

Aug. 1, 1944.

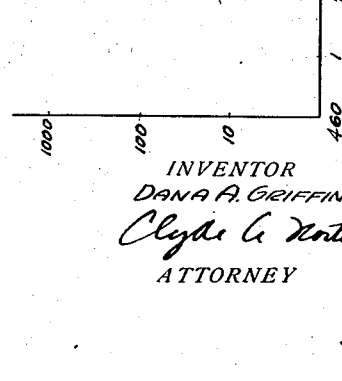
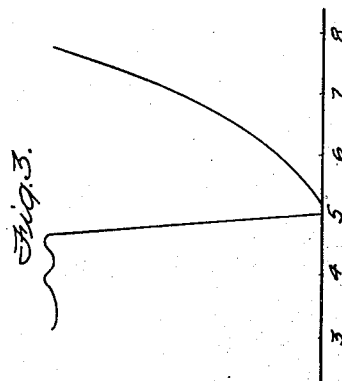
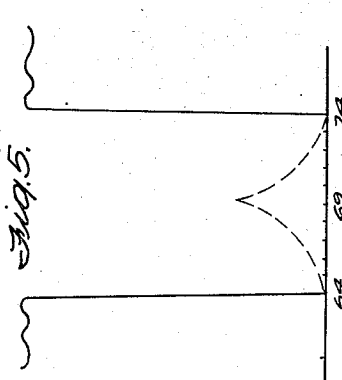
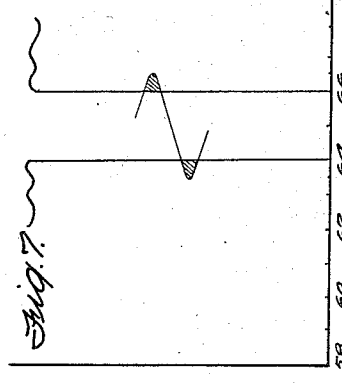
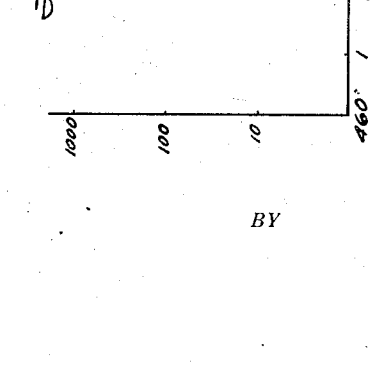
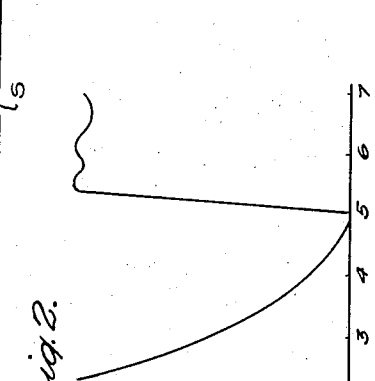
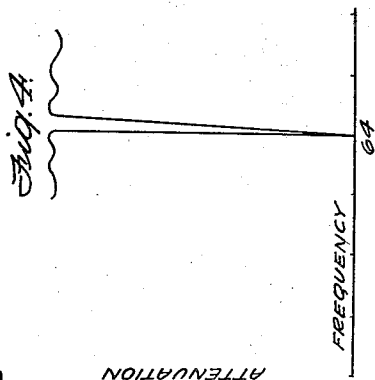
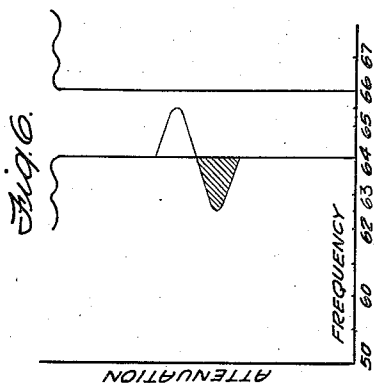
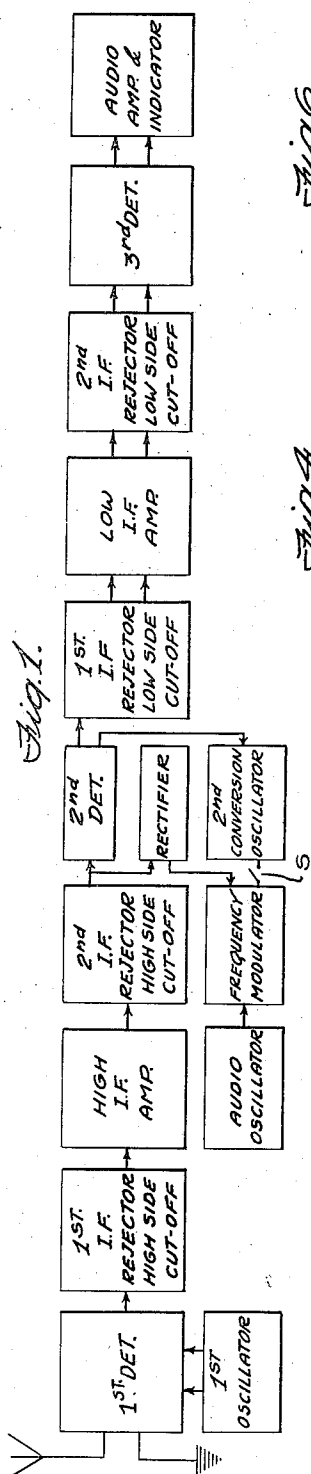
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2,354,749

