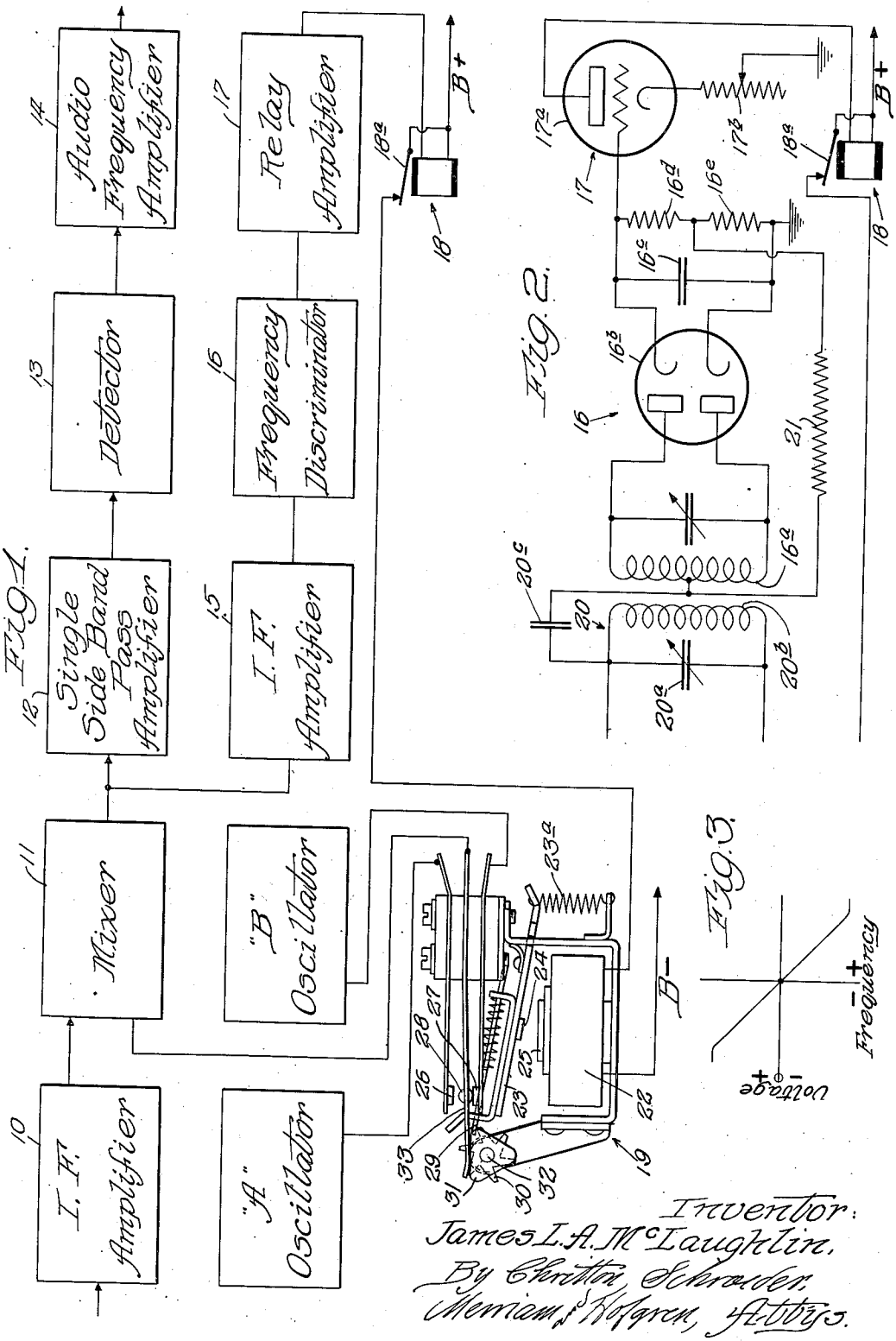
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AUTOMATIC HETERODYNE ELIMINATOR

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AUTOMATIC HETERODYNE ELIMINATOR

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14 Claims. (Cl. 250—20)

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This application relates to a heterodyne eliminator, and more particularly to an apparatus adapted to automatically eliminate an undesired signal so closely adjacent a desired signal that it lies in one of the sidebands associated with the desired signal and causes highly objectionable heterodyne interference.

