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BAND-PASS SELECTOR SYSTEM

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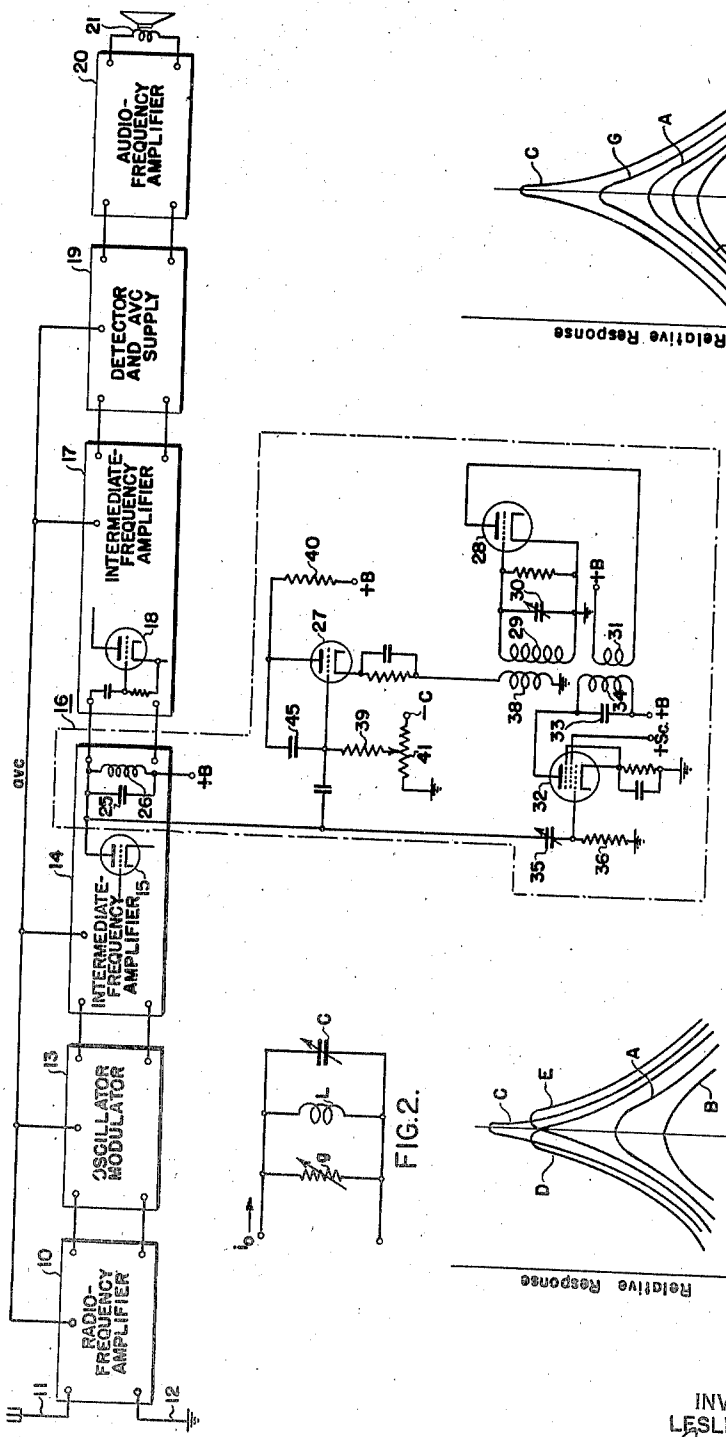


FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

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BAND-PASS SELECTOR SYSTEM

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12 Claims. (Cl. 250—20)

This invention relates to band-pass selector systems and, more particularly, to such systems in which the width of the frequency band translated by the system is adjustable. While band-pass selector systems constructed in accordance with the present invention are of general utility, they are particularly suitable for use in the intermediate-frequency channel of modulated-carrier signal receivers of the superheterodyne type for controlling the selectivity and fidelity of response of the receiver.

