Nov. 1, 1938. J. PLEBANSKI 2,135,051

SUPERHETERODYNE RECEIVING SYSTEM

Filed April 29, 1937 2 Sheets-Sheet 1

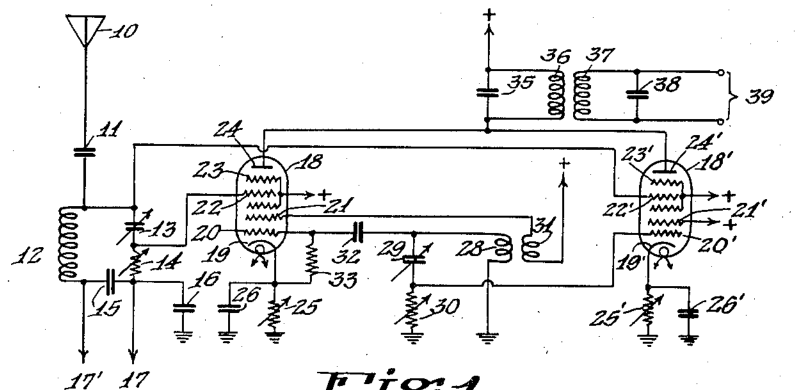

Fig: 1

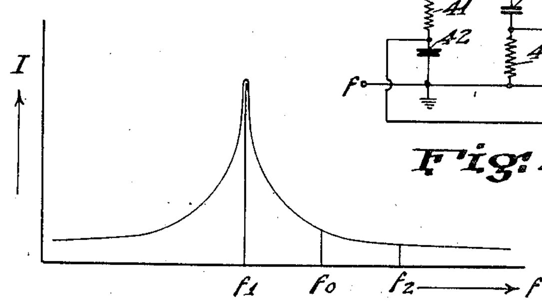

Fig: 2

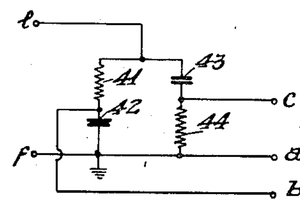

Fig: 4

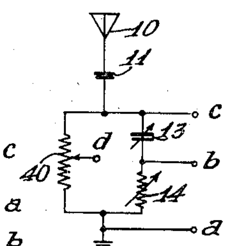

Fig: 3

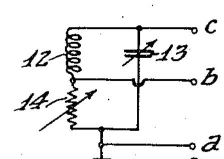

Fig: 5

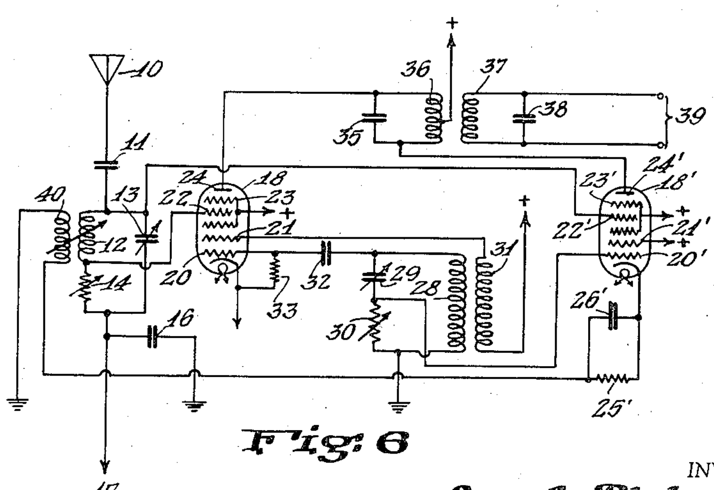

Fig: 6

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SUPERHETERODYNE RECEIVING SYSTEM

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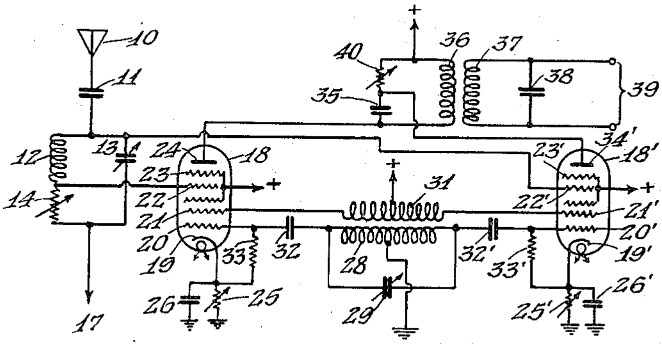

