ABSTRACT: A sideband generator, comprising a high frequency signal generator of frequency $f_n$, a circuit for generating low frequency signals of frequency $F_{ac}=1/T$, characterized in that it comprises a bridge with two inputs and two outputs forming the sum and/or the difference of the signals fed to the inputs, the two inputs of said bridge being connected to the source of high frequency energy by means of numerically controlled distributing and phase-shifting means.
SIDEBAND GENERATOR HAVING STEP CONTROLLED MODULATION

This invention relates to a sideband generator and may be used to provide either two systems of sidebands by modulating a high-frequency signal to provide input to a high-frequency signal at low-frequency in which each step lasts for the same time duration, or to provide an output carrier wave amplitude modulated by a periodic signal. More particularly the generator of the invention has the advantage that it is capable of being constructed to take advantage of integrated circuits with their attendant benefits.

In accordance with one aspect of the invention there is provided a sideband generator comprising a high-frequency signal generator producing a signal at a frequency \( f_s \), a circuit for generating low-frequency signals at a frequency \( f_p \), a bridge network having two input junctions and two output junctions from which are obtained the sum and/or the difference of the signals fed to the input junctions of the bridge which are connected to the high-frequency signal generator by a switchable phase-shifting means controlled by a numerically sensitive control element.

In accordance with a second aspect of the invention a sideband generator comprises a high-frequency signal generator producing a signal at frequency \( f_s \), a low-frequency signal generating circuit producing a signal at a frequency \( f_p \), a common path having a finite electrical length through which the high-frequency signals pass, switching means operating to alter, in equal steps, the electrical length of the path over a predetermined range of steps to provide at the output terminal of the line a high frequency signal whose amplitude varies in steps of equal time, diodes in said switching means having conducting and nonconducting states at which they respectively transmit and block the high-frequency signal to the line, and a numerically operated control element providing bias voltages applied to the diodes selectively to forwardly bias them to their conducting states when they are required to transmit the high-frequency signals and to back-bias them to their blocking states when they are not required to transmit the high-frequency signals.

In the preferred application of the invention the high-frequency signal provides a carrier which is amplitude modulated by the low-frequency signal which is so applied that the modulation envelope appears stepped, each step lasting for the same time interval. In carrying out the invention use is preferably made of a hybrid bridge modulator composed of four sections of coaxial line arranged in the form of a bridge circuit and having one pair of opposite corner junctions providing input terminals and the other pair of opposite corner junctions providing output terminals. Each of the arms have a length \( \lambda/4 \), where \( \lambda \) is the wavelength of the high-frequency signal, while the remaining arm has a length of \( 3\lambda/4 \). If the output corner junctions are suitably provided with impedances matching the line impedance of the coaxial arms of the bridge, advantage can be taken of the well-known properties of quarter-length line transformers to provide at the output corner junctions of the bridge the high-frequency signal whose amplitude fluctuates in accordance with the path length extending from the high-frequency signal generator to the output corner junctions of the bridge.

In carrying out the invention with a coaxial bridge network, the input corner junctions of the bridge are preferably connected to receive the high frequency signal from the switching circuit and the high-frequency signal at predetermined points spaced from the electrical center of the connection extending between the two input corner junctions of the bridge. The switching circuit may be arranged to step between predetermined intermediate positions at equal intervals of time, each position introducing a small difference in the path length extending from the high-frequency generator to each of the two output corner junctions of the bridge. The phase suppression properties of the bridge can be arranged to produce a reduction in the amplitude of the high-frequency signal fed to one output corner junction while simultaneously an increase in the amplitude of the high-frequency signal fed to the opposite corner junction.

The invention now will be described in more detail, by way of examples, with reference to the accompanying drawings, in which:

FIG. 1 illustrates a coaxial line bridge network of known type;
FIG. 2 is a block schematic diagram of a sideband generator;
FIGS. 3, 4 and 5 illustrate signals appearing at various points in the circuit of FIG. 2 over a period of time \( T \) which is equal to the inverse of the desired frequency of modulation;
FIGS. 6, 7, 8 and 10 show switching and control circuits shown in block form in FIG. 2;
FIG. 9 shows a logic circuit represented in block schematic form in FIG. 2.