Band-pass selector systems of conventional design usually comprise a pair of resonant circuits tuned to the same or different frequencies and suitably coupled, inductively, capacitively, or by a combination of these individual couplings. The desired response of this type of selector system is substantially uniform over a band of frequencies in the vicinity of the mean resonant frequency of the selector, while signal components of all other frequencies are sharply discriminated against and attenuated to a substantial degree by the selector. In general, the width of the frequency band passed by such a selector system may be varied by adjusting the coupling between the two circuits, by adjusting the resonant frequencies of the two circuits relative to each other, or by a combination of these two adjustments. Selector systems of the type described generally utilize coupling systems which are non-directive in nature; that is, either circuit may be the input circuit and the other the output circuit without substantially affecting the characteristics of the system. Such a system is to be contrasted with that type of selector utilizing a vacuum-tube coupling in one or both directions between the input and output circuits wherein one or both of the couplings are primarily unidirective.

Band-pass selector systems wherein the non-directive form of coupling is utilized are, in general, open to the criticism that only mechanical, or relatively complicated nonmechanical, arrangement are known for adjusting the width of the frequency band to be translated. Band-pass selector systems employing unidirective couplings in both the forward and backward directions between the tuned circuits, however, require a separate vacuum tube, or the equivalent, in each of the forward and backward coupling paths. All of the above-mentioned band-pass selectors, moreover, require two resonant circuits.

It is an object of the present invention, therefore, to provide an improved band-pass selector system of simple arrangement in which one or more of the above-mentioned disadvantages of prior art systems are eliminated.

It is another object of the invention to provide an improved band-pass selector system requiring only one tuned circuit in the signal-translating channel with which it is associated.

In accordance with the present invention, a modulated-carrier signal-translating stage comprises a tuned circuit including parameters of resistance, capacitance, and inductance, and normally resonant in the vicinity of the frequency of the carrier wave to be translated. There is provided means for varying one of the parameters of the tuned circuit at a frequency twice that of the carrier wave to be translated by the stage, whereby the selectivity of the stage depends on both the timing of the variations with respect to the carrier frequency of the translated signal and the amplitude or range of the variations. There is also provided means for adjusting the relation between the amplitude of the variations and the phase angle between the variations and the signal-carrier wave to impart predetermined adjustable selectivity characteristics to the stage.

In accordance with a preferred embodiment of the invention, the capacitance of the tuned circuit is varied sinusoidally at twice the frequency of the carrier wave while the actual conductance of the tuned circuit is maintained substantially constant. In this preferred embodiment of the invention an oscillator, synchronized by means of the signal-carrier wave to be translated by the stage, is utilized to generate a frequency at twice that of the signal-carrier wave. These oscillations are utilized to vary the transconductance of a control vacuum tube which, in turn, is utilized as an adjustable capacitance across the tuned circuit, for example, in accordance with the well-known "Miller effect." Also in accordance with the preferred embodiment, the timing or phase of the generated oscillations may be adjusted with respect to that of the signal-carrier wave, the bias applied to the control tube may be adjusted to control the maximum amplitude of the capacitance variations of the tuned circuit, and these two adjustments may be relatively adjusted to impart predetermined adjustable selectivity characteristics to the stage.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Fig. 1 of the drawing is a circuit diagram, partly schematic, of a modulated-carrier signal receiver of the superheterodyne type employing a band-pass selector constructed in accordance with the invention; Fig. 2 is an equivalent circuit diagram of a portion of the circuit of Fig. 1 utilized to explain the general theory of the invention; while Figs. 3 and 4 are graphs illustrating certain of the operating characteristics of the circuit of Fig. 1.

Referring now more particularly to Fig. 1 of the drawing, there is shown a circuit diagram, partly schematic, of the improved band-pass selector system of the invention embodied in a modulated-carrier signal receiver of the superheterodyne type for controlling the selectivity of the intermediate-frequency channel of the receiver. Briefly described, the receiver comprises a radio-frequency amplifier **10** having input terminals connected to an antenna ground circuit **11**, **12**, and output terminals coupled to a frequency changer or oscillator-modulator **13**. Connected in cascade with the oscillator-modulator unit **13**, in the order named, are an intermediate-frequency amplifier **14** including a vacuum-tube amplifier **15**, variable band-pass selector **16**, an intermediate-frequency amplifier **17** including a vacuum-tube amplifier **18**, a detector and automatic amplification control or A. V. C. unit **19**, an audio-frequency amplifier **20**, and a sound reproducer **21**. The bias potential derived from the automatic amplification control source **19** may be applied to one or more stages of radio-frequency amplifier **10**, the modulator included in unit **13**, and one or both of the stages of intermediate-frequency amplification **14** and **17**.

