May 6, 1941. L. GABRILOVITCH 2,240,500

SELECTIVE WAVE RECEPTION

Filed May 29, 1937

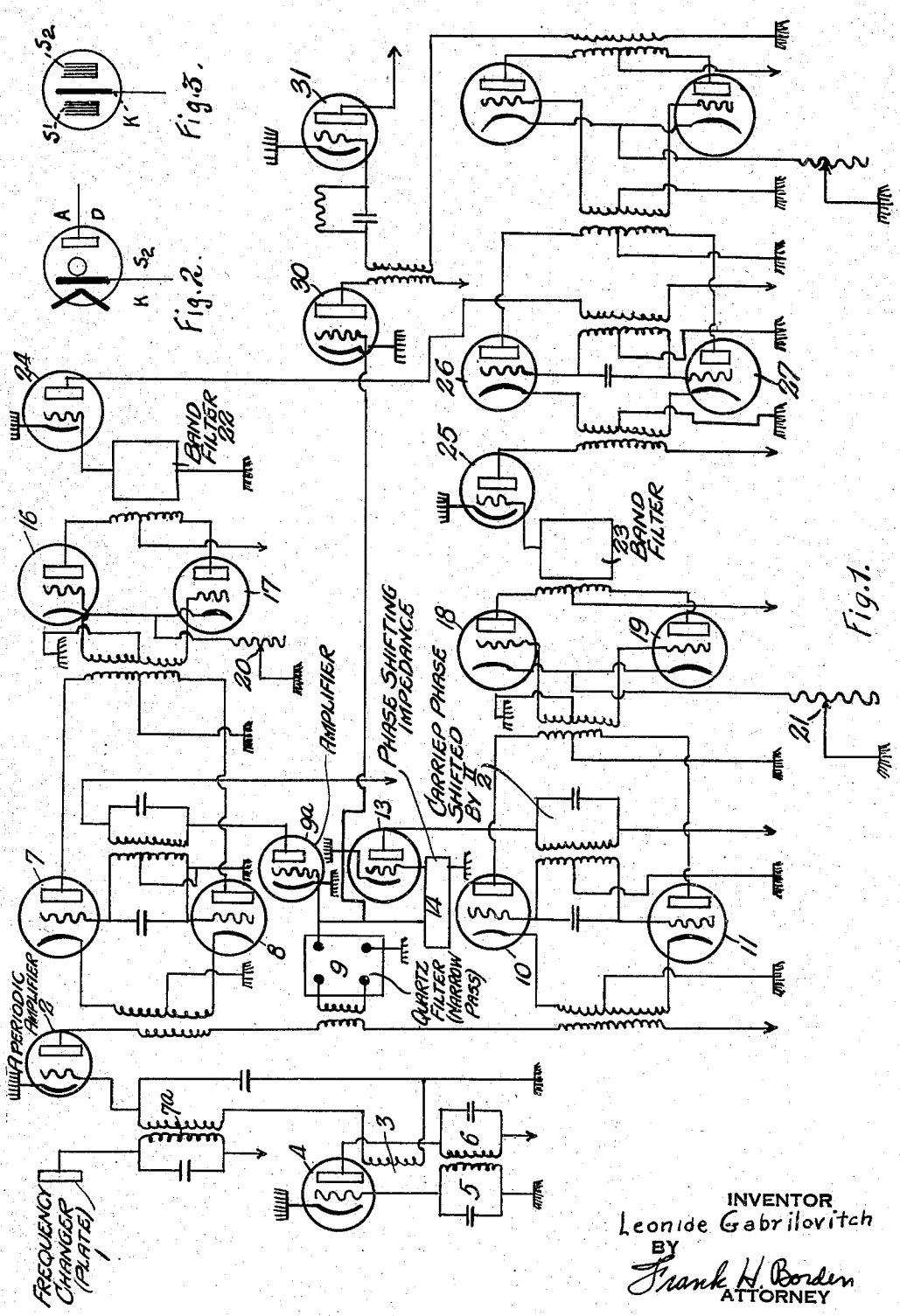


Fig.1.