Turning first to FIG. 1 this shows a coaxial bridge circuit of known type having four coaxial lines 1, 2, 3 and 4 each of 50 ohms impedance and connected at corner junctions A, B, C and D. The coaxial lines 1, 2 and 3 are each of length equal to \( \lambda/4 \) (where \( \lambda \) is the wavelength of a high-frequency input signal at a frequency \( f_p \)) while line 4 has a physical length \( 3\lambda/4 \). A fifth line 6 also of 50 ohms impedance interconnects the input corner junctions A and B of the bridge network and the center M of line 6 is connected to a high-frequency signal generator 5 producing a continuous carrier frequency signal \( f_c \). The electrical length of the fifth line extending from M to A is equal to the electrical length of the portion of the line extending from M to B and introduces into the signal fed from the high-frequency generator 5 at phase shift \( \Phi \).

The two output corner junctions C and D are earthed respectively through a pair of 50-ohm impedances 7 and 8 which match the coaxial line impedance of the bridge.

In the bridge of FIG. 1 the voltages at the corner junctions A and B are equal as the phase shift of the input signal \( f_p \), applied to them is the same, the path length MA and MB being equal. Considering first electrical energy introduced into the bridge at corner junction A, the two path lengths ACB and ADB, being of half a wavelength difference, result in corner junction B appearing, when viewed from corner junction A, as a short circuit. Likewise, corner junction A appears, when viewed from corner junction B, also as a short circuit. Considering now the output corner junction C, this will receive energy from input corner junctions A and B; However, as the length of the line 4 is half a wavelength different from the length of the line 1, the voltage at C will always be zero as the signals received from corner junctions A and B are in antiphase with one another. As corner junction C is terminated with a matching impedance there is no reflection of energy back into the bridge.

Turning now to corner junction D, this receives energy from corner junctions A and B which, as the path lengths of the coaxial lines 2 and 3 are the same, will always be in phase. All of the energy directed into the bridge is therefore extracted at the corner junction D which is terminated with 50 ohms matching impedance to prevent back reflection of energy into the bridge.

It follows from the analysis of the functioning of the bridge network that the voltages at the corner junctions A and B are made different by positioning the input contact on line 6 an electrical distance from point M. However, all of the power fed into the bridge will still be distributed between the output corner junctions C and D but the relative strengths of the output signals at these corner junctions will be a function of the displacement from point M of the position of introduction of the high-frequency signals from the generator 5.

FIG. 2 illustrates a circuit diagram of a sideband generator which takes advantage of this feature and produces a low-frequency modulation envelope of 30 cycles and of stepped configuration providing for equal quarter period eight steps equispaced in time as shown in FIG. 3. In the block circuit diagram of FIG. 2 the numerals 1 to 6 refer to the same components as are correspondingly numbered in FIG. 1. It will be
seen that the fifth line in Fig. 2 is equipped with several contacts $E_1$ to $E_6$ located on the same side of the center point $M$ of the line, the electrical path lengths $MA$ and $MB$ being equal. To simplify the drawing only $E_1$ and $E_6$ are referenced and they are represented as contact studs of a switching circuit $X$ having a switch arm 10 which is connected at point $G$ to an input signal generator 5. Generator 5 delivers a high-frequency continuous signal at $f_c=110$ Me/s.

Operation of the switching circuit $X$ is accompanied by stepping of the switch arm 10 between the studs $E_1$ to $E_6$. The stepping movement is controlled by a control element 11 which has eight inputs respectively to eight output control terminals $n_1$ to $n_8$ of a logic circuit 12. In actual practice the operation of the switching circuit $X$ is controlled electronically by the control element 11 as is explained in more detail below with reference to later Figures which have still to be described.