ELECTRICAL COMMUNICATION

Filed March 11, 1941

2 Sheets-Sheet 1



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2,354,749

ELECTRICAL COMMUNICATION

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Application March 11, 1941, Serial No. 382,695

18 Claims. (Cl. 250—20)

This invention relates to improvements in electrical communication, and more particularly to the selection of desired frequencies and elimination of undesired frequencies and noise. It is of particular utility in connection with the reception of radio signals, both telegraph and telephone, but it will be understood that the circuits and methods described and claimed herein are not limited to such use, but may be employed for other purposes.

Among the objects of my invention may be mentioned:

To provide for an extremely high degree of frequency selection;

To provide improved frequency selection, in which the selectivity characteristic curve is substantially rectangular, rather than of the usual resonance curve shape;

To provide band pass selectivity, with a substantially rectangular characteristic curve, in which the width of the band selected may be easily and simply controlled and varied as desired;

To provide apparatus which may be used for the reception of either radio, telegraph or telephone signals with a substantially rectangular characteristic curve, in which the width of the received band may be continuously and smoothly varied from zero up to 10,000 cycles or more; and in which said variation may be made at an audible rate;

To provide radio receiving apparatus for the reception of continuous wave telegraph signals free from many of the difficulties characterizing even the best of such present-day apparatus;

To provide such apparatus giving an improved signal-noise ratio, and a minimum of receiver noise during the intercharacter spaces;

To provide such apparatus enabling the operator to receive telegraph signals with a pleasing tone, easy to copy, and which is not a function of the receiver tuning, and which is not subject to change in pitch with drifting of the frequency of the beat frequency oscillator;

To provide such apparatus in which the audio note of the telegraph signal is produced by frequency modulation of the conversion oscillator;

To provide such apparatus in which the frequency deviation of the conversion oscillator is controlled automatically by the amplitude of the signal being received;

Still other objects and advantages of my invention will be apparent from the specification.

In this application I have particularly pointed out and distinctly claimed the part, improvement

or combination which I claim as my invention or discovery and I have explained the principles thereof and the best mode in which I have contemplated applying those principles so as to distinguish my invention from other inventions.

In the drawings:

Figure 1 is a simplified diagram illustrating the principles of operation of apparatus according to my invention;

Figure 1a is a simplified diagram of a modification of my invention, particularly useful in the reception of continuous wave telegraphy;

Figs. 2, 3, 4, 5, 6 and 7 are curves explaining the operation of my invention, and

Fig. 8 is a circuit diagram showing the circuit according to one form of my invention.

In accordance with the best conventional practice, continuous wave telegraph signals are received in a superheterodyne receiver using a beat frequency oscillator to beat with the signal and give an audible tone, and selectivity is obtained by using a crystal filter circuit in the intermediate frequency amplifier.

This type of receiver has several defects. It is critical in adjustment, drift of the frequency of the beat frequency oscillator causes a change in the pitch of the signal note, and it is difficult to hold the signal note in the range of pitch which is easiest to copy. Furthermore, if the crystal is used in its most selective adjustment, the set noises, in combination with the beat frequency oscillator, cause a continuous ringing noise which makes weak signals hard to copy, and with fast keying, the signal tones slur into the spaces, because of the high Q of the crystal circuit.

For telephone reception, the crystal filter is not well suited, because the nose of its resonance curve is too sharp, and the skirts are too broad.