Considering first the operation of the receiver as a whole without regard to the details of the band-pass selector **16** of the invention, per se, a desired received signal is selected and amplified in radio-frequency amplifier **10** and is converted to a modulated intermediate-frequency signal by oscillator-modulator **13**. The signal as thus converted is further amplified in intermediate-frequency amplifier **14**, is selected by variable band-pass selector **16**, is further amplified in intermediate-frequency amplifier **17**, and detected by detector **19**, thereby producing the audio-frequency modulation components which are, in turn, amplified by audio-frequency amplifier **20** and reproduced by the sound reproducer **21**. The amplification of the received signal is subject to automatic control by the control-bias potential derived from source **19** to maintain the amplitude of the signal input to detector **19** relatively constant for a wide variation of received signal amplitudes, in a manner well understood in the art.

Referring now more particularly to the portion of the system of Fig. 1 comprising the present invention, there is provided a band-pass selector **16** including a single tuned circuit **25**, **26** in the signal-translating channel of the receiver and utilized as a coupling circuit between vacuum tubes **15** and **18**. It will be understood that only the portion of the circuits of tubes **15** and **18** necessary to describe the present invention are shown in the drawing and that these tubes are provided with additional circuits in a manner well understood in the art to effect operation thereof as conventional vacuum-tube amplifiers. In order to vary the selectivity of tuned circuit **25**, **26**, the effective capacitance thereof is pulsated at a frequency approximately twice that of the intermediate-frequency carrier wave. For this purpose, there is provided a vacuum tube **27** having input electrodes coupled across tuned circuit **25**, **26** and having its grid and anode reactively coupled by a condenser **45**, thereby being effective to reflect capacitance into tuned circuit **25**, **26** in accordance with the well-known "Miller effect."

In order to vary the transconductance of tube **27** at a frequency twice that of the intermediate-frequency carrier wave, thus to pulsate the capacitance across tuned circuit **25**, **26** at the double frequency, there is provided a vacuum-tube oscillator **28** tuned to generate oscillations at this double frequency by means of a frequency-determining circuit **29**, **30** coupled to its input electrodes and a feed-back circuit including an inductance **31** in its output circuit and inductively coupled to inductance **29**. In order to synchronize the oscillator **28** with the carrier wave of the intermediate-frequency signal of the receiver, a voltage is coupled to the oscillator from the intermediate-frequency channel of the receiver through a vacuum-tube limiter **32**. Tube **32** operates as a conventional limiter and is provided in order to eliminate the effects of the amplitude-modulation components or amplitude variations of the intermediate-frequency signal. Tube **32** comprises a tuned output circuit including a condenser **33** and inductance **34** inductively coupled to feed-back inductance **31** of the oscillator circuit.

A phase-shifting network including a variable condenser **35** and resistor **36** is provided for varying the phase of the synchronizing signal applied to oscillator **28**, thereby to control the timing or phase of the generated oscillations. The output oscillations of oscillator **28** are coupled into the cathode circuit of the control tube **27** by means of an inductance **38** inductively coupled to inductance **29** of the oscillator circuit. A source of variable bias including a resistor **39** connected to an adjustable tap on resistor **41** is provided for vacuum tube **27** in order that the magnitude of the capacitance variations reflected into tuned circuit **25**, **26** may be varied. Operating potentials for tubes **27**, **28**, and **32** may be supplied from suitable sources indicated as +B and +Sc, the anode circuit of control tube **27** including a load resistor **40**.

Reference is now made to Fig. 2 for an explanation of the effect of varying the parameters of a tuned circuit at twice the carrier frequency of a modulated-carrier signal applied thereto. In Fig. 2 there is shown a tuned circuit comprising parallel-connected inductance L and capacitance C effectively shunted by a resistor having a conductance g. Conductance g and capacitance C are indicated as being variable for the reason that the circuit is to be analyzed under the condition of periodic pulsation of each of these parameters at twice the carrier frequency of the system. The tuned circuit L, C is thus the equivalent of the effective inductance and capacitance associated with tuned circuit **25**, **26** of Fig. 1 and the current i_0 is thus effectively the equivalent of the output current supplied by tube **15**. It is assumed for the purposes of analysis that:

$$i_0 = I \sin \omega t + M \sin (\omega + a)t + M \sin (\omega - a)t \quad (1)$$