INVENTOR
Leonide Gabrilovitch
BY
Frank H. Borden
ATTORNEY

Patented May 6, 1941 2,240,500

UNITED STATES PATENT OFFICE

2,240,500

SELECTIVE WAVE RECEPTION

Leonide Gabrilovitch, Paris, France

Application May 29, 1937, Serial No. 145,622
In France September 5, 1936

12 Claims. (Cl. 250—20)

This invention relates to wave reception, and particularly to methods and apparatus for selective reception of modulated electric waves.

The existing methods and devices for selective reception of electric waves are based on the properties of resonance in electric circuits, by which the waves to be selected within a certain band of frequencies are enhanced, while the waves outside the band remain without any appreciable amplification.

It is impossible by using existing methods of selection to receive a modulated wave without receiving at the same time all oscillations situated between the carrier and the side bands. One is, therefore, obliged to sacrifice either the width of the passing band for the sake of selectivity or to sacrifice selectivity for the purpose of obtaining a sufficiently wide passing band. Such a state of things militates against the development of broadcasting, and also against the production of a really practical system of telephonic multi-communication, either by cable or wire, as well as against the establishment of a system of television using relative long waves, which would permit obtaining transmissions at long distances.

The fundamental purpose of this present invention is to present a new method of selection according to which the selective reception of electro-magnetic waves is produced by means other than those which have been applied heretofore, that is, resonance phenomena, and thereby, among other advantages, to secure a selected modulated wave, among other closely related modulated waves.

I propose to obtain this result by means of a synchronous variation of internal resistance of thermionic electron tubes inserted in series, with the circuit arranged for selective reception. I wish it to be understood, however, that the use of variations in the internal resistance of tubes, as such, is well known in the art for the purpose of varying the ratio of amplification; on this basis, various inventions have been worked out dealing with the problem of anti-fading, elimination of static, and the like. In this present invention, however, the application of the method of varying the internal resistance of electronic tubes is different, and the problem with which this invention deals can be briefly formulated as follows:

Being given two or several modulated waves having carriers of different frequencies, the difference of which is smaller than the frequency of modulation, the problem is to diminish the intensity of one of these modulated waves without decreasing the intensity of the other. The solution of this initial problem, according to this invention, is as follows:

The sum of these two modulated waves is passed through a thermionic tube or system of tubes, the resistance of which is made to vary oscillatably in synchronism with the carrier frequency of the modulated wave to be eliminated. It can be shown by means of a mathematical analysis, which conclusions are also entirely corroborated by experiments, that if the variations in internal resistance, synchronized with the carrier frequency of the wave to be eliminated, are sufficiently intense, the modulated wave in question will be very appreciably weakened; whereas the second modulated wave, the carrier of which is not synchronized with variations in the internal resistance of the tube, will go through without any appreciable attenuation.

In order to be able to accomplish this result, I provide suitable electronic tubes with either electro-static or magnetic control, considered as diodes with grids. It is to be understood that the expression "diode with grid" used in the following, has for its purpose to define the performance of such a three-electrode tube inserted in series with the circuit, and operating at a variable anode potential, as distinguishing from conventional triodes defined as performing under a constant plate potential less the usual impedance drop in the external circuit.

With this invention, a diode with grid is a three-electrode vacuum tube comprising a cathode, an anode, and a grid, mounted in such a manner that there exists no constant potential applied to the anode, so that the cathode and the anode are exactly at the same potential at the point of equilibrium of the system. With such a tube and mounting, even a relatively small negative potential applied to the grid of the diode described causes a very substantial increase in the resistance of the tube.

The second important feature and fundamental purpose of this invention is the combination of two such diodes with grids in a push-pull circuit. In fact, if only one such diode were used in the circuit it would function inevitably as a rectifier, in so far as it would only conduct when the cathode is negative with respect to the anode. It will be evident that the application of the push-pull circuit to these diodes with grids permits the obviation of this difficulty.

The importance of this invention from the standpoint of selective reception can also be un-

derstood from the fact that when two modulated waves have carrier frequencies very close to each other, their side bands overlap each other. For instance, in recent experiments satisfactory results were obtained by this method for a difference of carrier frequencies of the order of 100-cycles, while the width of each side band was of the order of 2,000 cycles per second. Obviously no successful selection between these modulated carriers could be secured by the use of "resonance." It is clear that with ordinary methods of selection applied heretofore no such separation would be possible, in so far as the side bands of such two modulated waves would be practically coincident, and the means of selection eliminating one of these side bands belonging to one modulated wave would inevitably eliminate the other side band of the other modulated wave, so that there would be no selection. It is thus apparent that the problem of selection applied to modulated waves, the carriers of which are so close to each other that the side bands arising from the modulation overlap each other, could not be solved by ordinary means of selection involving usual methods of resonance involving either tuned circuits or filters in general.