One feature of this invention is that it provides improved apparatus for eliminating undesired signals and heterodyne interference caused thereby; another feature of this invention is that it provides automatic means for changing the frequency characteristics of an undesired signal without changing the frequency characteristics of the desired signal; yet another feature is that either of the two sidebands associated with a desired signal is rapidly and automatically selected, the other sideband being attenuated; a further feature of this invention is that it provides radio receiving apparatus able to automatically cut through and get a desired signal in the face of interference otherwise rendering such a signal unintelligible; and still another feature of this invention is that it provides an improved indication of correct tuning to a desired signal; other features and advantages of this invention will be apparent from the following specification and the drawings, in which:

Figure 1 is primarily a schematic block diagram of apparatus including a preferred embodiment of my invention with the machanical construction of a portion of one feature of my invention shown in detail; Figure 2 is a schematic diagram of part of the apparatus shown in Figure 1 and included in my invention; and Figure 3 is a voltage versus frequency curve of a frequency discriminator such as is used in my invention.

A radio signal normally comprises three component parts, a carrier wave of fixed frequency and two sidebands of varying width created by modulation of the carrier wave with the intelligence which it is desired to transmit. Receiving apparatus can, of course, be designed with almost any desired amount of selectivity, but making the circuits too selective results in chopping off the outer edges of the sidebands and in losing part of the intelligence. Accordingly, the usual radio receiver is provided with a selectivity of about ten kilocycles width, designed to receive the carrier and two sidebands extending out to about 5,000 cycles on each side thereof. An even wider reception band is desirable for high fidelity reproduction; and anything narrower than about 6,000 cycles not only loses the higher notes of

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music, but even tends to make speech unintelligible.

It will be understood that the above discussion is directed to the type of amplitude modulation now generally used conventionally, and my invention will be described in connection with such a system. It will be understood, however, that my invention will also find use with very narrow band radio telegraphy signals, or very wide band frequency modulated signals. The principles are the same in each case, and it is thought that it would unduly complicate the disclosure of my invention if an effort were to be made to describe it in connection with every possible system of transmittion and reception.

When an undesired signal carrier wave lies within a sideband, therefore, the ordinary radio receiving system is unable to eliminate it and it heterodynes with the desired signal carrier to produce an annoying single frequency tone which substantially or entirely crowds out the desired intelligence. For example, a pair of undesired signal carriers one and one-half kc. and two kc. lower in frequency than the desired carrier results in the production of three heterodyne beat notes of 500 cycles, 1500 cycles, and 2000 cycles per second. If the undesired carriers are of substantial voltage amplitude the resultant beat notes will entirely blanket out the desired intelligence.

As disclosed in my Patent No. 2,364,863, issued December 12, 1944 I have found that under such conditions selection of the upper sideband and elimination of the lower sideband will entirely remove the undesired signals and their heterodyne interference without losing the intelligence, since it has long been known that all of the desired intelligence can be derived from a single sideband, single sideband transmission and reception having been used in certain specialized phases of radio work such as transoceanic radio telephony.

In carrying out my present invention my preferred apparatus comprises switch actuated means whereby the receiver may be operated as a conventional receiver or as a single sideband receiver; and in the latter case the upper or the lower sideband is automatically selected depending upon which sideband contains no unwanted interference. I have found that such selection can be best accomplished by using two oscillators, one a certain frequency above the frequency of the desired signal and the other an equal frequency below the frequency of the desired signal, and causing one or the other oscillator to heterodyne with the input which contains both the desired and undesired signal, the selection of the

oscillator being made automatically as a function of the undesired signal. In conjunction with this arrangement I employ a band pass filter cutting off sharply below the changed frequency of the desired signal, and passing 4 or 5 kilocycles of frequencies above that of the changed desired signal, so that only one sideband is selected to furnish the desired intelligence.

The use of two such different heterodyning oscillators enables the elimination of two completely separate single band pass amplifiers, so that either sideband may be readily chosen with only a single band pass amplifier. It will be understood that this arrangement is applicable to single sideband transmitters as well as to receivers, although it is here being disclosed only in connection with a receiver.