A timing signal generator 13 supplies a signal at 960 c/s which operates a counter having five binary stages. The first four binary stages are formed by bistable multivibrators 14, 15, 16 and 17 which are mounted in series and each of which provides a pair of complementary outputs. The fifth stage of the counter is formed by two bistable multivibrators 18 and 19 which are connected to receive respective outputs of the complementary pair of outputs from the multivibrator 17. Each of the two multivibrators 18, 19 gives a pair of complementary outputs which are individually fed to input control terminals $m_1$ to $m_6$ of the logic circuit 12. The eight outputs from the four multivibrators 14 to 17 are respectively connected to input control terminals $m_1$ to $m_6$ of the logic circuit 12.

The output corner junctions $C$, $C'$ of the bridge network are respectively connected to contact pairs $p_1$, $p_2$ and $q_1$, $q_2$. The contacts $p_1$ and $p_2$ are connected by a coaxial line 19 which introduces a phase displacement of half a wavelength. Likewise a coaxial line 22 introduces a phase displacement of half a wavelength. Likewise a coaxial line 22 introduces a displacement of half a wavelength between the contact pair $q_1$ and $q_2$. Associated with the two contact pairs are respective switching members 20, 23 which are controlled by switch controllers 21 and 24. The switch controller 21 receives two inputs from the output control terminals $n_1$ and $n_2$ of the logic circuit 12 and controls operation of the switching member 20, while the switch controller 24 receives two inputs from the output control terminals $n_3$ and $n_4$ and controls operation of the switching member 23. When the switching members 20 and 23 are in respective positions $p_1$ and $q_1$ the high-frequency signal delivered at main output terminals $S_1$ and $S_2$ suffers a phase inversion as a result of the half wave lines 19 and 22.

As the coaxial lines $AD$ and $BD$ are each quarter-wavelength transformers of ratio $1/\sqrt{2}$, the high frequency voltage at corner junction $D$ is given by the equation:

$$V_D = \frac{V}{\sqrt{2}} \sin \left( \omega t + \phi + \psi + \frac{\pi}{2} \right) + \frac{V}{\sqrt{2}} \sin \left( \omega t - \phi - \psi - \frac{3\pi}{2} \right)$$

that is to say:

$$V_D = \frac{2V}{\sqrt{2}} \cos \left( \omega t + \phi \right) \cos \psi$$

The switch arm 10 is switched in turn to each of the intermediate contacts $E_1$ to $E_6$ during successive equal periods of $\Delta T=1960$ second. The switch arm 10 spends a time of $\Delta T$ on the contact $E_6$ for the reason seen immediately in Fig. 3 and it then steps back over the intermediate contacts during successive periods of time $\Delta T$ until it reaches $E_1$ at which it is again held for a period $2\Delta T$. The distance between $E_1$ and $E_6$ approximates to a quarter-wavelength so as to obtain at the corner junctions C and D high-frequency signals which are in phase with one another but whose levels vary as the sine and cosine of the electrical angle.

The logic circuit 12 is controlled by the timing signal generator 13 supplying signals at a frequency of 960 c/s to the binary counter whose five binary stages with double complementary output transform the high-frequency signal $f_c$ from generator 5 into two systems of sidebands contained in a modulation envelope of 30 c/s and shifted in phase by $90^\circ$ with respect to each other.

Figs. 3 and 4 respectively represent a 30 c/s sideband system. The sideband level is denoted by the axis $y_1$ in Fig. 3, and by the axis $y_2$ in Fig. 4. The 30 cycle modulating envelope is stepped form and is divided into equal time intervals corresponding to each step in dependence upon the signals appearing at the output control terminals $n_1$ to $n_4$ of the logic circuit 12. In Fig. 3 these signals bear the reference $(n_1$ to $n_4$) and they control the stepping of the switch arm 10 of the switching circuit $X$ between the positions $E_1$ to $E_6$. They also control by way of the output control terminals $n_1$ to $n_2$ the operation of the switching members 20 and 23 which determine whether the phase inverting lines 19, 22 are introduced between the output of the bridge network and respective main output terminals $S_1$ and $S_2$.