The above-disclosed principle of variation of the internal resistance of diodes with grids synchronized with the carrier of a modulated wave, permits elimination of the latter in spite of the above-mentioned difficulty.

The variation of internal resistance above referred to can be accomplished in various ways. For example, I can apply for this purpose the action of an external magnetic field at right angles to the direction of the electric field, which deviates electronic paths by virtue of the so-called Lorentzian force, as this is customary to do in magnetically controlled thermionic tubes. A substantially similar result, so far as variation of internal resistance is concerned, can also be produced by varying the grid potential of a three-electrode vacuum tube, inserted in a circuit, and considered merely as a diode with grid or as a resistor, the resistance of which can be varied by this electrostatic great potential variation.

The selective action of such a circuit containing a variable resistor formed by the internal resistance of an electronic tube, can be explained mathematically as follows:

Assume, as an example, that a magnetically controlled diode is used as a variable resistor, within the rectilinear portion of its characteristic. Its internal resistance is:

$$\rho=\rho_0+q|H|$$

Where

ρ designates the internal resistance of the diode under the effect of magnetic field

ρ_0 is its internal resistance in absence of the magnetic field.

H is the intensity of the magnetic field.

q is a constant.

It is seen, thus, that ρ is a function of the absolute value of H, since the internal resistance of the diode is independent of the direction of the field, provided the latter remains perpendicular to the electronic current moving from the cathode towards the anode.

Assume now that a variable voltage E is applied, between the cathode and the anode of the diode, having the following form:

$$E=E_0 \sin \omega t$$

Assume, furthermore, that the magnetic field oscillates exactly in accordance with the same rhythm as the above voltage; that is

$$H=H_0 \sin \omega t$$

In such a case, the current through the diode will be:

$$I=\frac{E_0 \sin \omega t}{\rho_0+qH|\sin \omega t|}$$

Where I is the output of the diode and

$$|\sin \omega t|$$

designates the absolute value of the sinusoidal function.

As a result of the analysis of the above expression, for the plate current I, it follows that throughout the cycle the value of I is contained between the limits

$$+\frac{E_0}{qH_0} \text{ and } -\frac{E_0}{qH_0}$$

and since q, the co-efficient of proportionality as above specified, otherwise designated as the constant of "blowing," can be made as large as one pleases, it is apparent that the current corresponding to the synchronously varied resistance in the circuit can be made as small as desired.

An entirely different effect is obtained when the magnetic blowing is not synchronized with the oscillations applied to the diode.

Assume, for instance, that this oscillation has the form of

$$E=E_0 \sin (\omega+\eta)t$$

whereas the field of blowing varies according to the equation

$$H=H_0 \sin \omega T$$

Under these conditions, the plate current I_p of the diode will have the form:

$$I_p=\frac{E_0 \sin (\omega+\eta)t}{\rho_0+qH_0|\sin \omega t|}=\frac{E_0 \cos \eta t \sin \omega t}{\rho_0+qH_0|\sin \omega t|}+\frac{E_0 \sin \eta t \cos \omega t}{\rho_0+qH_0|\sin \omega t|}$$

The first of the two terms of the sum, namely

$$\frac{E_0 \cos \eta t \sin \omega t}{\rho_0+qH_0|\sin \omega t|}$$

will be practically wiped out; whereas the second term, namely

$$\frac{E_0 \sin \eta t \cos \omega t}{\rho_0+qH_0|\sin \omega t|}$$

will oscillate between the values

$$+\frac{E_0}{\rho_0} \text{ and } -\frac{E_0}{\rho_0}$$

independently of the value of

$$qH_0$$

In fact, the expression

$$\frac{\cos \omega t}{\rho_0+qH_0 \sin \omega t}$$

represents a periodical function of time, having the period

$$\frac{2\pi}{\omega}$$

The value of this function, as seen from an inspection of the above expression, oscillates between

$$+\frac{1}{\rho_0} \text{ and } -\frac{1}{\rho_0}$$

Further developing these calculations, it is possible to prove that the amplitude of current corresponding to the synchronous frequency is contained within the following limits:

$$\frac{4}{\pi qH_0}\log\left(\frac{\rho_m}{\rho_0}\right)>I_p>\frac{4}{\pi qH_0}\left[\log\left(\frac{\rho_m}{\rho_0}\right)-1\right]$$