Fig: 7

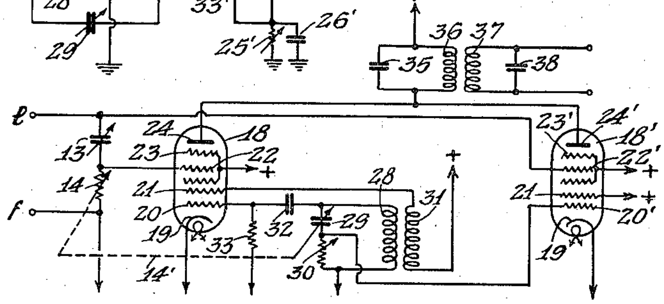

Fig: 8

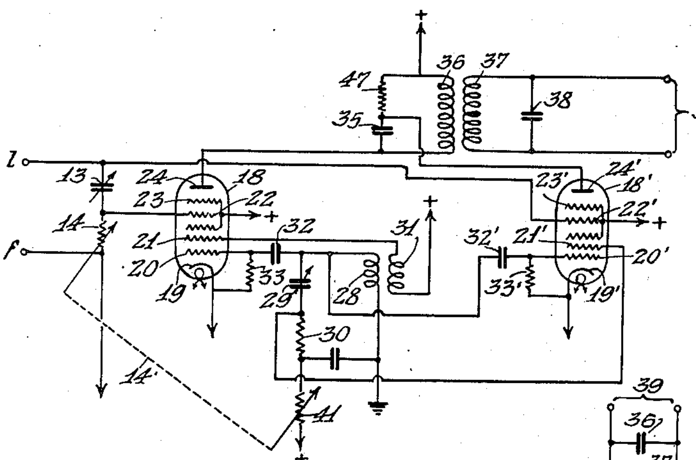

Fig: 9

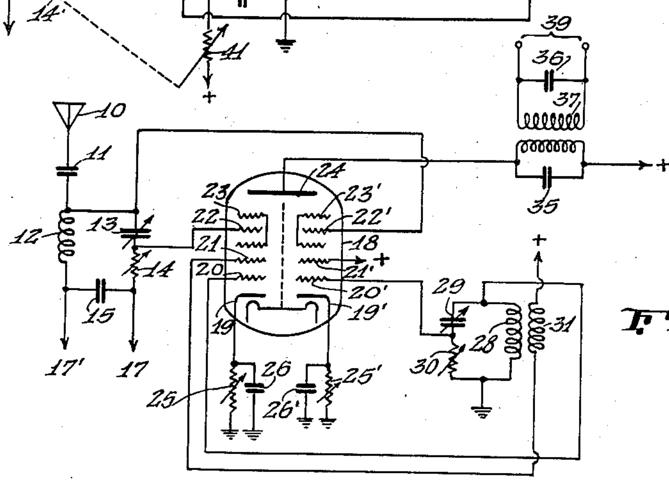

Fig: 10

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UNITED STATES PATENT OFFICE

2,135,051

SUPERHETERODYNE RECEIVING SYSTEM

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Application April 29, 1937, Serial No. 139,638
In Poland December 1, 1936

17 Claims. (Cl. 250—20)

The present invention relates to amplifiers, more particularly amplifiers of the superheterodyne type as used in radio receivers and the like, wherein an incoming signalling wave is combined with a locally produced oscillation to secure an intermediate or beat frequency signal applied to an intermediate amplifier designed for efficiently amplifying the intermediate frequency signal.

In general, the object of the invention is the provision of a novel circuit system of the above general character and a method of operating the same by which an interfering signal having a frequency differing from the frequency of the desired signal is canceled and its effect upon the receiver substantially eliminated.

A more specific object of the invention is the provision of a system for and a method of eliminating the so-called image frequency interference produced in amplifiers of the above character.

Another object is the provision of an automatic image frequency rejecting system in a superheterodyne radio receiver which is equally effective for all operating frequencies within the receiving range for which the receiver is designed to operate.

A further object is the provision of an automatic image rejector system for a superheterodyne receiver which is equally effective over the entire frequency range of the receiver, thereby enabling the use of a limited number of preselection or amplifying stages or to entirely eliminate pre-selection of the incoming signal.