In the particular embodiment of my invention illustrated herewith it will be understood that the signal delivered to the intermediate frequency amplifier designated as 10 in Figure 1 is a desired signal at a conventional intermediate frequency. That is, my apparatus as disclosed in Figure 1 would be preceded by a conventional radio frequency amplifier, preferably tuned, a tuning oscillator and a mixer so that the desired radio frequency signal would be changed to a frequency intended for usual intermediate frequency use, as 455 kc. per second. Thus in a complete receiver embodying my invention there may be two stages of heterodyning through which the radio frequency signal passes before it is rectified to provide the audio-frequency intelligence, and I am terming the first intermediate frequency, which is the frequency delivered to the intermediate frequency amplifier designated at 10 in the particular embodiment of my invention shown in Figure 1 the desired signal, it being understood that this is lower than the original radio frequency signal, but higher than the second intermediate frequency.

By adjustment of the receiver tuning oscillator, therefore, the desired radio frequency signal has been converted to a frequency of 455 kc., this being the input to IF amplifier 10. This signal has two sidebands four or five thousand cycles in width associated with it, and an undesired carrier frequency may have come through as a frequency of, for example, 452 kc., lying in the lower sideband.

I make use of two crystal oscillators, one adapted to oscillate precisely at a certain frequency above and the other adapted to oscillate at the same frequency below the frequency of the desired signal. In Figure 1 I have indicated one of these crystal oscillators as "A," this oscillator operating at a certain frequency below the frequency of the desired signal, as 405 kc.; and the other as crystal oscillator "B," this operating at the same frequency above the frequency of the desired signal, as 505 kc. Since both differ in frequency exactly 50 kc. from the frequency of the desired signal, heterodyning of the output of either of these oscillators with the desired signal in the mixer 11 will result in a changed desired signal of 50 kc. This changed signal will, of course, still have its sidebands with it. The undesired signal, however, can now be made to lie in either sideband depending upon the oscillator used. If oscillator "A" is supplied to the mixer for heterodyning operation the undesired signal will have a frequency of 47 kc. in the case assumed, while if oscillator "B" is used as shown in Figure 1 the undesired signal will have a frequency of 53 kc.

The output of the mixer is divided into two portions, one being supplied to a single sideband pass amplifier 12 adapted to pass a frequency band from 50 to 54 kc., said amplifier being designed to cut off sharply below 50 kc. The output of this single sideband pass amplifier is supplied in a conventional manner to a detector 13 and then to an audio-frequency amplifier 14 to provide the desired audio output.

The general operation of the system heretofore described is in accordance with the system disclosed in my aforementioned Patent No. 2,364,863 and I have not illustrated the circuits of the various portions of a receiver operating in the manner just described since reference may be had to such patent to supplement the present disclosure in such regard.

My apparatus shown diagrammatically in Figure 1 would be preceded by the radio frequency amplifier, tuning oscillator and mixer of a conventional receiver, preferably of the communications type; my intermediate frequency amplifier 10 would be built in accordance with standard intermediate amplifier practice; my oscillators "A" and "B" would each in themselves be conventional fixed oscillators precision controlled to the desired frequency; the mixer 11 would, of course, follow conventional practice, as would also the single sideband pass amplifier 12, the detector 13, and the audio frequency amplifier 14.

Whereas the apparatus utilizing switching disclosed in my prior Patent No. 2,364,863 depended upon manual switching means to select the correct oscillator to eliminate the heterodyne interference, my present invention makes such selection by means of a switch which is operated by the interference itself as a function of the conditions in the sidebands and which automatically selects the correct oscillator to eliminate the sideband containing the heterodyne interference. Such automatic heterodyne switching permits more rapid action, and in the presence of interference such as is so often encountered in time of war wherein the enemy attempts to block radio reception by rapidly shifting an interfering signal back and forth across the frequency of the desired signal, my new system will automatically switch the interference out as fast as it shifts from one sideband to the other.