In accordance with my invention, I eliminate these difficulties by eliminating the crystal filter and the beat frequency oscillator which produces audio beats, and by employing, instead, in my preferred form, a triple detection system, employing a first conversion oscillator and detector to produce a first intermediate frequency, a second conversion oscillator and second detector to produce a second intermediate frequency, and a third detector to produce the audible signal. For the reception of continuous wave telegraph signals, I may frequency modulate the second conversion oscillator at an audio rate.

I obtain frequency selectivity by the use of infinite rejection circuits in the intermediate frequency stages, these infinite rejection circuits

being employed to cut off on each side of the desired band. The width of the band to be received is determined by controlling the frequency of the conversion oscillator; that is to say, by varying its tuning and this may be done manually for the purpose of controlling the band width or it may be done at an audio rate for continuous wave telegraph reception.

In the preferred form of my invention, I may employ the infinite rejection circuits ahead of and after the second detector. This will be most easily understood by reference to Fig. 1.

Infinite rejection circuits are well known in the art, and in general, it may be stated that they employ compound coupling, with the inductive coupling arranged to oppose and neutralize the capacitive coupling for one particular frequency, so that at that particular frequency the attenuation of the circuit is practically infinite. For a description of such circuits and their characteristics, reference may be had to "QST" for November, 1937, pp. 19 et seq.

Such circuits may have a frequency attenuation characteristic such as shown in Figs. 2 and 3, wherein the ordinates represent attenuation and the abscissae frequency. The curve of Fig. 2 is that of what I term a low pass, or high cut-off circuit, while that of Fig. 3 is what I term a high pass, or low cut-off circuit. The difference is that in the low pass circuit, the attenuation gradually decreases with increase in frequency until it reaches the critical frequency, at which the attenuation rises extremely rapidly to practically infinity, and remains at a high value for further increase, while the high-pass characteristic is substantially the mirror image of the low-pass characteristic.

I prefer to employ a pair of cascaded low pass or high cut-off circuits to determine the upper frequency limit of the band to be selected, and a pair of low cut-off circuits in cascade to determine the lower frequency limit of the selected band. The band of frequencies included between the upper and lower limits or width of the selected band may be controlled by the tuning of the second conversion oscillator solely, and does not require any adjustment of the high or low-pass circuits. Why this is the case will be explained hereafter.

Referring now more particularly to Fig. 1, incoming signals from the antenna may be impressed upon the first detector system supplied with heterodyning oscillations from the first oscillator. The first detector system may comprise one or more stages of amplification at received signal frequency, and one or more circuits tuned to signal frequency, as well known in the art. For the purpose of explaining the operation of my invention, it may be assumed that the first intermediate frequency is 465 kilocycles, the incoming signal is 1000 kilocycles, and the first oscillator frequency to tune this signal is 1465 kilocycles.

The output of the first detector system may be supplied to the first infinite rejector system, which may have its critical or infinite attenuation frequency set at 465 kilocycles or slightly above, i. e. from a fraction of a kilocycle to two or three kilocycles, as the case may be. Under these conditions any frequency within a few kilocycles of 465, but lower than 465, will pass through the first infinite rejection circuit and be impressed upon the high intermediate frequency amplifier system.

For the purpose of attenuating the frequencies which are transmitted by the first circuit, the output of the high I. F. amplifier may be impressed upon a second high cut-off infinite rejection circuit, like the first infinite rejection circuit. The action of this second circuit is the same as that of the first and it serves to attenuate still further the frequencies attenuated by the first circuit.

Thus any intermediate frequency higher than 465 kilocycles will be severely attenuated, because for any frequency above that value the attenuation is practically infinite and remains so. For example, an incoming signal of 990 kilocycles will be practically excluded, while an incoming signal of 1001 kilocycles will be admitted.

The output of the second infinite rejection circuit may be impressed upon the second detector system, supplied with local oscillations from the second conversion oscillator, which, for telephone reception will not be modulated, but for telegraph reception of continuous wave signals may be frequency modulated by the modulator system, supplied with the desired audio frequency tone by an audio frequency oscillator. Switch S may be closed when telegraph reception is desired, and left open for telephone reception.

A portion of the output of the second infinite rejection circuit may be rectified and impressed upon the frequency modulator, for telegraph reception, in a manner which will be described later. This, however, does not affect the principles of the circuit as a whole, and need not be considered further at this point.