The above and further objects and features of the invention will become more apparent from the following detailed description taken with reference to the accompanying drawings forming part of this specification and wherein

Figure 1 is a circuit diagram showing the superheterodyne or mixing section of a radio receiver or the like constructed in accordance with the invention,

Figure 2 is a resonance curve of the input circuit of Figure 1,

Figures 3 to 5 show modifications of input circuits embodied in Figure 1,

Figures 6 to 10 illustrate further modifications of a superheterodyne system according to the invention shown in the previous illustrations.

Like reference numerals identify like parts throughout the different views of the drawing.

With the afore-mentioned objects in view, the invention in general contemplates the provision of a system for and a method of automatically balancing out or cancelling the image frequency current obtained in the output circuit of the first detector or mixer section of a superheterodyne receiver by means of a current of opposite phase, thereby enabling a complete elimination of the interference rather than merely attenuating it as in the case of systems and methods known in the prior art.

As is well known, if an incoming signalling wave having a frequency f_s is combined with a locally produced or heterodyne signal having a frequency f_h by means of a modulator or mixer of any of the well known types, an intermediate or beat frequency signal is obtained having a frequency f_i equal to the difference of the incoming and local oscillations, viz. $f_h - f_s$. If a further signal having a frequency $f_s + 2f_i$ is simultaneously received, it will mix with the heterodyne frequency f_h and produce the same intermediate frequency thereby causing interference with the desired receiving signal.

According to known methods, this interfering signal also known as image frequency due to its location relative to the signal frequency like an object to its image on opposite sides of the local or heterodyne frequency is attenuated before it reaches the first detector or mixer stage in the receiver. In this way, the interference may be reduced, but is never entirely eliminated. In order to sufficiently attenuate an image frequency signal, one or more pre-selector stages are required involving the use of at least two tuned circuits with the attendant difficulties of ganging and tracking and making it further desirable to choose an intermediate frequency as high as possible. This, however, has a disadvantage of greatly reducing the selectivity of the receiver.

By the present invention, the above disadvantages are substantially overcome and elimination of the image frequency interference ensured in a most efficient and simple manner without substantially impairing the efficiency and selectivity and other characteristics of the receiver. Moreover, it is possible by the employment of the invention to provide an aperiodic input circuit and to use a low intermediate frequency thereby increasing the selectivity and greatly simplifying the construction and operation of the entire receiving system.

Referring to Figure 1 of the drawings, there is shown at 10 an antenna connected to an input circuit through a coupling condenser 11. The input circuit comprises a self-induction coil 12 shunted by a variable condenser 13 in series with a non-reactive or ohmic impedance 14 and a blocking condenser of high capacity 15. The input circuit is further connected to ground through a condenser 16 to complete the antenna circuit. There are further shown a pair of electronic modulator or mixer valves 18 and 18′ of well known construction comprising, respectively, cathodes 19 and 19′, first or oscillating grids 20 and 20′, oscillator or anode grids 21 and 21′, input or control grids 22 and 22′ surrounded by screen grids 23 and 23′ and anodes 24 and 24′. Items 25 and 25′ are biasing resistances connected in the cathode leads of the valves by-passed by condensers 26 and 26′ to provide suitable grid biasing potentials in a manner well known. The input grids 22 and 22′ are excited by potentials in phase quadrature derived from an input radio signal. For this purpose the grid 22 of the tube 18 is connected to the junction between the condenser 13 and the non-reactive impedance 14 while the grid 22′ of the tube 18′ is connected to the upper terminal of the condenser 13 or input inductance 12 of the input circuit. In this manner, the grids 22 and 22′ are controlled in accordance with reactive and non-reactive potentials derived from an input radio signal which potentials are in phase quadrature as is well understood.