In accordance with my present invention the other portion of the output of the mixer 11 is fed into another intermediate frequency amplifier 15 which is tuned to the frequency of the changed desired signal, and this amplifier's output wave constitutes the input signal for a frequency discriminator 16 which is adapted to convert frequency difference into an actuating voltage. This voltage is applied to the input of a relay amplifier stage 17, and results in a changed output current from said stage. The change in output current actuates a first or control relay 18, which in turn actuates a second or impulse relay 19, said impulse relay being adapted to select either oscillator "A" or oscillator "B" to heterodyne with the input signal as conditions may warrant, as will be hereafter explained.

Assuming that the desired signal of 455 kc. which comprises the input to IF amplifier 10 has two sidebands of 5 kc. each associated with it, and that the lower sideband contains an undesired signal of a frequency of 452 kc. (such frequencies of 455 kc. and 452 kc. having been converted from higher radio frequencies in prior stages of the receiver), and that "B" oscillator is fixed at 505 kc. and is connected to the mixer

11, then the output of mixer 11 will contain the desired signal now changed to 50 kc. with its associated sidebands, the undesired signal being now included in the upper sideband as a frequency of 53 kc. A portion of the output of mixer 11 is delivered to the single sideband pass amplifier 12 which is designed to pass and amplify frequencies of from 50 to about 54 kc., but to cut off sharply below 50 kc., and to taper off in its acceptance of frequencies above about 54 kc. The output of this amplifier, now containing only one sideband, is supplied in conventional manner to a detector and then to an audio frequency amplifier to provide the desired audio output, the operation of the system up to this point being similar to that described and shown in somewhat greater detail in my aforementioned Patent 2,364,863.

My present invention lies in the novel use which is made of the other portion of the output of mixer 11. Referring now to Figure 2, the tuned circuit 20, including the condenser 20*a* and the inductance 20*b*, comprises the output circuit of a conventional intermediate frequency amplifier designated generally as 15 in Figure 1. This amplifier receives the other portion of the output of mixer 11, and is tuned to pass 50 kc. and sidebands on each side thereof, the tuning of its output circuit being accomplished by varying the condenser 20*a* in the particular circuit illustrated, but it will be understood that such tuning and the tuning of other circuits illustrated in the drawings could also be accomplished by means of a variable inductance, or in any other conventional manner, and my invention should not be limited to any particular way of tuning the tuned circuits called for. The output of the 50 kc. IF amplifier 15 containing the changed desired signal of 50 kc. with its associated sidebands, the upper sideband including the changed undesired signal of 53 kc., is delivered to a frequency discriminator stage shown generally as 16 through both inductive and capacitive coupling, the latter being through the condenser 20*c*, which may have a value of 100 micromicrofarad. Such frequency discriminator may be of any conventional type, the particular discriminator illustrated in Figure 2 comprising a tuned input circuit 16*a* which is tuned to 50 kc.; two diodes 16*b*, which may be contained in the same envelope, as in a type No. 6H6 tube; an output circuit comprising the condenser 16*c* and the resistor 16*d* and 16*e*; and a circuit connecting the electrical center of the output circuit to the electrical center of the input circuit, and including resistor 21. The output of the frequency discriminator stage 16 comprises the input of a relay amplifier stage 17, the discriminator output being shown as directly coupled to the control grid of the tube 17*a*, which may be a tube type No. 6V6 connected as a triode. The flow of plate current through tube 17*a* is controlled by the variable resistor 17*b* connected between the cathode and ground, and is adjusted so that with no output from the frequency discriminator, just enough plate current flows to operate the control relay 18, which is connected in the plate circuit of the tube, so that with no output from the discriminator the relay contact 18*a* is pulled down to the position other than that shown in Figures 1 and 2. In a particular system which I have built incorporating my invention, the control relay 18 is adjusted to operate at 25 milliamperes and to release at 23 milliamperes, and the cathode resistor 17*b* is adjusted so that the relay just operates in the absence of any actuating voltage in the output of the discriminator. The relay arm 18*a* is spring biased to the position shown in the drawings when the relay is released, i. e., when the energizing current drops below 23 milliamperes in the example given.