The frequency of the second conversion oscillator may be chosen of a value to reduce the signal frequency still further, while still maintaining it above audibility. Purely by way of example again, it may be assumed to be 400 kilocycles, giving an output, from the second detector of 65 kilocycles. The output of the second detector may be supplied to the third infinite rejector circuit, arranged to provide a low side cut-off at 65 kilocycles, i. e., tuned to a frequency from a fraction of a kilocycle to several kilocycles below 65 kc. Any frequency less than 65 kilocycles will be greatly attenuated, while frequencies a few kilocycles above 65 will be passed through to the low intermediate frequency amplifier.

The output of the low intermediate frequency amplifier may be fed to a fourth infinite rejection circuit having a low side cut-off, similar to the third circuit, and tuned to a frequency from a fraction of a kilocycle to several kilocycles below that to which the third infinite rejector circuit is tuned, and serving to still attenuate the undesired frequencies which may pass through the third infinite rejector circuit. The output of the fourth circuit may be supplied to the third detector system, the output of which may be supplied to any suitable audio frequency amplifier system and signal indicator.

The effect of varying the frequency of the second conversion oscillator may now be seen. With the frequencies assumed, a signal of 1,000 kilocycles is the only one that can come through to the third detector. Any signal frequency less than 1000 kilocycles will be cut off by the high side cut-off circuits, while any signal greater than 1000 kilocycles will be cut off by the low cut-off circuits. This condition is shown by the over-all selectivity curve of Fig. 4.

If the second conversion oscillator be now

tuned above 400 kilocycles, all frequencies which pass the high side cut-off circuits, after the second detection, will be too low to pass through the low side cut-off circuits, and nothing will be received. This may be visualized by assuming the two curves which make up the upper and lower frequency limits in Fig. 4 to be moved toward each other until they pass, and the space between them, which represents the frequency width of the admitted band, becomes zero.

On the other hand, if the conversion oscillator be tuned to a frequency below 400 kilocycles, the effect is just the reverse, the curves of Fig. 6 being in effect moved further apart, widening the over-all admittance band and producing a response characteristic such as shown in Fig. 7.

If the high and low side cut-off circuits be interchanged, then to expand the band it would be necessary to tune the conversion oscillator above 400 kilocycles.

In any event, it will be seen that by varying the frequency of the second conversion oscillator, and without changing the tuning of the cut-off circuits the admittance band may be broadened or narrowed as may be desired, and this change in width does not take place in discrete steps, but is a continuous and smooth function of the second oscillator frequency. This lends itself to optimum reception under widely varying conditions. For instance, if telegraph reception is desired under severe interference conditions, the second conversion oscillator may be tuned so as to establish an extremely narrow admittance band. On the other hand, if high fidelity telephone reception is desired, the second conversion oscillator may be set to provide an admittance band of 10,000 cycles, or even more. Should interference develop, the band may be narrowed to just the extent desired to provide the best compromise between interference and quality.

At this point, it may be noted that variation of the tuning of the second conversion oscillator to change the band width may require a slight retuning of the first oscillator to keep the carrier frequency of the incoming signal after conversion, in the center of the over-all admittance band of the receiver. This is because varying the tuning of the second conversion oscillator does not in effect change the frequency at which both high and low side cut-offs occur, but only the low side. That is to say, referring to Fig. 5 changing the conversion oscillator frequency may be regarded as moving the low frequency cut-off toward or away from the high frequency cut-off, which remains unchanged; hence a signal which has its carrier frequency centered in the admittance band for one band width, may need to be re-centered by a slight readjustment of the first oscillator frequency in case the width of the admittance band is changed substantially.

Referring now more particularly to Fig. 8, I have shown the details of the circuit of a preferred form of my invention, with the exception of the circuits ahead of the output of the first detector, which is well-known in the art and forms per se no part of my invention. The output of the first detector system is fed into the first infinite rejector circuit 10 which may comprise coupled inductances 10a and 10b, a third inductance 10c, capacities 10d, 10e and 10f, and variable resistance 10g. Since these circuits are, per se, well-known in the art, and the method of establishing the values of the various constants for particular frequencies are also known,

the same is not believed necessary to be discussed.

The output of the first infinite rejector system may be impressed upon the control grid 11b of the amplifier tube 11, having a cathode 11a, control grid 11b, screen grid 11c and anode 11d. Other types of tubes may be employed as will be understood, the tubes herein shown and described being merely by way of example. The output of tube 11 may be fed to the second infinite rejection circuit 12 which again may comprise coupled inductances 12a and 12b, third inductance 12c, capacities 12d, 12e and 12f and variable resistance 12g, and may be tuned to a frequency slightly higher than that of first infinite rejector circuit 10. The output of circuit 12 may be supplied to the control electrode of the second detector tube 13, which may have cathode 13a, control electrode 13b, screen electrode 13c and 13d, injector electrode 13e and anode 13f.