Similarly, the grids 20 and 20′ of the oscillator section of the valves are excited by locally produced potentials in phase quadrature through a local oscillating or tank circuit comprised of an inductance 28 shunted by a variable condenser 29 in series with a non-reactive or ohmic impedance 30. The oscillating tank circuit is connected to the oscillator grid 20 of valve 18 through a grid coupling condenser 32 and grid leak 33 resistance in a known manner, while the grid 20′ of the valve 18′ is connected to the junction between the oscillating condenser 29 and the non-reactive impedance 30 of the oscillating circuit as shown. In order to maintain self-sustained local oscillations in the oscillating circuit, there is provided a feed-back or tickler coil 31 connected in the supply lead from the positive or anode grid 21 of the valve 18 to a source of high tension supply indicated by the + sign. The anodes 24 and 24′ are connected to a common output circuit including a beat frequency transformer with a primary 36 and a secondary 37 tuned to the frequency of the intermediate or beat signals, by the aid of tuning condensers 35 and 38 shunted across the primary and secondary windings as shown. The intermediate frequency signals obtained at the output terminals 39 may be impressed upon an intermediate frequency amplifier which may be followed by a detector and audio amplifier in a manner well known. The input or control grids 22 and 22′ may be additionally biased in a known manner by the aid of additional biasing potential sources connected to points 17 and 17′ respectively.

In Figure 2 there is shown a resonance curve for the input circuit of Figure 1 wherein f_1 corresponds to the frequency of an incoming radio signal, f_0 corresponds to the frequency of the locally produced or heterodyne signals, and f_2 represents the image frequency or frequency of the interfering signal equal to

$$f_1+2(f_0-f_1)=2f_0-f_1$$

in the example illustrated wherein $f_2>f_0>f_1$.

From the foregoing it is seen that both the incoming signal having a frequency f_1 and the image or interfering signal having a frequency f_2 are combined or mixed with the locally generated signals having a frequency f_0 in both valves whereby the signal, heterodyne and interfering potentials in the first valve are in phase quadrature to the signal, heterodyne and interference potentials in the second valve. Assuming that the modulation or mixing takes place in accordance with a linear law in a first approximation, the operation may be expressed by the following theoretical equations well understood by those versed in the art:

$$(A_1 \sin w_1t+A_2 \sin w_2t)H_1 \cos w_0t=\frac{A_1H_1}{2}\sin(w_0-w_1)t+\frac{A_2H_1}{2}\sin(w_2-w_0)t$$

for valve 18 and

$$(A_1' \cos w_1t+A_2' \cos w_2t)H_1' \sin w_0t=\frac{A_1'H_1'}{2}\sin(w_0-w_1)t-\frac{A_2'H_1'}{2}\sin(w_2-w_0)t$$

for valve 18′ wherein A_1, H_1 and H_1', H_2' are constants and $w_1=2\pi f_1$, $w_2=2\pi f_2$ and $w_0=2\pi f_0$.

For different types of modulation following a more complicated law the results will be substantially the same although the formuli may be more complicated.

From the above equations it is seen that both signal and interference frequency components of opposite phase will appear in the common output or anode circuit of the tubes. If

$$A_1H_1=A_1'H_1'$$

the desired signal will be balanced or cancelled while in the case of $A_2H_1=A_2'H_1'$ the image or interfering frequency signal will be rejected or cancelled. As is seen, $A_1=IR$, wherein I represents the current in the input circuit and R the value of the resistance 14. Furthermore, it is seen that $A_1'=Iw_1L$, wherein L represents the value of the inductance 12 of the input circuit. Thus, in order to make $A_1H_1=A_1'H_1'$ it is necessary that IRH_1 be equal to Iw_1LH_1' or in other words, that $RH_1=w_1LH_1'$. In the last equation H_1, H_1', w_1 and L are constants, wherefrom it follows that the balance or cancellation of either the desired signal or the interfering signal can be effected by adjusting the resistance 14 in the input circuit. If the balance is obtained for the desired signal, only the interfering signal will appear and vice versa.

In order to affect a complete elimination of the interfering or image signal, it is necessary that the controlling potentials are exactly 90° out of phase as described previously. This is obtained in an easy manner by producing reactive and non-reactive potential drops in the input or oscillating circuits and in order to insure and maintain exact quadrature phase relation it is further desirable to eliminate the stray capacities, to reduce the internal capacities of the valves as far as possible and to use substantially pure ohmic resistors in the input and oscillating circuits. In this manner, it is possible to obtain a complete suppression of the image frequency in a superheterodyne system substantially without any preselection and without the drawbacks and difficulties experienced with prior art methods.