A frequency discriminator operates to convert frequencies which vary from a selected frequency, and which are presented to its input, into voltage variations in its output circuit. In the particular circuit shown generally at 16 in the drawings, the input circuit 16*a* is tuned to 50 kc. When a frequency of 50 kc. is presented to the input circuit, the phase relationships are such that each half of the diode 16*b* is caused to conduct equally, and the total voltage across resistors 16*d* and 16*e* in the output circuit is zero. When a frequency higher than 50 kc. is presented to the input, the phase relationships are such that the diodes no longer conduct equally, and a negative voltage appears across resistors 16*d* and 16*e* in the output circuit, as shown graphically in Figure 3; and when a frequency lower than 50 kc. is presented to the input, a positive voltage appears across resistors 16*d* and 16*e* in the output circuit.

In the case assumed above, two frequencies are presented to the input. Of course, since the changed desired frequency of 50 kc. is the frequency to which the discriminator is tuned, no voltage change across the output results therefrom. However, the changed undesired frequency of 53 kc. results, as shown in Figure 3, in a negative voltage appearing across resistors 16*d* and 16*e*. This negative voltage is coupled to the grid of tube 17*a*, and causes a reduced flow of plate current through this tube in the conventional manner. When the plate current is reduced, relay 18 is de-energized, and the relay arm moves into the position shown in Figures 1 and 2. As will be seen from Figure 1, this causes energization of the coil 22 of a second or impulse relay 19, and the arm 23 of this relay is drawn down to a substantially horizontal position (when the relay is positioned as in Figure 1), further downward progress of the arm being prevented when the projection 24 strikes the core 25. The arm 23 is biased by the spring 23*a* to return to its upward or release position upon de-energization of the coil 22 in the conventional manner, but contrary to conventional relay operation, when the arm returns to its release position the relay contacts are not moved, the position of such contacts being changed only when the relay arm 23 moves from its release position to its operating position upon energization of the coil. This action is obtained by providing two stationary contacts 26 and 27, and one contact 28 which is movable between two positions, and which engages contact 26 in one position, and engages contact 27 in the other position. Movement of contact 28 between its two positions is accomplished by means of a pawl 29 attached to relay arm 23 and cooperating with a six toothed ratchet 30 which is rigidly mounted together with a three sided cam 31 on a shaft 32. Contact 28 is mounted on an arm 33 of spring material, and is biased to normally engage contact 27, the end of the contact arm 33 engaging the cam 31. Upon movement of the relay arm 23 from its release position as shown in the drawing to its operate position, the pawl 29 engages a tooth of the ratchet and moves the shaft holding the ratchet and the cam through one-sixth

of a cycle, or 60°. The end of the spring arm 33 which is shown as cooperating with the flat side of the cam so that the contact 28 engages the contact 27 in the drawing now rides onto the adjoining apex of the cam, and the movable contact 28 now engages contact 26. When the coil 22 is de-energized the pawl 29 slides over the cooperating tooth of ratchet 30, and the position of the contacts is not disturbed. The movable contact 28 is connected to the input of the mixer, stationary contact 26 is connected to the output of "A" oscillator, and contact 27 is connected to the output of "B" oscillator, so that each time the impulse relay 19 is energized one or the other of the oscillators is selected to feed the mixer.

In the assumed case, when impulse relay coil 22 becomes energized, contact 28 is moved by the operation of the above described mechanism to engage contact 26, and "B" oscillator, being the 505 kc. oscillator, is switched out while "A" oscillator, being the 405 kc. oscillator, is switched into the operating circuit. Now the undesired signal of 452 kc. beats with 405 kc. and is changed to a frequency of 47 kc., and is eliminated by the single sideband pass amplifier 12, the opposite sideband of 50–54 kc., which is free of the undesired signal, being delivered to the detector 13 and thence to the audio amplifier 14.

The other portion of the output of mixer stage 11, also containing the changed undesired signal of 47 kc., is amplified by the IF amplifier 15 and presented to the frequency discriminator 16. Since this undesired signal is of lower frequency than the frequency to which the discriminator is tuned, a positive voltage appears at the discriminator output as shown by Figure 3. The positive voltage is applied to the grid of tube 17*a*, causing an increase in plate current through this tube, and consequently relay 18 is energized, and arm 18*a* pulls down, breaking the circuit to the impulse relay 19. The impulse relay is de-energized, and its arm 23 moves to the position shown in the drawing, but the position of the contacts of such relay remains unchanged as heretofore explained.