The switch arm 10 is in the position $E_1$ for a time $\Delta T=1960$ second during which time the high-frequency signal from the generator 5 is applied to the bridge. During the first quarter-period of the 30 cycle modulation signal, that is to say until time $T/4$ where $T=1/30$, the two switching members 20 and 23 are in respective positions $p_1$ and $q_1$ as is dictated by the signals $(n_1)$ and $(n_2)$ delivered to the output control terminals $n_1$ and $n_2$ of the logic circuit 12. The phase inversion of the signal at the main output terminal $S_1$ is produced by the insertion of the coaxial line 19 between the output corner junction $C$ and the main output terminal $S_1$. This is done in response to the signal $(n_2)$ from terminal $n_1$, such signal being fed to the switch controller 21 when the switch arm 10 is in position $E_1$. Likewise the inversion of the signal at the main output terminal $S_2$ is produced by the signal $(n_4)$ fed to the switch controller 24 from the output control terminal $n_4$ when the switch arm 10 is in the position $E_6$. The two coaxial lines 19 and 22 are isolated when the signals $(n_1)$ and $(n_2)$ appear respectively at the output terminals $n_1$ and $n_2$.

It will be noted that the above-described circuit could be used to provide an amplitude modulator. In fact, if the output signal at the corner junction $D$ of the bridge network is connected directly to main output terminal $S_1$, which is terminated with a 50-ohm impedance to match the coaxial line impedance of the bridge, there is obtained on the other main output terminal $S_2$, which is directly connected to the output corner junction $C$ of the bridge, an amplitude modulated wave. Such a modulator does not require the presence of the phase inverting lines 19 and 22 of length $\lambda/2$, or the switch
controllers 21 and 24 and their instructing multivibrators 18
and 18' which form the last stage of the binary counter and
take care of the signal phase inversion. In such an amplitude
modulator, the respective positions of the contacts E3, E3'
on the fifth line 6 will be suitably selected to provide the shape of
modulating waveform required.

It should also be noted that the contacts E3, E3 can be ar-
 ranged in such a manner as to make possible the application of
phase shifts varying in inverse direction and by discrete jumps
from 0 to 2π in a time T and to obtain the modulation side-
bands directly at C and D without requiring the phase inver-
ting lines 19 and 22 together with their associated switch con-
trollers and switching members.

FIG. 6 shows electronic circuitry which may be used as the
switching circuit X of FIG. 2 in order to switch the high-
frequency signal f, from the generator S between the contacts
E6 to E6 of the fifth line 6. The circuit of FIG. 6 responds only
to the presence of the output signal at the output control ter-
inal n1 of the logic circuit 12 in order to establish a connec-
tion between the high-frequency generator S and the fifth line
6, and it will be understood that similar circuits take care of
the switching of the connections to the other contact E6 in
response to other signals appearing at different output control
 terminals n1 to n6.

The output control terminal n1 of logic circuit 12 is con-
 nected through a resistance 25 to the base of an NPN
transistor 26 having its emitter connected to a terminal 33
held at a negative voltage and its collector connected through
a pair of resistors 27 and 28 to a terminal 34 held at a high
positive voltage. The junction of the resistances 27 and 28 is
connected through an inductance 29 to a junction formed
between a capacitor 31 and a cathode of a diode 30. The
anode of the diode is connected to contact E6 of the coaxial
line 6 which feeds the input corner junctions A and B of the
bridge. A point K of the portion of the line 6 extending
between contact E6 and corner junction B is earthed through a
high value inductance 35. The capacitor 31 is connected through
a coaxial line 32 of length λ/2 to an output point G of the
high-frequency generator S which delivers signal f,

The transistor 26 is switched into its conductive condition
by the presence of a signal at the output terminal n1 of the
logic circuit 12. A negative voltage appears at the common
point of the diode 30 and the capacitor 31 when this occurs,
and forwardly biases the diode 30 which therefore conducts
allowing the high-frequency signal f, supplied by the generator
to be transmitted through the diode to the terminal E6.