As pointed out, the adjustment for the image frequency suppression may be effected by varying the resistance 14 in the input circuit. The same result is obtained by varying the resistance 30 in the oscillating tank circuit or by adjusting the grid biasing potentials of the valves such as by varying the resistances 25 and 25′ in the cathode leads or by applying variable biasing potentials to the input grids at points

17 and 17' in which latter case it is desirable to use tubes of the variable mu type to obtain a uniform and smooth regulation.

The circuit arrangement according to the invention is especially suited for aperiodic receivers such as shown in Figures 3 and 4 illustrating aperiodic input circuits which may be substituted for the tuned input circuit shown in Figure 1.

Referring to Figure 3, the antenna 10 is connected through coupling condenser 11 to an aperiodic input circuit comprising a resistance 40 grounded at its lower end and shunted by the condenser 13 in series with the variable phase-shift resistance 14. The quadrature potentials may be obtained from points *a*, *b* and *a*, *c* or from the point *a* and a tap *d* on the resistance 40 on the one hand, and between *a* and *c* on the other hand in which latter case the resistance 14 may be omitted.

An alternative method of obtaining quadrature potentials from an aperiodic input circuit is shown in Figure 4. The latter comprises a Wheatstone bridge system with four arms consisting alternately of a resistor and a condenser as shown at 41, 42, 43 and 44. The input signal is applied to the diagonal points *e*, *f* and the quadrature potentials are derived from the other diagonal points *b*, *c* and either of the resistors in the example shown resistor 44 or point *a*.

In Figure 5 there is shown a modified tuned input circuit which differs from Figure 1 in that the non-reactive impedance 14 is connected in series with the induction coil 12 of the input circuit as distinct from the connection in series with the condenser 13 as shown in Figure 1. As a result, the potential drop supplied by the resistance 14 will be 180° out of phase relative to the drop supplied according to Figure 1.

Referring to Figure 6, the system shown is substantially similar to Figure 1 with the exception that the intermediate frequency circuit is connected to the anode of valves 18 and 18' in push-pull arrangement. For this purpose the primary 36 of the intermediate frequency transformer has one end connected to the anode of valve 18 and the other end to the anode of valve 18' and is provided with a center tap connection leading to the high tension supply source indicated by the plus symbol in a known manner. There is furthermore shown a feedback inductance 40 inductively coupled with the input inductance 12 and inserted in the cathode lead of the valve 18'. In this manner the current in the input circuit may be regenerated to compensate for the losses produced by the resistance 14.

Referring to Figure 7, there is shown a further modification of a system shown by the previous illustrations. According to this modification the oscillating tank circuit 28, 29 and associate feedback inductance 31 are connected in push-pull to the oscillating and anode grids of the mixer valves 18 and 18'. Thus, the signal potentials impressed upon the control grids of the valves 18 and 18' are in phase quadrature while the locally produced potentials applied to the oscillating grids of the valves are phased 180° apart. In order to secure the required quadrature phase shift in the output circuit there is provided a non-reactive or ohmic resistance which in the example shown is connected in series with the condenser 35 shunting the primary 36 of the intermediate frequency transformer. The anode of valve 18 is connected to the intermediate frequency transformer in the known manner while the anode of the valve 18' is connected to the junction between the tuning condenser 35 and impedance 40 to effect the necessary quadrature phase shift of the oscillating potential components in the output circuit. In both Figures 6 and 7 there is shown an input or receiving circuit of the type described by Figure 5 wherein the non-reactive impedance provided for securing the required quadrature control potentials is connected in series with the input inductance.

An advantage of the invention as pointed out hereinabove resides in a substantial simplification of the high frequency section of a receiving system which may be made entirely aperiodic such as by using an input circuit as shown in Figure 3. In the latter case the only adjustable element is the condenser or equivalent tuning element in the tank circuit of the local oscillator. When changing the frequency it will be necessary to readjust the resistance 14 to maintain suppression of the image frequency and for this purpose it is advantageous to provide a variable resistance mechanically connected with the condenser tuning mechanism for the oscillator tank circuit in such a manner that the required value of the phase shift resistance is automatically adjusted for each frequency or wave length to which the system may be tuned and the image frequency suppressed for all tuning frequencies of the system. This mechanical connection is indicated schematically at 14' in Figure 8 of the drawings which otherwise is similar to the preceding figures.