It will be noted that when the frequency of the changed undesired signal is lower than the frequency of the changed desired signal at the input to the frequency discriminator, the plate current of the tube 17*a* is increased, causing relay 18 to operate, or to hold harder if it was already operated. On the other hand, if the frequency of the changed undesired signal is higher than the frequency of the changed desired signal at the input to the frequency discriminator, the plate current of tube 17*a* is decreased, causing relay 18 to release, and this in turn causes relay 19 to be energized with a consequent switching of oscillators.

Thus if "B" oscillator is switched in and an undesired signal initially of higher frequency than the desired signal, as 458 kc., appears at the input of IF amplifier 10, the desired frequency will again be changed to 50 kc., but the undesired frequency will now be changed to 47 kc. This frequency will be blocked by the single sideband pass amplifier 12, which passes only 50 to 54 kc. The other portion of this signal which is delivered to the frequency discriminator causes increased plate current through tube 17*a*, with the result that relay 18 is not released, but is caused to hold harder, and consequently no shifting of oscillators occurs.

In the event that contact 28 engages contact 26 when the set is first turned on so that "A" oscillator is switched in, an undesired signal higher than the desired signal at the IF amplifier 10 will result in a switching of oscillators, while an undesired signal lower than the desired signal will not result in a switching of oscillators, and in both cases the undesired signal will ultimately be changed to a frequency which is eliminated by the band pass amplifier 12.

Another advantage of my invention is that, even if no undesired signals are present in the sidebands of the desired signal, a tuning indication is given the operator enabling him to obtain greater accuracy of tuning than is possible with a conventional radio receiver. It will be seen from Figure 3 that when the desired signal is tuned in correctly the frequency discriminator has an output of zero volts, and the relay amplifier tube 17*a* is operating with normal plate current, holding relay 18 in operate position. If the desired signal is incorrectly tuned, the impulse relay 19 will automatically switch over to the other oscillator whenever the changed signal places a negative voltage on the grid of the relay amplifier tube 17*a*. Consequently, as the operator tunes into a desired signal, the system will automatically switch the sidebands as the tuning control crosses the correct setting, and a slight "rocking" of the tuning knob on both sides of the correct setting will result in a clicking sound as the relays operate and release, giving the operator an audible indication by which to obtain accurate tuning. The selectivity of tuning thus obtained can be broadened by increasing the current through the relay amplifier tube 17*a* by adjusting the variable resistor 17*b*.

An operative circuit embodying my invention might contain, in those portions here being first disclosed, parts having the values and characteristics hereinafter immediately stated. The control relay should be a sensitive relay, and may be of about 2500 ohms resistance and adjusted to operate at 25 milliamperes and to release at 23 milliamperes. The cathode resistor 17*b*, with a tube of the type suggested, may be 5000 ohms; resistors 16*d* and 16*e* may be of 100,000 ohms each; and resistor 21 may be 75,000 ohms. The inductances 20*b* and 16*a* may be each 30 millihenrys, and the condenser 16*c* 500 micromicrofarads, for a discriminator tuned to 50 kc. In one system which I have built a B+ voltage of 250 volts is used for the plate voltage of tube 17*a* and to energize impulse relay 19. The rest of my system may use parts of values in accordance with conventional receiver practice.

While I have shown and described a certain embodiment of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. Radio receiving apparatus of the character described adapted to eliminate an undesired signal closely adjacent a desired signal having sidebands associated therewith, including: means for providing a desired signal having sidebands associated therewith; means for providing two separate waves, one having a frequency equal to that of the desired signal plus a certain frequency and the other having a frequency equal to that of the desired signal less said certain frequency, whereby heterodyning of said waves with the desired signal changes the frequency of the desired signal

to the same frequency in both cases while changing that of the undesired signal to different frequencies; and apparatus automatically operable as a function of undesired signal conditions in the sidebands for selecting one of said waves to heterodyne with the desired signal and for eliminating the changed undesired signal while retaining the changed desired signal.