These expressions show that an electric wave undergoes an attenuation in amplitude by a variation of its internal resistance, synchronized with this wave. It does not undergo any appreciable attenuation when the frequency with which the internal resistance of the tube varies is not synchronized with the frequency of the voltage applied to the tube. The oscillating magnetic field of blowing thus represents a means of selection in the same manner as resonance.

In fact, if one applies to a diode provided with a device of blowing the sum of two oscillations, having different frequencies of the form:

$$A \sin \omega t + B \sin (\omega+\eta) t$$

and if, at the same time, the diode undergoes a blowing synchronized with one of these two oscillations, that is, the field of blowing, for example, varies in accordance with equation

$$H = H_0 \sin \omega t$$

the oscillation

$$A \sin \omega t$$

will produce alternating current of the frequency

$$\omega/2\pi$$

and of amplitude which is smaller than

$$A/qH_0$$

Whereas the oscillation

$$B \sin (\omega+\eta) t$$

will produce a modulated current, the carrier frequency of which will be

$$\omega/2\pi$$

and the amplitude of which will be greater than

$$\frac{4B}{\pi q H_0}[\log \rho_m/\rho_0 - 1]$$

The greater is

$$\rho_m/\rho_0$$

That is, the stronger the blowing, the more selective the device.

As a result of the above study, it appears possible to eliminate from a plurality of incoming oscillations, by means of a synchronized blowing, a given oscillation, while leaving all others substantially without any change.

It is evident that the above conclusions are applicable not only to continuous waves, but also to modulated waves. This invention, however, has particular importance in connection with the latter.

The problem to be solved in practice consists in eliminating from a given plurality of modulated waves all of the waves but one, which is the wave to be received.

In order to be able to obtain an absolutely general solution of this problem, from a theoretical standpoint, this invention provides means whereby the plurality or spectrum of waves is conveyed through a system of thermionic tubes, the internal resistance of which is made to vary in synchronism with the carrier frequencies of disturbing waves. This result can be obtained in different ways, which, however, derive from the following basic idea:

Two parallel receptions are used, each having a system of tubes with variable internal resistance, as above explained. In one of these parallel receptions, the variation of internal resistance is produced by the carrier of the wave to be received, and consequently is synchronized with this oscillation. In the second reception, the variation of internal resistance is produced by an oscillation which has the same frequency as the carrier oscillation of the wave to be received, but having a phase difference

$$\pi/2$$

with respect to the phase of this carrier wave.

As a result of this, in the first reception the wave to be received is eliminated, whereas in the second one this wave is maintained. In both receptions, however, each disturbing oscillation is transformed into two oscillations located symmetrically on both sides of the carrier of the wave to be received, as was explained in the above discussion.

The method of selection to be used consists essentially in using the product of the first reception, that is, the plurality of waves, in which the wave to be received is eliminated, for varying the internal resistance of one or several thermionic tubes, through which the product of the second reception is conveyed. By the product of the second reception is meant the plurality or spectrum of waves, containing both the wave to be received as well as the disturbing waves. This is accomplished by varying the internal resistance of thermionic tubes in response to the product of the first reception, while the product of the second reception appears as a voltage, or potential difference, impressed between the cathodes and anodes of said tubes.

It is essential to note the following broad feature of this invention. In a great majority of circuits, the characteristic parameters of the circuit are constant. By parameter is meant any of the quantities, such as resistance, inductance, capacitance, or generalized quantities such as impedances, admittances, and the like, which determine the properties of the circuit or of the network in general.