In Figure 9 there is shown a circuit similar to Figure 8 but differing therefrom by the provision of a resistance tuning device 41 in place of a variable condenser shown in Figure 8. In order to vary the frequency of the oscillating tank circuit, the output potentials supplied from the anode grid of the valve 18' are impressed upon the junction point between the oscillating tank condenser 29 and the series impedance 30 thereby setting up a feedback current in quadrature phase relation relative to the original oscillating current generated in the tank circuit. By controlling the intensity of this current by varying the amplifying gain of valve 18', such as by adjusting a variable resistance 41 included in the anode or oscillating grid circuit, the apparent reactive impedance or wave length of the tank circuit may be varied within a predetermined range. Resistance tuning arrangements of this type are described in more detail in my co-pending patent application entitled Electrical systems, Ser. No. 73,865, filed April 11, 1936 which is referred to for further details regarding the operation of Figure 9. The tuning resistance 41 is mechanically coupled with the phase shift resistance 14 in the input circuit in a similar manner as described by Figure 8. The wave length range obtainable with a resistance tuning system of this type is less than may be obtained with a variable condenser. However, the range can be extended by the provision of a plurality of separate resistors sequentially connectable by a gang switch to cover a desired receiving range.

From the foregoing it is seen that while the high frequency part of a superheterodyne system is greatly simplified by the employment of the invention, an additional detector or mixer valve is required. The latter can however be avoided by employing any other modulator of known type such as a rectifying arrangement comprising dry rectifiers or the like. Alternatively, the two mixer valves may be combined in the form of a composite valve such as shown in Figure 10. The latter is substantially identical to Figure 1 with the exception that a common anode **24** is provided for both valves which are included in a single envelope. Both valve sections may be constructed in the usual manner and mounted about a common cylindrical heater in a manner well known in the design and construction of composite discharge valves.

As is understood, the new modulating system described by the invention has other uses and applications whenever it is desired to mutually modulate or combine separate current waves. Thus the invention may serve for producing single side band modulated signals. In the latter case the input circuit in the examples shown, serves for supplying a carrier frequency f_1 from a suitable source of oscillations or driver. The oscillating or tank circuit serves for supplying a modulating current having a frequency p. The theoretical equations in this case are as follows:

For valve **18**:

$$A_1 \sin w_1 t B_1 \cos pt = \frac{A_1B_1}{2} \sin (w_1 - p)t + \frac{A_1B_1}{2} \sin (w_1 + p)t$$

For valve **18'**:

$$A_2 \cos w_1 t B_2 \sin pt = \frac{A_2B_2}{2} \sin (w_1 - p)t + \frac{A_2B_2}{2} \sin (w_1 + p)t$$

For the case that

$$\frac{A_1B_1}{2} = \frac{A_2B_2}{2}$$

the result obtained is:

$$O + A_1B_1 \sin (w_1 + p)t \text{ or } A_1B_1 \sin (w_1 - p)t$$

dependent on the connection of the intermediate frequency circuit as shown according to Figure 1 or 5, respectively. The modulating circuit may be either periodic or aperiodic as shown in Figure 4. In the latter case, the system may be used for modulating a carrier current in accordance with any complex modulating wave.

The provision of the non-reactive impedance **14** in the input circuit involves an increased damping and loss of input signal strength. However, it was found that this resistance can be chosen with a low value (from 5 to 100 ohms). As is understood, the conversion conductance of the valve **18** should be higher than the conversion conductance of the valve **18'**. The phase shifting resistance **30** in the oscillating tank circuit may have values from 100 to 500 ohms and the damping produced thereby may easily be compensated by increasing the coupling between the tank circuit and feedback inductance to maintain the circuit in an oscillating condition. Furthermore, as pointed out before, the loss produced by the resistance **14** in the input circuit may be compensated by a regeneration of feedback arrangement of any type such as illustrated by Figure 6.

It has further been found in employing the invention, that while the image frequency interference may be completely eliminated, the desired signal strength is also decreased slightly. In addition, it was found that this decrease is more pronounced the lower the intermediate frequency chosen. However, it is also possible to obtain the opposite effect; that is, an increase in signal strength, with suppression of the image frequency. In this latter case according to the invention the intermediate or beat frequency and the local oscillating frequency should be chosen in such a manner that the former is equal to the sum of the signaling frequency and the oscillating frequency. Thus, for instance, if the intermediate frequency is 450 kc., then for receiving signals of 10 or 300 kc. the local oscillating frequency should be 440 kc. or 150 kc., respectively. The image frequency in the latter case will be 890 kc. or 600 kc., respectively. If the circuits are arranged and adjusted in the manner described herein so as to eliminate the image frequency, it will be found that the desired signal strength may be increased nearly twice.