2. Radio receiving apparatus of the character described adapted to eliminate an undesired signal closely adjacent a desired signal having upper and lower sidebands associated therewith, including: means for providing a converted desired signal of a predetermined frequency having converted sidebands; means for providing two separate waves of fixed frequencies, one having a frequency equal to said predetermined frequency plus a certain frequency and the other having a frequency equal to said predetermined frequency less said certain frequency, whereby heterodyning of said waves with the converted desired signal changes its frequency to the same frequency in both cases while changing that of the converted undesired signal to different frequencies; and apparatus automatically operable in response to said converted undesired signal for selecting one of said waves to heterodyne with the converted desired signal and for eliminating the changed undesired signal while retaining the changed desired signal.

3. Radio receiving apparatus of the character described adapted to eliminate an undesired signal closely adjacent a desired signal having upper and lower sidebands associated therewith, including: means for providing a changed desired signal of a predetermined frequency having changed sidebands; a band pass filter circuit adapted to pass one of said changed sidebands and exclude the other; and switch-actuated electrical apparatus separate from said tunable means and automatically operable as a function of undesired signal conditions in the sidebands, for selectively reversing the order of said sidebands whereby one or the other of said sidebands lies within the pass band of the filter circuit.

4. Apparatus of the character described, including: means for providing a desired signal having sidebands associated therewith; an intermediate frequency band pass filter circuit adapted to pass one of said sidebands and exclude the other; means for providing two separate waves, one having a frequency equal to that of the desired signal plus the intermediate frequency and the other having a frequency equal to that of the desired signal less the intermediate frequency; and automatic electrical apparatus operable in response to the presence of undesired energy in the sidebands for selectively causing one or the other of said waves to heterodyne with the desired signal to select which of said sidebands is to be passed by the filter circuit.

5. Radio receiving apparatus of the character described adapted to eliminate an undesired signal closely adjacent a desired signal having sidebands associated therewith, including: means for providing a desired signal having sidebands associated therewith; two oscillators, one having a frequency equal to that of the desired signal plus a certain frequency and the other having a frequency equal to that of the desired signal less said certain frequency, whereby heterodyning of said oscillators with the desired signal changes the frequency of the desired signal to the same

frequency in both cases while changing that of the undesired signal to different frequencies; and electrical apparatus including a circuit automatically actuated as a function of undesired signal conditions in the sidebands for selectively causing one or the other of said oscillators to heterodyne with the desired signal and for eliminating the changed undesired signal while retaining the changed desired signal.

6. Apparatus of the character described, including: means for providing a desired signal having sidebands associated therewith; and intermediate frequency band pass filter circuit adapted to pass one of said sidebands and exclude the other; two oscillators, one having a frequency equal to that of the desired signal plus the intermediate frequency and the other having a frequency equal to that of the desired signal less the intermediate frequency; and an automatic device operable in response to the presence of an undesired signal in the sidebands for selectively causing one or the other of said oscillators to heterodyne with the desired signal to select which of said sidebands is to be passed by the filter circuit.

7. Radio receiving apparatus of the character described adapted to eliminate an undesired signal closely adjacent a desired signal having sidebands associated therewith, including: means for providing a desired signal having sidebands associated therewith; an intermediate frequency band pass filter circuit adapted to pass one of said sidebands and exclude the other; two oscillators, one having a frequency equal to that of the desired signal plus the intermediate frequency and the other having a frequency equal to that of the desired signal less the intermediate frequency; an electrical device automatically operable as a function of undesirable signal conditions in one of the sidebands for selectively causing one or the other of said oscillators to heterodyne with the desired signal to select which of said sidebands is to be passed by the filter circuit; and means for rectifying the sideband passed by said filter circuit.

8. Radio receiving apparatus of the character described adapted to eliminate an undesired signal closely adjacent a desired signal having sidebands associated therewith, including: means for providing a desired signal having sidebands associated therewith; two oscillators, one having a frequency equal to that of the desired signal plus a certain frequency and the other having a frequency equal to that of the desired signal less said certain frequency, whereby heterodyning of said oscillators with the desired signal changes the frequency of the desired signal to the same frequency in both cases while changing that of the undesired signal to different frequencies; a band pass filter circuit adapted to pass one of the sidebands associated with the changed desired signal and exclude the other; and automatic electrical apparatus operable in response to the presence of said undesired signal in one of said sidebands for selectively causing one or the other of said oscillators to heterodyne with the desired signal to select which of said sidebands is to be passed by the filter circuit.