In this invention, however, the performance of the circuit is such that one of the parameters, namely the resistance, is made to vary synchronously with a certain frequency, corresponding exactly to the carrier frequency of the modulated wave. In such a case, as just explained, the modulated wave disappears, or at least is very appreciably reduced, while the other modulated waves, whose carrier frequencies are not so synchronized with the variation of the resistance of the circuit do not undergo any appreciable attenuation. Furthermore, if the circuit conveys a band or spectrum of modulated waves, and the variable resistor undergoes variations synchronized either with a certain number of discrete carrier frequencies, or with a certain band of carrier frequencies—the modulated waves whose carriers correspond to the respective rhythms in the resistance variation—disappear, or are very greatly reduced, while other modulated waves remain without any appreciable attenuation.

These new phenomena, on which this invention is based, are not governed by linear differential equations with constant co-efficients, such as are well known types of oscillations of pendulums, oscillating circuits, and the like, but have a property that the parameters of such circuits or, more generally, of the system of such circuits, are functions of externally applied forces. Such differential equations may be designated as quasi-linear equations, and the phenomena which fall within the scope of these equations are quasi-linear phenomena.

The essential feature of these quasi-linear phenomena is that the principle of superposition

of small oscillations governing the greater part of known oscillatory phenomena either of dynamics or of electricity, is not applicable to such phenomena. On the other hand, with respect to steady disturbances, these phenomena belong rather to the realm governed by linear differential equations. These quasi-linear equations are thus on the threshold between the linear and non-linear differential equations. It is apparent that, instead of a synchronized variation of one parameter—the resistance—a suitable synchronized variation in other parameters—the inductances or capacities—would produce similar results from the standpoint of selectivity of the circuit with respect to modulated waves in a quasi-linear circuit.

From this broad standpoint, the present invention establishes primarily a new principle of selectivity in quasi-linear circuits as an entirely different principle distinguishing from that of resonance, which principle Lord Kelvin established about seventy years ago, and secondarily permits of applying this new method to a selective reception of modulated waves by means of a synchronized variation of parameters of this quasi-linear circuit, even in the case when the carrier frequencies of modulated waves are so close to each other that their side bands practically overlap each other, which separation or selection has not been possible to accomplish heretofore.

A number of additional important features and conditions to be fulfilled for the purpose of obtaining a practical system for selective reception of modulated waves is described in the following, with reference to the accompanying drawing in which Figure 1 represents a diagram of the system comprising a preferred embodiment of the invention and Figures 2 and 3 represent two different uses of a magnetically controlled diode.

The control device in Figures 2 and 3 comprises a pair of coils S_1 and S_2 fixed inside the bulb on either side of the convection current flowing from the cathode K to the anode A. The coils are located in such a manner that the control field is perpendicular to the path of the electrons.

The two parallel receptions described above are represented on the figure by an upper row and a lower row of devices. In the upper row, the modulated wave to be received is eliminated, whereas in the lower row this wave is maintained. In each of these rows, the plurality of oscillations coming from the plate of the amplifier tube **2** passes at first through the push-pull system of vacuum tubes **7** and **8**, which tubes are arranged to work as variable resistors in the manner previously explained.

It is immaterial whether the cathodes or anodes in the system are subject to regulation. In the attached drawing, the plurality of incoming waves is applied to the cathodes of the push-pull system.

The character **9** represents a quartz filter with a narrow passing band, which may be of the order of 30 or 40 cycles; this filter has for its purpose to isolate from the plurality of oscillations emerging from the plate of tube **2** the carrier wave to be received. The latter oscillation is used for the purpose of varying the grid potential of both tubes **7** and **8** in the push-pull connection. For this purpose, an amplifier tube **9a** amplifies this oscillation before it is applied to the grids of tubes **7** and **8**. This causes the internal resistance of these tubes **7** and **8** to vary strictly in accordance with the frequency of the carrier wave to be received.

From what has previously been explained, this synchronized variation of internal resistance produces a very substantial weakening of the modulated wave to be received. As regards the push-pull system of the lower row, formed by tubes **10** and **11**, its grids are submitted to the action of an oscillation having the same frequency as the carrier wave to be received, but having a phase difference of $\pi/2$ from the carrier wave. In fact, the oscillation leaving the filter **9** is applied to the grid of the amplifier **13**, through a system of impedances **14**, which shifts the phase by $\pi/2$. The oscillation emerging from the plate **13** is applied to the grids of the lower push-pull system formed by tubes **10** and **11**, so that the variation of internal resistance of this last-mentioned push-pull has a phase difference of $\pi/2$ with respect to the variation of internal resistance of the upper row push-pull formed by tubes **7** and **8**.