$$g = g_0[1 + 2q \sin (2\omega t + \phi)] \quad (2)$$

$$C = C_0[1 + 2k \sin (2\omega t + \psi)] \quad (3)$$

where:

q=half the percentage pulsation of conductance g;

k=half the percentage pulsation of capacitance C;
ϕ=the phase angle of the conductance pulsation measured with respect to the double frequency;
ψ=the corresponding phase angle of the capacitance pulsation;
g_0=the mean value of conductance g;
C_0=the mean value of capacitance C;

and the terms in Equation 1 are those corresponding to the conventional expression for a modulated-carrier current having symmetrical upper and lower sidebands.

Under these assumptions the differential equation applicable to the circuit of Fig. 2 is:

$$ge+C\ de/dt+\int edt/L=i_0 \tag{4}$$

where:
t =time;
e=the instantaneous voltage across the circuit;
ω=the angular frequency of the input-carrier wave; and
a=the angular frequency of the modulation of the input-signal wave

The steady-state solution of this equation contains terms at angular frequencies ω, $\omega+a$, $\omega-a$, $\omega+2a$, $\omega-2a$, etc. The magnitudes of all the terms except the first three of the above are small and may be neglected.

e may then be assumed to be:

$$\begin{aligned} e=&A\cos\omega t+B\sin\omega t\\ &+F\cos(\omega+a)t+H\sin(\omega+a)t\\ &+X\cos(\omega-a)t+Y\sin(\omega-a)t \end{aligned} \tag{5}$$

where A, B, F, H, X, and Y are the coefficients associated with the various terms of the equation. When the inductance L and the mean capacitance C_0 are tuned to the frequency of the input-carrier wave, the value of ω may be designated by ω_0, that is

$$\omega_0=1/\sqrt{LC_0}$$

The steady-state solution of differential Equation 4 then provides the following:

$$E_c=\frac{\sqrt{A^2+B^2}}{\sqrt{2}}=\frac{I}{\sqrt{2}C_0\omega_0(p-qp\sin\phi+k\cos\psi)} \tag{6}$$

$$\begin{aligned} E_s&=\frac{\sqrt{F^2+H^2}}{\sqrt{2}}=\frac{\sqrt{X^2+Y^2}}{\sqrt{2}}\\ &=\frac{M}{\sqrt{2}C_0\omega_0\sqrt{(p-qp\sin\phi+k\cos\psi)^2+4\alpha^2}} \end{aligned} \tag{7}$$

where
E_c=the R. M. S. carrier voltage across L, C;
E_s=the R. M. S. sideband voltage across L, C;
α $=a/\omega_0$; and
p =the power factor of the original circuit.

In Equations 6 and 7 the term $(qp\sin\phi-k\cos\psi)$ is of the dimension of a power factor. This quantity must always be less than p to prevent self-oscillation of the tuned circuit L, C. It may be made positive or negative by a proper choice of ϕ and ψ, in which case the resulting over-all arrangement is regenerative or degenerative, respectively. This regenerative or degenerative effect may be produced by pulsation of susceptance or conductance or both. In any case the resultant response of the band-pass selector is symmetrical if:

$$qp\cos\phi+k\sin\psi=0 \tag{8}$$

This is most easily satisfied by making $\phi=\pm\pi/2$ and $\psi=0$ or π. If $k=0$ or $q=0$, respectively, these are the only angles which give symmetry. Therefore, if $q=0$, $\cos\psi=\pm1$ for symmetrical expansion, or if $k=0$, $\sin\phi=\pm1$.

The response characteristic of a circuit having regenerative feedback and tuned to the input signal is well known and may be shown to be represented by the equation:

$$E_s=\frac{M}{\sqrt{2}C_0\omega_0\sqrt{(p-p_n)^2+4\alpha^2}} \tag{9}$$

where p_n is the absolute value of the effective power factor introduced by a negative conductance across the tuned circuit and the other terms are as in Equation 7. Attention is called to the fact that the expression of Equation 9 is of exactly the same form as that of Equation 7 above.