In the absence of the signal at the output control terminal
n1, the transistor 26 does not conduct and a positive voltage
appears at the common point between the diode 30 and the
capacitor 31. This voltage is positive with respect to earth so
that the diode 30 is back-biased into its nonconducting condi-
tion and therefore prevents the transmission of the high-
frequency signal to the contact E6.

The above described circuit is duplicated for each of the
connections between the output control terminals n1 to n6 and
the contacts E6 to E6. The generator S is connected in com-
mon at G to the extremities of all of the coaxial lines such as
32 associated with the switching circuit. During normal func-
tioning only one of the diodes 30 is conducting at any time
interval ΔT. The diodes 30 are preferably selected to have a high
conductance to reduce losses when in their conducting condi-
tion, and a low capacitance so that there is no risk of perturba-
tions being introduced into the bridge network as a result of
the corner junction B having a very low impedance attached
it to when the diode 30 is not conducting.

FIGS. 7 and 8 illustrate alternative switch control circuits
which may be used to introduce the half-wavelength lines 19
and 22 in the circuitry extending from the bridge network to
the main output terminals S1 and S6.

In FIG. 7 the output corner junction C of the coaxial line
bridge of FIG. 2 is connected to the main output terminal S1
through a rectifying bridge composed of four diodes 36, 37, 38
and 39 and a coaxial line 40 of length λ/2 connected between
the cathodes of the diodes 37 and 38.

The output control terminals n4 and n5 of the logic circuit
12 of FIG. 2 are connected, in FIG. 7, to respective bases of a
pair of NPN transistors 41 and 42. The transistor emitters are
respectively connected to a terminal 47 held at a constant
negative voltage and the transistor collectors are respectively
connected through two resistance chains 43—44 and 45—46
to a terminal 48 held at a positive high voltage with respect to
earth. The junction of the resistance 43 and 44 is connected
through and inductance 49 to the cathodes of the bridge
diodes 36 and 39, and the common junction of the other re-
stance chain 45, 46 is connected through a second in-
ductance 50 to the junction of the coaxial line 40 with the
cathode of bridge diode 38. The anodes of the four bridge
diodes are earthed through inductances 51 and 52 of high
value.

The transistors 41 and 42 are controlled by the signals ap-
pearing simultaneously on the output control terminals n1 and
n12 of the logic circuit 12 in such a way that one of them is al-
ways in its conducting condition when the other is blocked,
that is to say nonconducting. For example, if the transistor 41
is conducting, the diodes 36 and 39 are biased in con-
ducting conditions and therefore have flowing through them a
continuous current which enables them to transmit the high-
frequency signal supplied at the output corner junction C of
the bridge network (not shown) to the main output terminal
S1. If now the transistor 42 conducts and the transistor 41 is
nonconducting or blocked, the other pair of diodes 37 and 38
conduct and allow the high-frequency signals from the output
corner junction C of the bridge rectifier to be transmitted by
way of the half-wavelength line 40 to the main output terminal
S1. This results in a phase inversion of the signal at the main
output terminal S1.

FIG. 8 illustrates an alternative phase shifting circuit which
may be connected between the output corner junction C of the
bridge network and the main output terminal S1. The cir-
cuit of FIG. 8 is controlled by the signals appearing at the out-
put control terminals n1 and n12 of the logic circuit 12 as for-
merly described with reference to FIG. 7. The output corner
junction C of the bridge is connected to the main output ter-
"nal S1 through a first diode 53 having its cathode connected
through a capacitor to the main output terminal, and through
a second diode 54 whose cathode is connected through a
" capacitor and a half-wavelength line 57 to the main output
" terminal S1. The diodes 53 and 54 have their cathodes re-
" spectively connected through two inductances 55 and 56 to
" intermediate points in a pair of resistance chains provided
" between the collectors of two NPN transistors 58, 59 and a
" source of positive voltage. The bases of the transistors 58, 59 are re-
" spectively connected to the output control terminals n11, n12 of
" the logic circuit 12 and the transistor emitters are connected to a
" common source of negative voltage.