It will be apparent from the above that the invention is not limited to the specific arrangement of parts and circuits shown herein for illustration and that the underlying novel thought of the invention is susceptible of numerous variations and modifications coming within its broad scope and spirit as defined in the appended claims. It is therefore intended that the description and drawings are to be regarded in an illustrative rather than a limiting sense.

I claim:

1. In a radio system, means for producing a pair of signal current components having a quadrature phase relation, further means for producing a pair of auxiliary current components having a quadrature phase relation, means for modulating each of the signal current components by one of the auxiliary current components, and means for combining the modulated currents in a common output circuit.

2. In a radio system, circuit means for receiving incoming signal oscillations, means for deriving therefrom a pair of signal current components having a quadrature phase relation, a local oscillator for producing heterodyning oscillations having a frequency different from the signal frequency, means for deriving from said oscillator current components having a quadrature phase relation, a pair of modulating devices, means for impressing signal current and local current components in phase quadrature relation upon each of said modulating devices, and a common output circuit for said modulating devices resonant to the beat frequency between the signal and local oscillation frequencies.

3. In a radio system, a circuit for receiving incoming signal oscillations, said circuit including reactive and non-reactive impedance elements, a pair of modulating devices, means for impressing signal potentials having a quadrature phase relation derived from said receiving circuit upon said modulating devices, an oscillator for producing local oscillations having a frequency different from the signal frequency, said oscillator comprising a tuned oscillatory circuit including both reactive and non-reactive impedance elements, means for impressing potentials in phase quadrature derived from said oscillatory circuit upon said modulating devices, and a common output circuit for said modulating devices resonant to the beat frequency between the signal and local oscillation frequencies.

4. In a radio system, a circuit for receiving incoming signal oscillations, said circuit including reactive and non-reactive impedance elements, a pair of modulating devices, means for impressing signal potentials having a quadrature phase relation derived from said receiving circuit upon said modulating devices, an oscillator for producing local oscillations having a frequency different from the signal frequency, said oscillator comprising a tuned oscillatory circuit including both reactive and non-reactive impedance elements,

means for impressing potentials in phase quadrature derived from said oscillator upon said modulating devices, the signal and local oscillating potentials impressed upon each of said modulating devices being in phase quadrature relative to each other, and a common output circuit for said modulating devices resonant to the beat frequency between the signal and local oscillating frequencies.

5. In a radio system, a circuit for receiving incoming signal oscillations, said circuit including both reactive and non-reactive impedance elements, a pair of modulating devices, means for impressing signal potentials in phase quadrature derived from said receiving circuit upon said modulating devices, an oscillator for producing local oscillations having a frequency different from the signal frequency, said oscillator comprising a tuned oscillatory circuit including both reactive and non-reactive impedance elements, means for impressing potentials in phase quadrature derived from said oscillatory circuit upon said modulating devices, the signal and local oscillating potentials impressed upon each of said modulating devices being in phase quadrature relative to each other, a common output circuit for said modulating devices, and means for adjusting the relative amplitudes of the signal and locally produced potentials impressed upon said modulating devices.

6. In a radio system, a circuit for receiving incoming signal oscillations, said circuit including both reactive and non-reactive impedance elements, a pair of modulator-amplifiers, means for impressing signal potentials in phase quadrature derived from said receiving circuit upon said modulator-amplifiers, an oscillator for producing local oscillations having a frequency different from the signal frequency, said oscillator comprising a tuned oscillatory circuit including both reactive and non-reactive impedance elements, means for impressing local oscillation potentials in phase quadrature derived from said oscillatory circuit upon said modulating devices, the signal and local potentials impressed upon each of said modulating devices being in phase quadrature relative to each other, a common output circuit for said modulator-amplifiers resonant to the beat frequency between the signal and local frequencies, and a regenerative circuit between the output of at least one of said modulator-amplifiers and said receiving circuit.