In accordance with the circuit arrangement shown in Fig. 1 only the parameter of capacitance of the tuned circuit **25**, **26** is varied, which means that the factor q in the above equations is zero. This embodiment is preferred since calculations indicate that detuning produced by fundamental frequency effects in tube **27** may be compensated by a readjustment of the value of either of the elements of tuned circuit **25**, **26**. The harmonic effects in tube **27** produce beat-frequency currents in its output circuit due to the difference in frequency of the applied voltages. The effective sideband voltage output of the circuit of Fig. 1 for a signal input comprising symmetrical upper and lower sidebands may be expressed by the equation:

$$E_s=\frac{M}{\sqrt{2}C_0\omega_0\sqrt{(p+RA_2C_1L\omega_0^2E\cos\theta)^2+4\alpha^2}} \tag{10}$$

where
R=the value of resistor **40**;
C_1=value of capacitance **45**;
ω_0=angular frequency of the intermediate-frequency carrier wave;
E=maximum value of the voltage pulsation applied to tube **27** from coil **38**;
θ=phase angle of E with respect to the intermediate-frequency carrier voltage;
L=value of the inductance **26**;
A_2=coefficient in the series expression for the plate current of tube **27** as expressed by:

$$i_p=-A_1e_g-A_2e_g^2-A_3e_g^3+\ \ldots$$

The term $RA_2C_1\omega_0^2E\cos\theta$ has the dimensions of a power factor by which the original power factor of tuned circuit **25**, **26** is increased by the double-frequency pulsations. Obviously, the term may be made negative and the circuit regenerative by making $\theta=\pi$.

In summary, therefore, it is seen that the arrangement of Fig. 1 comprises means for varying the reactance of tuned circuit **25**, **26** at twice the frequency of the intermediate-frequency carrier wave; that the capacitance of the tuned circuit **25**, **26** is pulsated by means of a tube **27** in accordance with the "Miller" effect; that oscillator **28** generates oscillations at twice the carrier frequency which are used to vary the transconductance of the "Miller" tube **27**; that the phase of these generated oscillations can be adjusted by adjustment of condenser **35**, thereby to adjust the phase of the synchronizing signals applied to oscillator **28**; that the limiter **32** is effective to remove the amplitude-modulation components from the signal utilized to synchronize oscillator **28**; and that the amplitude of the capacitance pulsations of circuit **25**, **26** may be adjusted by adjusting the tap on resistor **41** in the manner described above.

Reference is made to Fig. 3 for a description

of the effect of pulsating only one of the parameters of tuned circuit **25, 26**. In Fig. 3, curve A represents the normal response characteristic of tuned circuit **25, 26**. If the capacitance of circuit **25, 26** is varied at twice the carrier frequency of the system and the phase of these capacitance pulsations is zero with respect to that of the intermediate-frequency carrier wave; that is, if the carrier frequency goes through zero amplitude in the positive direction at the same time that the capacitance pulsation is changing through zero in the positive direction, tuned circuit **25, 26** has a response characteristic as illustrated by curve B. It is assumed that, in his case as in the case of curve A, there is no conductance pulsation of tuned circuit **25, 26**. The corresponding characteristic of the system of the phase angle is equal to π, all other conditions being unchanged is shown by curve C.

On the other hand, if the capacitance of the circuit is maintained constant and the conductance is pulsated at a frequency equal to twice that of the carrier frequency and with a phase of conductance pulsation equal to $+\pi/2$ with respect to the signal-carrier wave, the tuned circuit **25, 26** has a response characteristic as shown by curve C of the drawing. The corresponding characteristic for a phase angle of $-\pi/2$ is that of curve B, all other conditions being unchanged. As explained above, a pulsation of capacitance at phase angles of other than zero or π results in an unsymmetrical response characteristic. The response of the system for capacitance pulsation at a phase angle of $-\pi/4$ is shown by curve D while the corresponding characteristic for the phase angle of $+\pi/4$ is shown in curve E.

Characteristic curves showing the response of the system when the capacitance of tuned circuit **25, 26** is pulsated with varying amplitudes at twice the carrier frequency of the system and with phase angles of zero and π with respect to the signal-carrier wave are shown in Fig. 4. Thus, curve A represents the normal resonant characteristic of tuned circuit **25, 26** and corresponds to curve A of Fig. 3. If the amplitude of the capacitance pulsations is varied under the conditions outlined above and with a phase angle of zero, the response characteristic of tuned circuit **25, 26** becomes increasingly more broad as shown by curves A, F, and B, curve B thus corresponding to curve B of Fig. 3. Such an increase in amplitude of capacitance pulsations is effected by adjustments of the tap on resistor **41**. Corresponding characteristics for a phase angle of π, all other conditions remaining unchanged, are shown by curves A, G, and C.