9. Apparatus of the character claimed in claim 8 wherein said electrical apparatus includes impulse-operated switch means.

10. Radio receiving apparatus of the character described adapted to eliminate an undesired signal closely adjacent a desired signal having sidebands associated therewith, including: means for

providing a desired signal having sidebands associated therewith; means adapted to pass one of said sidebands and to exclude the other; means for providing two separate waves, one having a frequency equal to that of the desired signal plus a certain frequency and the other having a frequency equal to that of the desired signal less said certain frequency; and an automatic relay device operable in response to the presence of said undesired signal in one of said sidebands for selectively causing one or the other of said waves to heterodyne with the desired signal to select which of said sidebands is to be passed.

11. Radio receiving apparatus of the character described adapted to eliminate an undesired signal closely adjacent a desired signal having sidebands associated therewith, including: means for providing a desired signal having sidebands associated therewith; an intermediate frequency band pass filter circuit adapted to pass one of said sidebands and exclude the other; two oscillators, one having a frequency equal to that of the desired signal plus the intermediate frequency and the other having a frequency equal to that of the desired signal less the intermediate frequency; and relay apparatus responsive to the presence of said undesired signal in one of said sidebands for selectively causing one or the other of said oscillators to heterodyne with the desired signal to select which of said sidebands is to be passed by the filter circuit.

12. Apparatus of the character described, including: means for providing a desired signal having sidebands associated therewith; a band pass filter circuit adapted to pass one of said sidebands and exclude the other; means for providing two separate waves, one having a frequency equal to that of the desired signal plus a certain frequency and the other having a frequency equal to that of the desired signal less said certain frequency, whereby heterodyning of said waves with the desired signal changes the frequency of the desired signal to the same frequency in both cases while changing that of the undesired signal to different frequencies; apparatus for converting frequencies different from the frequency of the changed desired signal to an actuating voltage; and automatically operable apparatus controlled by such voltage, and operable selectively to cause one or the other of said waves to heterodyne with the desired signal to select which of said sidebands is to be passed by the filter circuit.

13. Radio receiving apparatus of the character described adapted to eliminate an undesired signal closely adjacent a desired signal having sidebands associated therewith, including: means for providing a desired signal having sidebands associated therewith; an intermediate frequency band pass filter circuit adapted to pass one of said sidebands and exclude the other; means for providing two separate waves, one having a frequency equal to that of the desired signal plus the intermediate frequency and the other having a frequency equal to that of the desired signal less the intermediate frequency, whereby heterodyning of said waves with the desired signal changes the frequency of the desired signal to the same frequency in both cases while changing that of the undesired signal to different frequencies; a frequency discriminator for converting frequencies different from the frequency of the changed desired signal to an actuating voltage; a first relay connected to be actuated by such voltage; and a second relay connected to be operated by actuation of said first relay, and operable selectively to cause one or the other of said waves to heterodyne with the desired signal to select which of said sidebands is to be passed by the filter circuit.

14. Radio receiving apparatus of the character described adapted to eliminate an undesired signal closely adjacent a desired signal having sidebands associated therewith, including: means for providing a desired signal having sidebands associated therewith; an intermediate frequency band pass filter circuit adapted to pass one of said sidebands and exclude the other; two oscillators, one having a frequency equal to that of the desired signal plus the intermediate frequency and the other having a frequency equal to that of the desired signal less the intermediate frequency, whereby heterodyning of said oscillators with the desired signal changes the frequency of the desired signal to the same frequency in both cases while changing that of the undesired signal to different frequencies; a frequency discriminator for converting frequencies different from the frequency of the changed desired signal to an actuating voltage; a first relay controlled by such voltage; and a second relay connected to be operated by actuation of said first relay, and operable selectively to cause one of the other of said oscillators to heterodyne with the desired signal to select which of said sidebands is to be passed by the filter circuit.

JAMES L. A. McLAUGHLIN.

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