The action produced by these push-pull systems is suitably increased by means of an aperiodic amplifying system biased at the cut-off point, and shown as formed by tubes **16**, **17**, **18**, and **19**. By "aperiodic amplification" is meant any well-known method of amplification in which the amplification of a signal occurs over a rather wide band of frequency spectrum.

The cathodes of these push-pull amplifiers **16** and **17** on the one hand, and **18** and **19** on the other hand, are connected to the ground through potentiometers **20** and **21**, which permits of biasing their grids to a sufficiently negative potential with respect to the cathode, so as to obtain the desired point on their characteristic.

22 and **23** are two band filters which cut off all oscillations of either higher or lower frequencies than those of the carriers of the wave to be received.

The purpose of these filters is to produce a still further improvement in the selectivity of the circuit. It can be shown mathematically that if one neglects to cut off from the plurality of incoming waves the oscillations, the frequencies of which are either lower than the carrier wave to be received or higher than that frequency, there will appear in the output of diodes with grids the terms which will have a common high frequency component. This would mean that the effect of the variation in the internal resistance in the denominator of the output current would produce the same action on each of these component currents. If, therefore, this variation in internal resistance attenuates the disturbing waves, it also attenuates in the same proportion the modulations to be received; if it allows the latter to pass, it is incapable of stopping the disturbing waves. As a result of this, there will be a lower selectivity, and an entirely different result is obtained in the case when means are provided for cutting off from the products of the two receptions either their upper or their lower side bands. The purpose of filters **22** and **23** is to accomplish the above-mentioned improvement.

Amplifiers **24** and **25** are provided for the purpose of compensation of the losses in intensity produced by variable polarization, which losses cannot be entirely compensated for by the gain resulting from the aperiodical amplification at the cut-off point produced by tubes **16**, **17**, **18**, and **19**, as previously described.

Tubes 26 and 27 represent a third push-pull arrangement of diodes with grids; the cathodes of this push-pull are acted upon by the plurality of oscillations arriving from the tube 25, and containing the modulated wave to be received, as well as the disturbing oscillations; the grids of these push-pull tubes are acted upon by the plurality of waves arriving from the amplifier 24, and containing only the disturbing waves.

Tube 31 is a detector tube, the grid of which is acted upon by the plurality of waves arriving from the tubes 26 and 27 on the one hand, and the carrier of the wave to be received arriving from the filter 9 on the other hand. The performance of the circuit has been sufficiently explained, so that no further explanation is necessary.

The above-described arrangement should be understood broadly and not in a limiting sense. For instance, I can use different compensation methods in the parallel receptions above described. In the first of these receptions, for example, the modulated wave to be received will be eliminated; in the second reception, these waves will be maintained. The products of each of these receptions will be separately detected thereafter. In this manner, there will be two systems of low frequency currents; one system derived from the first reception will represent modulations of all modulated waves, including the wave to be received. By letting one system of oscillations so produced act on the other one through the instrumentality of the resistance variation of thermionic tubes in the form of diodes with grids, as above explained, modulations to be received will be isolated from all other disturbances.

It is also possible for certain applications, such as, for example, establishing a telephonic multicommunication through a single circuit, to modify the disclosed arrangement by another one based on the following principle:

Assume, for instance, that several telephonic communications carried by several carrier frequencies distant from each other by a given number of cycles, is conveyed through one single circuit. In such a case, one can separate from the plurality of incoming oscillations all the carrier waves, for example, by means of a suitable number of quartz filters, each of which has a very narrow passing band.

In order to be able to separate a given conversation, one can submit the plurality of incoming oscillations to the action of all carrier frequencies, with the sole exception of one single carrier, namely one which conveys the modulated wave to be received. The mechanism of this action will be produced again by means of a synchronized variation of parameters of a quasi-linear circuit, such as a resistance variation of diodes with grids, on which the plurality of all carrier waves will act, with the exception of the carrier of the wave to be received.