From the foregoiing, it is apparent that the tap on resistor **41** and the value of capacitance **35** may be relatively adjusted to procure predetermined selectivity characteristics for the intermediate-frequency channel of the receiver shown. It will be understood that, while in the embodiment illustrated in Fig. 1 the capacitance of tuned circuit **25, 26** is pulsated, it is equally practicable to pulsate the inductance thereof, or a reactance of either kind in the circuit **25, 26** may be pulsated simultaneously with the conductance thereof in order to provide a readily and flexibly adjustable band-pass selector.

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A modulated-carrier signal-translating stage comprising, a tuned circuit including parameters of resistance, capacitance and inductance and normally resonant in the vicinity of the frequency of the carrier wave to be translated, means for varying one of said parameters at a frequency of twice that of said carrier frequency, whereby the selectivity of said stage depends on both the phase angle of said variations with respect to the carrier wave of said translated signal and the amplitude of said variations, and means for providing a predetermined relation between the value of the amplitude of said variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

2. A modulated-carrier signal-translating stage comprising, a tuned circuit including parameters of resistance, capacitance and inductance and normally resonant in the vicinity of the frequency of the carrier wave to be translated, means for varying one of said parameters at a frequency twice that of said carrier frequency, whereby the selectivity of said stage depends on both the phase angle of said variations with respect to the carrier wave of said translated signal and the amplitude of said variations, and means for adjusting the relation between the value of the amplitude of said variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

3. A modulated-carrier signal-translating stage comprising, a tuned circuit including reactance of one kind and normally resonant in the vicinity of the frequency of the carrier wave to be translated, means for varying said reactance to vary the resonant frequency of said tuned circuit at a frequency twice that of said carrier frequency, whereby the selectivity of said stage depends on both the phase angle of said variations with respect to said translated carrier signal and the amplitude of said variations, and means for adjusting the relation between the value of the amplitude of said frequency variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

4. A modulated-carrier signal-translating stage comprising, a tuned circuit including parameters of resistance, capictance and inductance and normally resonant in the vicinity of the frequency of the carrier wave to be translated, means for varying sinusoidally one of said parameters at a frequency twice that of said carrier frequency, whereby the selectivity of said stage depends on both the phase angle of said variations with respect to said translated carrier signal and the amplitude of said variations, and means for adjusting the relation between the value of the amplitude of said variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

5. A modulated-carrier signal-translating stage comprising, a tuned circuit including capacitance and normally resonant in the vicinity of the frequency of the carrier wave to be translated, means for varying said capacitance to vary the resonant frequency of said tuned circuit at a frequency twice that of said carrier frequency, whereby the selectivity of said stage depends

on both the phase angle of said variations with respect to said translated carrier signal and the amplitude of said variations, and means for adjusting the relation of the value of the amplitude of said variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

6. A modulated-carrier signal-translating stage comprising, a tuned circuit including parameters of resistance, capacitance and inductance and normally resonant in the vicinity of the frequency of the carrier wave to be translated, means comprising a vacuum tube simulating an adjustable impedance coupled to said tuned circuit, means for controlling said vacuum tube at a frequency twice that of said carrier frequency to vary one of said parameters, whereby the selectivity of said stage depends on both the phase angle of said variations with respect to said translated carrier signal and the amplitude of said variations, and means for adjusting the relation between the value of the amplitude of said variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

7. A modulated-carrier signal-translating stage comprising, a tuned circuit including parameters of resistance, inductance and capacitance and normally resonant in the vicinity of the frequency of the carrier wave to be translated, an oscillator tuned to generate oscillations at twice the resonant frequency of said tuned circuit, means comprising said oscillator for varying one of said parameters at the frequency of said oscillations, whereby the selectivity of said stage depends on both the phase angle of said variations with respect to said translated carrier signal and the amplitude of said variations, and means for adjusting the relation between the value of the amplitude of said variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