7. In a radio system, a circuit for receiving incoming signal oscillations, said circuit including both reactive and non-reactive impedance elements, a pair of electronic mixing devices each comprising an electron discharge path, means for controlling a portion of said electron paths in accordance with signal potentials in phase quadrature derived from said receiving circuit, a local oscillator for producing oscillations having a frequency different from the signal frequency, said oscillator comprising a tuned oscillatory circuit including both reactive and non-reactive impedance elements, means for independently controlling another portion of said electron paths in accordance with locally produced potentials in phase quadrature derived from said oscillatory circuit, the signal and local potentials controlling the separate portions of each of said electron paths being in phase quadrature relative to each other, and a common output circuit for said electron paths resonant to the beat frequency between the signal and heterodyning frequencies.

8. In a radio system, a signal input circuit including a reactive and non-reactive impedance element in series, a pair of modulating devices, means for impressing signal current potentials in phase quadrature derived from said reactive and non-reactive impedance elements upon said modulating devices, a local oscillator for producing oscillations having a frequency differing from the signal frequency, means for deriving local potentials in phase quadrature from said local oscillator, means for impressing said local quadrature potentials upon each of said modulating devices, the signal and local potentials applied to each of said modulating devices being in phase quadrature relative to each other, a variable tuning element for controlling the frequency of said local oscillations to correspond to incoming signals of different frequencies, and a common output circuit for said modulating devices resonant to the beat frequency between the signal and local frequencies.

9. In a system as claimed in claim 8 including means for varying the non-reactive impedance in said receiving circuit simultaneously with the adjusting of said tuning element.

10. In a radio system, an input circuit for receiving signal oscillations comprising an inductive and a capacitative reactance in parallel, a non-reactive impedance in series with one of said reactances, a local oscillator including an oscillatory circuit comprising an inductive and capacitative reactance in parallel, a further non-reactive impedance in series with one of the reactance elements of said oscillatory circuit, a pair of modulating devices, means for impressing signal potentials developed across said input circuit and local potentials developed across the non-reactive impedance of said oscillatory circuit upon the first of said devices, further means for impressing signal potentials developed across the non-reactive impedance of said input circuit and heterodyning potentials developed across said oscillatory circuit upon the other modulating device, and a common output circuit for said modulating devices.

11. In a radio system, an aperiodic input circuit for receiving signal oscillations, comprising a reactive and a non-reactive impedance in series, a local oscillator for producing oscillations of a frequency different from the signal frequency, said local oscillator including an oscillatory circuit comprising a capacitative and an inductive reactance in parallel, a non-reactive impedance in series with one of the reactances of said oscillatory circuit, a pair of modulating devices, means for impressing signal potentials developed across said input circuit and heterodying potentials developed across the non-reactive impedance of said oscillatory circuit upon the first of said devices, further means for impressing local potentials developed across said oscillatory circuit and signal potentials developed across the non-reactive impedance of said input circuit upon the other modulating device, and a common output circuit for said modulating devices.

12. In a system as claimed in claim 10 including means for adjusting the relative amplitude of the potentials applied to at least one of said modulating devices.

13. In the art of receiving radio signals comprising the steps of producing signal current components having a phase quadrature relation, producing local current components having a phase quadrature relation, modulating each of said signal current components with the local current

component in quadrature phase relation thereto, and combining the modulated currents.

14. In the art of translating radio signals, the steps of producing quadrature signal and quadrature interfering energies, generating local auxiliary energies having a quadrature phase relation, modulating each of the quadrature signal and interfering energies with the local energy in phase quadrature thereto, combining the modulated outputs and adjusting the relative magnitude of the respective quadrature energies to balance out the interfering signal in the combined output.

15. In a radio system comprising means for producing quadrature signal and quadrature interfering energies, means for generating local auxiliary energies having a quadrature phase relation, means for separately modulating each of said quadrature signal and interfering energies with the local energy in phase quadrature thereto, a combined output for said modulating means, and means for adjusting the relative magnitude of the respective quadrature energies to balance the interfering signal in the combined output.

16. In the art of translating carrier signals, the steps of producing quadrature signal energies and quadrature interfering energies, generating quadrature local energies, producing beat energies from each of the quadrature signal and interfering energies and the local energy in phase quadrature thereto, and combining the beat energies produced.

17. A system for translating carrier signals comprising means for producing quadrature signal energies and quadrature interfering energies, further means for producing local quadrature energies, means for producing beat energies from each of the quadrature signal and interfering energies with the local energy in quadrature phase relation thereto, and a common output for the beat energies produced.

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