Under these conditions, all the incoming modulated currents will be greatly attenuated, and weakened, with the sole exception of that corresponding to the modulated wave to be received.

It is to be understood that the phraseology of the claims is to be limited in its interpretation to cover merely the separation of one modulated carrier wave from a pair of modulated carrier waves having overlapping side bands so that by plurality I restrict myself to two.

What is claimed is:

1. A method of selective reception of modulated electric waves through a quasi-linear electric circuit which consists in impressing a plurality of modulated carrier waves through said circuit, said waves comprising respectively desired and undesired waves, in varying at least one of the parameters of said circuit synchronously with the carrier of the undesired modulated wave whereby said last mentioned wave is substantially weakened while other desired modulated waves the carriers of which are not oscillating in synchronism with the variations of the parameters of the aforementioned quasi-linear circuit go through the latter without being attenuated in the same proportion.

2. A method of selective reception of modulated electric waves by means of an electric circuit with variable parameters, which comprises conveying the incoming plurality of modulated waves through said circuit, and in varying at least one of the parameters of this latter in synchronism with the carriers of a certain number of modulated waves contained in the incoming plurality, whereby the modulated waves in question undergo a substantial weakening while other modulated waves contained in the first mentioned incoming plurality, the carriers of which are not oscillating in synchronism with the variations of the parameters of the above mentioned quasi-linear electric circuit go through same without being attenuated in the same proportion.

3. A method of selective reception of modulated electric waves by means of an electric quasi-linear circuit comprising a variable resistor element constituting the variable resistance of the above mentioned quasi-linear circuit, the method comprising conveying the incoming plurality of modulated waves through said circuit, in varying the resistance of said element in synchronism with the carrier wave of a determined modulated wave to be eliminated, whereby the latter is substantially weakened, while other modulated waves the carriers of which are not synchronized with said resistance variation of said element go through said circuit without being weakened in the same proportion.

4. A method of selective reception of modulated electric waves by means of an electric quasi-linear circuit comprising a variable resistor element, which consists in conveying the incoming plurality of modulated waves through said circuit in varying the resistance of said element in synchronism with the plurality of carrier waves of a certain number of modulated waves to be eliminated, whereby the latter undergo an appreciable attenuation while the remaining modulated waves to which there corresponds no such resistor variation synchronized with their respective carrier wave, go through the circuit without being attenuated in the same proportion.

5. In a circuit for selective reception of modulated electric wave a quasi-linear circuit arranged to have conveyed through it the incoming plurality of modulated waves and containing a variable resistor element formed by a thermionic tube mounted in the form of a triode to the anode of which no constant voltage is applied, means for periodically varying the internal resistance of said tube and means for synchronizing said resistance variation of said tube with the carrier wave of the modulated wave to be eliminated whereby the modulated wave in question undergoes an appreciable attenuation in passing through said circuit while the modulated wave to which there corresponds no resistance variation of said tube synchronized with their car-

riers, go through the first mentioned quasi-linear circuit without being attenuated in the same proportion.

6. In a circuit for selective reception of modulated waves a quasi-linear circuit comprising a variable resistor element formed by a thermionic tube, means for making the internal resistance of said tube vary periodically and means for synchronizing said resistance variation of said tube with the plurality of the carrier waves of a certain number of modulated waves to be eliminated, whereby the latter undergoes an appreciable attenuation in passing through said circuit while other modulated waves to which there correspond no resistance variation of said tube synchronized with their carriers, pass through the circuit in question without being weakened in the same proportion.

7. In a circuit for selective reception of modulated electric waves a quasi-linear circuit comprising a variable resistor element formed by a diode with magnetic control, means for periodically varying the internal resistance of said diode, said means comprising an external oscillating magnetic field at right angle to the direction of electronic flux, and means for synchronizing said resistance variation of said diode with the carrier of a determined modulated wave to be caused to disappear.