8. A modulated-carrier signal-translating stage comprising, a tuned circuit including parameters of resistance, capacitance and inductance and normally resonant in the vicinity of the frequency of the carrier wave to be translated, an oscillator for generating oscillations at twice the resonant frequency of said tuned circuit, phase control means for said oscillator, means responsive to said oscillations for varying one of said parameters at a frequency twice that of said carrier frequency, whereby the selectivity of said stage depends on both the phase angle of said variations with respect to said translated carrier signal and the amplitude of said variations, and means comprising said phase control for said oscillator for adjusting the relation between the value of the amplitude of said frequency variations and the value of the phase angle between said frequency variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

9. A modulated-carrier signal-translating stage comprising, a tuned circuit including parameters of resistance, inductance and capacitance and normally resonant in the vicinity of the frequency of the carrier wave to be translated, an oscillator for generating oscillations at twice the resonant frequency of said tuned circuit, means for deriving a synchronizing signal for said oscillator from the signal to be translated by said stage, means for adjusting the phase of said derived signal, means comprising said oscillations for varying one of said parameters at a frequency twice that of said carrier frequency, whereby the selectivity of said stage depends on both the phase angle of said variations with respect to said translated signal and the amplitude of said variations, and means comprising said phase control for adjusting the relation between the value of the amplitude of said variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

10. A modulated-carrier signal-translating stage comprising, a tuned circuit including parameters of resistance, inductance and capacitance and normally resonant in the vicinity of the frequency of the carrier wave to be translated, means for varying one of said parameters at a frequency twice that of said carrier frequency, whereby the selectivity of said stage depends on both the phase angle of said variations with respect to said translated carrier signal and the amplitude of said variations, means for adjusting the amplitude of said variations, and means comprising said last-mentioned means for adjusting the relation between the value of the amplitude of said variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

11. A modulated-carrier signal-translating stage comprising, a tuned circuit including parameters of resistance, capacitance and inductance and normally resonant in the vicinity of the frequency of the carrier wave to be translated, means comprising a vacuum tube simulating an adjustable impedance coupled to said tuned circuit, means for controlling said vacuum tube at a frequency twice that of said carrier frequency to vary one of said parameters, whereby the selectivity of said stage depends on both the phase angle of said variations with respect to said translated carrier signal and the amplitude of said variations, bias-control means for said vacuum tube to adjust the amplitude of said variations, and means comprising said bias control for adjusting the relation between the value of the amplitude of said variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

12. In a modulated-carrier wave-signal receiver of the superheterodyne type, a signal-translating stage comprising, a tuned circuit in the intermediate-frequency channel of said receiver, said tuned circuit being normally resonant in the vicinity of the frequency of the intermediate-frequency signal-carrier wave to be translated by said channel and including parameters of resistance, inductance and capacitance, an oscillator tuned to generate oscillations at twice the resonant frequency of said tuned circuit, means for deriving a voltage from the signal input to said stage for synchronizing said oscillator, adjustable means for controlling the phase of said derived voltage, a vacuum tube simulating an adjustable impedance coupled to said tuned circuit, means for applying said oscillations to said vacuum tube to control said vacuum tube at a frequency twice that of said carrier frequency to vary one of said parameters, whereby

the selectivity of said stage depends on both the phase of said variations with respect to said translated signal-carrier wave and the amplitude of said variations, an adjustable bias for said vacuum tube to adjust the amplitude of said variations, and means comprising said phase control and said adjustable bias for adjusting the relation between the value of the amplitude of said variations and the value of the phase angle between said variations and said carrier wave to provide predetermined selectivity characteristics for said stage.

LESLIE F. CURTIS.

Certificate of Correction

Patent No. 2,216,160. October 1, 1940.

LESLIE F. CURTIS

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 43–44, for the word "arrangement" read *arrangements*; page 2, second column, line 72, equation 3, after "$2\omega t+\psi$" and before the bracket insert a parenthesis; page 3, first column, line 46–47, equation 6, for

$$\frac{I}{\sqrt{2C_0\omega_0(p-qp\sin\phi+k\cos\psi)}}$$

read

$$\frac{I}{\sqrt{2C_0\omega_0(p-qp\sin\phi+k\cos\psi)}}\ ;$$

page 4, first column, line 14, for "his" read *this*; line 57, for "foregoiing" read *foregoing*; and second column, line 54, claim 4, for "capictance" read *capacitance*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 3rd day of December, A. D. 1940.

[SEAL]

HENRY VAN ARSDALE,
Acting Commissioner of Patents.