The output of the tube 13 may be supplied to the third infinite rejector circuit (low side cut-off) 14, which may comprise coupled inductances 14a and 14b, third inductance 14c, capacities 14d, 14e and 14f and variable resistance 14g. The output of this circuit may be supplied to the low I. F. amplifier tube 15 which may comprise cathode 15a, control grid 15b, screen grid 15c and anode 15d. Each of the tubes 11, 13 and 15 may be provided with a resistance in a cathode lead to ground, these being 11g, 13g and 15g, shunted by capacities 11h, 13h and 15h respectively.

The output of tube 15 may be supplied to the fourth infinite rejection circuit 16 which may be a low side cut-off circuit, preferably tuned to a frequency slightly lower than that of the third infinite rejector circuit 14. The fourth infinite rejection circuit may comprise inductances 16a and 16b coupled together, third inductance 16c and capacities 16d, 16e and 16f and variable resistance 16g.

The output of the fourth infinite rejection circuit may be supplied to the anode 17b of diode 17, the cathode 17a of which may be connected to ground. One side of inductance 16b may be connected through resistance 30 to ground, said resistance may be shunted by capacity 31, the audio frequency output being taken through connection 32 as shown. Since audio frequency amplifier and indicator circuits are well-known in the art and form per se no part of my invention, they are not described in detail.

The oscillation to be applied to tube 13 for the purpose of reducing the signal from the high intermediate frequency to the low intermediate frequency may be generated in tube 18 which may have cathode 18a, control electrode 18b and anode 18c. This tube may be provided with a feedback or oscillator circuit of any usual type such, for instance, as that shown, having inductance 19a and condenser 19c connected between ground and control electrode 18b, a connection from cathode 18a through resistance 18g, shunted by condenser 18h, to ground, and the output circuit connected from anode 18c through inductance 19b which may be coupled to inductance 19d, thence to ground through capacity 19d and to the source of plate voltage through radio frequency choke RFC.

The anode 18c may also be connected through capacity 19e to the injector grid 13e of the second detector, which may be connected to ground through radio frequency choke RFC. Selection of the frequency of the conversion oscillator 13 may be made by varying condenser 19c or in any other suitable manner known in the art. With switch 20

in open position as shown, the tube 18 operates as a simple conversion oscillator supplying unmodulated oscillations to the tube 13 and the apparatus may be used in this condition for the reception of telephone signals or amplitude modulated waves. It is not suitable for the reception of continuous wave signals having a constant carrier frequency. For the reception of such signals, switch 20 may be closed to frequency modulate oscillator 18. Switch 20 may connect the control grid 18b of oscillator 18 through resistance 23 to grid 24b of frequency modulator tube 24. This tube may have cathode 24a, grid 24b, control grid 24c, screen grids 24e and 24f, and anode 24g connected through condenser 34 to the upper terminal of resistance 26. Anode 24 may also be connected through radio frequency choke RFC to the source of plate voltage. Cathode 24a may be connected through resistance 24g to ground, the resistance being shunted by condenser 24h. Grid 24d may be connected through resistance 28 and capacity 30 to ground. Capacity 30 may be shunted by additional resistance 29.

Any suitable variable audio frequency oscillator 8 may be provided for establishing the note or tone to be impressed upon continuous wave signals. One terminal of this oscillator may be connected to ground, and the other terminal to variable connection 9 on resistance 28. The tube 24 and its associated circuit forms a frequency modulator (in effect a variable inductance) serving to deviate the frequency generated by the conversion oscillator 18 and since such circuits are per se well known in the art and form no part of this invention, the same are not described in detail. It may be noted, however, that setting the frequency of the audio oscillator 8 fixes the tone introduced into the circuit, whereas adjustment of connection 9 controls the magnitude of the deviation of the frequency of oscillator 8.