8. In a system for selective reception of modulated waves means for obtaining selectivity comprising two parallel receiving circuits, each circuit having a variable resistor in the form of triodes without high plate voltage arranged in a push-pull connection within each said parallel circuit, a narrow band filter passing the frequency of the carrier wave corresponding to the modulated wave to be selected, means for producing resistance variation of one pair of said triodes in a push-pull connection in one of said parallel circuits whereby the modulated wave of said carrier frequency is eliminated as a result of a synchronous resistance variation in a quasi-linear circuit, means for shifting the phase of said carrier frequency by a quarter period, means for varying the resistance of the said triodes in the second parallel circuit in response to said phase shifted carrier frequency, whereby the modulated wave to be received is eliminated in the first-mentioned parallel circuit whereas said wave is maintained in the last mentioned circuit, means for combining responses of said parallel receiving circuits comprising a third push-pull circuit of triodes without high plate voltage so connected with said parallel receiving circuits that in both parallel receptions each of the oscillations constituting a disturbing wave is transformed into two oscillations the frequencies of which are situated symmetrically on both sides of the carrier frequency of the modulated wave to be received and the amplitudes of which are continuously equal which reproduces the correct modulated wave to be transmitted through a selective quasi-linear circuit.

9. In a system for selective reception of modulated waves with overlapping side bands, selective quasi-linear circuits for parallel reception each circuit comprising variable resistors in the form of triodes the resistance of which is controlled; means in one of said circuits by which the resistance variation is synchronized with and responsive to the carrier of the modulated wave to be received, whereby said modulated wave is eliminated; means for shifting the phase of the carrier wave by one quarter period, means for applying said phase shifted wave for the purpose of variation of resistance of the second circuit whereby said second circuit transmits all incoming modulated waves including the wave to be finally selected, means for detecting separately the plurality of modulated waves resulting from reception in said first and in said second quasi-linear receiving circuits, means for superposing the systems of low-frequency currents thus obtained whereby from the two systems, one containing all modulated waves and the other all modulated waves less the wave to be received, the modulated wave to be selected is finally obtained.

10. In a system for selective reception of modulated electric waves with overlapping side-bands, two electric quasi-linear circuits for parallel reception, each circuit comprising thermionic tubes with means for varying their internal resistance, means for receiving the plurality of incoming modulated waves, means for locally producing an artificial disturbing wave the amplitude of which is notably superior to that of the modulations to be received as well as to the disturbances to be eliminated and the frequency of which is distant from that of the carrier wave to be received by a number of cycles considerably in excess to the maximum frequency of modulations to be received, said means for locally producing an artificial disturbance comprising a local generator, means for adding said artificial locally produced disturbing wave upon the plurality of incoming waves and means for adding these disturbing waves to the variable voltage utilized for periodically varying the resistance of the said quasi-linear circuits, whereby the deformation of modulation of the modulated wave to be received is obviated.

11. In a system for selective reception of modulated waves with overlapping side bands, two selective quasi-linear circuits for parallel reception, each circuit comprising triodes with means for varying their internal resistances, means for varying the internal resistance of the triodes in the first parallel receiving circuit synchronously with the carrier frequency of the modulated wave to be received whereby said modulated wave is eliminated in said first parallel receiving circuit, means for shifting the phase of said carrier wave by one quarter period, means for controlling the internal resistance of the triodes in said second parallel circuit in response to said phase shifted carrier wave, whereby all modulated waves go through said second parallel circuit, filter means arranged in each of said parallel receiving circuits and arranged so as to cut off from the plurality of modulated waves conveyed through both parallel circuits all waves which have a frequency either higher or lower than the frequency of the carrier wave of the modulated wave to be selected, whereby the intensity of modulations to be received is maintained.

12. In a system for selective reception of modulated waves with overlapping side bands, two selective quasi-linear circuits for parallel receptions, each circuit comprising triodes with means for varying their internal resistances, means for variation of resistances of the triodes in the first selective circuit in synchronism with the carrier frequency of the modulated wave to be received, whereby said modulated wave is eliminated in said first parallel circuit, means for shifting the phase of said carrier wave by one quarter period with respect to the wave controlling the resist-

ances of triodes of said first circuit, means for controlling the resistances of the triodes in said second parallel circuit in resynchronism with said phase shifted wave, whereby all modulated waves are capable of going through said second circuit, a system of detector tubes arranged in each circuit in a push-pull manner, means for biasing said detector tubes substantially at the cut-off point of their linear detection range whereby the selectivity of circuits is increased by adjusting the bias voltage on said detector tubes.

LEONIDE GABRILOVITCH.