commissioner of Patents.

13. In a superheterodyne receiver comprising a tunable input circuit for carrier signals, means including oscillation generating means for deriving from said signals modulated intermediate frequency signals, said latter means including a tunable frequency determining circuit, and means for simultaneously tuning said input circuit and said frequency determining circuit and maintaining a substantially constant frequency difference therebetween, means for adjusting said frequency difference by a constant value throughout the respective tuning ranges of said circuits comprising a fixed reactance element external to one of said tunable circuits but coupled thereto and an additional adjustable tuning reactance element connected across said fixed reactance element and at least a portion of its associated tunable circuit.
14. In a superheterodyne receiver comprising a tunable input circuit for carrier signals, means including oscillation generating means for deriving from said signals modulated intermediate frequency signals, said latter means including a tunable frequency determining circuit, and means for simultaneously tuning said input circuit and said frequency determining circuit and maintaining a substantially constant frequency difference therebetween, means for adjusting said frequency difference by a constant value throughout the respective tuning ranges of said circuits comprising a fixed inductance element external to said frequency determining circuit but coupled thereto, and an additional adjustable tuning condenser connected across said inductance and a capacitive portion of said frequency determining circuit.

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