For an understanding of the operation of the circuit in receiving continuous wave telegraph signals in one mode of operation, reference may be had to Fig. 6. Referring to Fig. 6, the curve may represent the over-all admittance band of the system as it appears at the output of the fourth infinite rejection circuit, the conversion oscillator 18 being tuned to such a frequency that the admittance band of the receiver as seen at this point extends from 64 to 66 kilocycles, and the resultant or beat frequency output between the incoming signal and the local oscillation having a carrier frequency of 64 kilocycles for example just at the lower edge of the admittance band and being deviated in frequency by the frequency modulation impressed upon the local oscillation from 62.5 kilocycles to 65.5 kilocycles. For this, it is assumed that the amplitude of both the incoming signals and the local oscillation is constant so that no amplitude modulation effects appear up to this point, the only modulation being the frequency deviation applied to the local oscillator.

If the deviation impressed by the frequency modulator were less than 2 kilocycles, and this deviation occurred entirely within the admittance band, nothing would be heard with the possible exception of key clicks or "mush." If the deviation is as shown in Fig. 6, so that the frequencies swing into and out of the admittance band, this change occurring once per cycle, it will be seen that an amplitude modulation effect is produced, the same being a complete passage of signals or no passage of signals at all, and since the signal passes into and out of the cut-off zone once for

each deviation cycle and the deviation frequency is fixed, for example, at 256 cycles per second, it is apparent that a 256 cycle note will be introduced and will be reproduced by the telephone or loud speaker, this note continuing while the signal oscillations are being received and of course being silent during the intercharacter spaces.

In the example above, the mean carrier frequency was given as at one edge of the admittance band, i. e., 64 kc. This is not necessary, however, and the mean carrier frequency may be either within or without the band, so long as it is deviated into and out of the band once per cycle.

For minimum noise on inter-character spacing, using the apparatus in this manner, it may be preferable to adjust the mean frequency of the second conversion oscillator until the admittance band is "less than zero," that is to say, until the curves of Fig. 4 have been in effect pushed together until they have passed, as explained supra, and the receiver has no admittance band. Then deviating the frequency of the second conversion oscillator at an audio rate, as by frequency modulation, in effect widens and narrows the admittance band at an audio rate, and control of the magnitude of the frequency deviation controls the magnitude of the maximum width which the admittance band may reach and introduces the audio tone.

Under certain conditions, it is possible to obtain a double frequency tone, that is a 512 cycle note with the audio oscillator set for 256 cycles per second. To do this, it is necessary to re-tune the fourth infinite rejection circuit so that it is a high-side cut-off circuit, the third infinite rejection circuit being left as before, but the circuit 16 being readjusted to provide high side cut-off slightly above the cut-off frequency of the low side cut-off circuit 14 for example at 66 kc. The admittance band width of the low I. F. channel may be from 64 to 66 kc. as shown by Fig. 7, and in this case the band width of the high I. F. channel is not critical, because the low I. F. channel now provides both high and low side cut-off.

If now the first oscillator be slightly re-adjusted, so as to move the carrier frequency from 64 kilocycles to 65 kilocycles, a curious effect will be noted. The frequency deviation will now be from 63.5 kilocycles to 66.5 kilocycles, and the deviation will cause the signal frequency to pass into and out of the admittance band of the low I. F. channel, both on the higher and lower sides twice per cycle instead of once. The portion of the frequency distribution which is outside of the admittance band both in Figs. 6 and 7 has for convenience been shaded and it will be seen readily by comparing Figs. 6 and 7 that a double frequency component is introduced under the condition of Fig. 7; that is to say, instead of the tone from the loud speaker being 256 cycles, it will be 512 cycles per second. If now either conversion oscillator be slightly retuned to shift the mean carrier frequency either way so that the frequency does not pass out of the admittance band on both sides but only one side, the tone will drop back to the fundamental, i. e. 256 cycles, in the example here given.

In the example just given, for obtaining the double tone frequency, the mean carrier frequency has been within the admittance band, as shown in Fig. 7, but the same effect may be produced by adjusting the mean carrier frequency to be out of the admittance band, and deviating it through the admittance band and beyond it.

The double tone frequency gives a new kind

of selectivity which is of advantage where the desired signal is interfered with by signals having frequencies near that of the desired signal, and lying on both sides of it. In this case, it is possible to deviate the desired signal frequency to give the double tone, while the signals lying on either side of it pass into and out of the admittance band only once per cycle. Then the interfering signals will have a tone of 256, for example, while the desired signal has a tone of 512, and the desired signal may be easily read.

In the foregoing we have described deviating the frequency of the local oscillator 18 so as to throw the resultant frequencies within and without the over-all admittance band. It will be understood, however, that a similar result can be obtained by holding the frequency of the local oscillator 18 constant and deviating the cut-off frequency of the fourth or third infinite rejector circuit or both. This has been shown in Fig. 8. For example, we may provide switch 25 interposed in a connection from the top of resistance 26 to the top point of inductance 16b in the fourth infinite rejector circuit 16. To operate by deviating the frequency of this rejector circuit, the switch 20 will be opened so that the frequency modulator tube 24 has no effect on the oscillator 18 and the switch 25 will be closed to connect this tube to the fourth rejector circuit 16. Since this frequency modulator tube operates in effect like an inductance of varying value, when the switch 20 is open and switch 25 is closed, the effective inductance of circuit 16 is varied and this variation produces the same effect as previously described, the signal being alternately passed through and alternately tuned out. That is to say, it converts the beat oscillation to a fully amplitude-modulated oscillation having a tone set by the audio frequency oscillator.

An improved signal to background noise ratio may be obtained when frequency modulating the oscillator 18, by closing switch 21, thereby establishing a circuit from the anode 22b of diode 22 through cathode 22a, and switch 21 to the lower end of resistance 28. This permits the diode 22 to build up a positive bias across the time constant circuit resistance 29 and condenser 30. During the reception of signal impulses this positive bias applied to the grid 24d of the frequency modulator tube 24 tends to increase the amount of frequency deviation during the signal pulses and to reduce the deviation during the inter-character spaces, thus decreasing the modulation of inter-character noise.

In connection with the adjustment of the magnitude of the deviation as controlled by connection 9, an adjustment should be made so that the minimum deviation is provided which is necessary to properly modulate the signal. Excess deviation above this amount has the effect of widening the band and is certain to increase the noise background and may even bring in an interfering signal.

It is also to be noted that the adjustments of the conversion oscillator 18 together with the proper adjustment of the deviation control 9 do not have to be changed once they are properly made (unless it is desired to vary the band width as above described). Signals may be tuned in and out merely by operating the main tuning control of the receiver, in this instance the tuning control of the first oscillator.

While I have shown and described certain preferred embodiments of my invention, it will be understood that modifications and changes may

be made without departing from the spirit and scope thereof as will be clear to those skilled in the art.

I claim:

1. In a superheterodyne receiver of the triple detection type a first conversion oscillator, a first intermediate frequency amplifier including means for attenuating only frequencies higher than a predetermined frequency, a second conversion oscillator, a second amplifier operating at a different intermediate frequency including means for attenuating only frequencies lower than a predetermined frequency, and means for adjusting the effective signal band width of the signal produced at the output of the second intermediate frequency amplifier, said means comprising manual means for adjusting the frequency of said second conversion oscillator.

2. In a superheterodyne receiver of the triple detection type, a first conversion oscillator, a first intermediate frequency amplifier including means for attenuating only frequencies lower than a predetermined frequency, a second conversion oscillator, a second amplifier operating at a different intermediate frequency including means for attenuating only frequencies higher than a predetermined frequency, and means for adjusting the effective band width of the signal produced at the output of the second intermediate frequency amplifier, said means comprising manual means for adjusting the frequency of said conversion oscillator.

3. The method of controlling the signal admission band width for high frequency oscillations in a receiver having an intermediate frequency selecting system, which comprises heterodyning the oscillations to produce oscillations of a first intermediate frequency, suppressing oscillations of a frequency adjacent to the first intermediate frequency and lying on one side only thereof, heterodyning the resultant oscillations to produce oscillations of a second intermediate frequency, suppressing oscillations of a frequency adjacent to said second intermediate frequency and lying on the other side only of said intermediate frequency, detecting the resultant oscillations, and controlling the frequency of the local oscillations in the second heterodyning step to regulate the effective band width of the signal produced at the output of the second intermediate frequency suppression step.

4. The method of controlling the admittance band width of a high frequency receiver and the position of a received carrier wave in the admittance band of the receiver, which comprises heterodyning the oscillations to produce oscillations of a first intermediate frequency, suppressing oscillations of a frequency adjacent to the first intermediate frequency and lying on one side thereof, heterodyning the resultant oscillations to produce oscillations of a second intermediate frequency, suppressing oscillations of a frequency adjacent to said second intermediate frequency and lying on the other side of said intermediate frequency, detecting the resultant oscillations, controlling the frequency of the local oscillation in the second heterodyning step to regulate the band width of the admitted signal, and regulating the frequency of the first heterodyning step to control the position of the signal carrier wave in the over-all admittance band.

5. High frequency selecting apparatus, comprising, in combination, means for heterodyning oscillations to produce oscillations of a first intermediate frequency, means for suppressing os-

cillations having a frequency adjacent to and lying on one side only of the intermediate frequency, means for heterodyning the resultant oscillations to produce oscillations of a second intermediate frequency, means for suppressing oscillations having a frequency adjacent to said second intermediate frequency and lying on the other side only thereof, means for detecting the resultant oscillations, and means for varying the effective band width of signal produced at the output of the second suppressing means, said means comprising means for varying the frequency of the local oscillator in the second heterodyne.

6. High frequency selecting apparatus, comprising, in combination, means for heterodyning oscillations to produce oscillations of a first intermediate frequency, means for suppressing oscillations having a frequency adjacent to and lying on one side only of said intermediate frequency, means for heterodyning the resultant oscillations to produce oscillations of a second intermediate frequency, means for suppressing oscillations having a frequency adjacent to said second intermediate frequency and lying on the other side only thereof, means for detecting the resultant oscillations, and means for smoothly and continuously varying the over-all admittance band width of the signal produced at the output of the second intermediate frequency suppressing means, said means comprising manual means for continuously varying the frequency of the local oscillation in the second heterodyne.

7. In a radio receiver for receiving continuous wave telegraph signals of constant frequency, in combination, a local oscillator for heterodyning incoming signals, a frequency selective intermediate frequency circuit, a tone frequency generator, means for deviating the frequency of the local oscillator at the frequency of said tone generator to produce frequency modulated intermediate frequency signals, means for converting said frequency modulated signals to amplitude modulated signals, and means for detecting said amplitude modulated signals.

8. The method of receiving a continuous wave signal having a fixed carrier frequency, which comprises, selecting the desired incoming signal, frequency modulating said selected signal with an audio-frequency tone, sharply attenuating frequencies of said frequency modulated selected signal lying on one side of a predetermined value to produce amplitude modulation on said signal, and detecting the amplitude modulated signal so produced.

9. In a superheterodyne receiver, in combination, a first conversion oscillator, an intermediate frequency circuit having a sharply defined frequency cut-off on one side only of its response curve, a second frequency adjustable conversion oscillator, a second intermediate frequency circuit having a sharply defined frequency cut-off on the other side only of its response curve, and means for adjusting the effective band width of the signal produced at the output of the second intermediate frequency circuit, said means comprising manual means for adjusting the frequency of said second conversion oscillator.

10. The combination claimed in claim 9, with means for frequency modulating said second conversion oscillator.

11. The combination claimed in claim 9, with means for frequency modulating said second conversion oscillator at an audio rate.

12. The combination claimed in claim 9, with means for frequency modulating said second conversion oscillator at an audio rate, and means associated with said first-mentioned intermediate frequency circuit for controlling the amount of said frequency modulation in accordance with received signal impulses.

13. In a receiver for receiving continuous wave signals having a fixed carrier frequency, in combination, a frequency selective circuit, means for passing received signals through said selective circuit, electronic means for altering the tuning of said selective circuit at an audio rate, whereby audio amplitude modulation of continuous wave signals is produced, and means for detecting the amplitude modulated signals so produced.

14. The method of receiving continuous wave telegraph signals of fixed frequency in a path having a variable signal admission band width characteristic, which comprises collecting incoming energy, selecting that portion of the collected energy which falls within a predetermined frequency band width and continuously varying the band width periodically from zero through intervening values to a predetermined value.

15. The method recited in claim 14, in which said signal admission band width is varied at an audible rate.

16. The method of receiving continuous wave telegraph signals having a fixed frequency which comprises collecting incoming signal energy, periodically deviating the frequency thereof, said deviation being of such value as to introduce a component of double the deviation frequency, selecting portions thereof which lie between predetermined frequency limits to produce amplitude modulation thereof, and detecting the amplitude modulated signal so produced.

17. In a superheterodyne receiver, in combination, a first conversion oscillator, a first intermediate frequency selective circuit, a second conversion oscillator, a second intermediate frequency circuit having a high side cut-off circuit and a low side cut-off circuit in tandem, and means for deviating the frequency of said second conversion oscillator.

18. In a receiver for receiving continuous wave telegraph signals having a fixed carrier frequency, means for selecting signals to be received; means for heterodyning said signals to produce signals of a different frequency; a selecting circuit through which said heterodyned signals are passed, said selecting circuit having characteristics such as to pass signals of a finite band width and means for varying the band width of the signal produced at the output of said selective circuit periodically at an audible rate.

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