The presence of a signal on the terminal n1 occurs when there
is no signal on the output control terminal n16 so that the
transistors 58, 59 are selectively conductive. The circuit is so
arranged that the diode 53 is forwardly biased into the con-
ducting condition by the signal (n16) while the diode 54 is
blocked through being back-biased. The signal from the out-
put corner junction C of the bridge network is not trans-
mitted to the main output terminal S1 by way of the diode 53.
If now the diode biasing is reversed so that the diode 54
becomes conductive and the diode 53 is blocked, the signal
supplied at the output corner junction of the bridge passes
through the line 57 which introduces into it a phase shift of
π.

FIG. 9 illustrates the logic circuit 12 which supplies control
 pulses to the control element 11 and to the switch controllers
21 and 24 of FIG. 2.

Referring to FIG. 9 the input control terminals m1—m6 are
connected to the complementary pairs of outputs of the mul-
vibrators 14—17 of FIG. 2, and the terminals m6—m12 are
connected individually to the complementary pairs of outputs of
the multivibrators 18 and 18'. The circuit for switching the high
frequency signal f, from the generator S to the selected con-
tact E6.—E6 is similar to that shown in FIG. 6, the diode 30
being conductive or not according to the state of the mul-

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tivibrators 14—17. It can be easily shown that the signal \(n_1\) for producing an output at the output control terminal \(n_1\) is:
\[
(n_1) = a \cdot c \cdot d + b \cdot d.
\]
In this equation \(a, b, c, d\) and \(a, b, c, d\) are the complementary signals delivered respectively at the outputs of the multivibrators 14 to 17 and applied to the inputs \(m_1-m_9\).

Turning to FIG. 9 the signals \(a, a, a, d\) are transmitted to the output control terminal \(n_2\), in accordance with the signal \(n_1\) by means of: a first group of AND gates which includes the \(n_2\), the \(n_2\), the second group of \(n_9\), and the \(n_9\) gates as well as the \(n_9\) AND gates. The \(n_9\) the \(n_9\) having two inputs respectively connected to two outputs of two \(n_9\) gates such as \(69, b\), and a third group of \(n_9\) gates such as the \(n_9\) AND gate 62 having two inputs respectively connected to two outputs of two \(n_9\) gates 61. The output of each \(n_9\) gate such as 62 is connected to one of the output control terminals \(n_1-n_9\).

The four outputs of the multivibrators 16' and 18' are connected respectively to the input control terminals \(m_9-m_9\), which are directly connected to the output control terminals \(n_1-n_9\) of the logic circuit 12. The signals delivered at the output control terminals \(n_1-n_9\) are illustrated in FIG. 8. FIG. 10 illustrates an embodiment of the line 6 shown in FIG. 2, with multiple contacts \(E_1-E_9\) connected in succession by diode circuits to the point \(G\) of the output of the generator 5.

The line is constructed by a flat metal strip 65 located between two metal plates, of which only one, 66, is shown, so as to obtain an impedance of 50 \(\Omega\) ohms. The metal strip is looped around and forth several times so as to provide loops such as loop 67, having at their inner ends the contacts \(E_1-E_9\).

In such an arrangement, the physical distance between the input point \(G\) for the frequency \(f_5\) and the contacts \(E_1-E_9\) is small, and the impedance provided at \(G\) by the blocked diodes, such as 30, is very high.

The line 6 may thus comprise simply a flat metal box with three coaxial terminals \(M, B, G\) and eight contacts for controlling the biasing of the diodes 30 in a similar manner as described above with reference to FIG. 6.

A sideband generator as described above is capable of dividing the power of an input signal with phase inversion, and may be used to feed two transmitter aerials with a set of side bands to provide an omnidirectional radio beacon operating at very high frequencies (V.H.F. (VOR)). In fact, at the main output terminal \(S_1\), the signals delivered vary in amplitude and phase as the sine of an angle, passing through maximum of 90 and 270° and minimum values with phase inversion of 0 to 180°, whereas the signals supplied at the main output terminal \(S_2\) vary as the cosine of the same angle passing through maximum values of 0 and 180° and through minimum values with phase inversion of 90 and 270°.

The example of sideband generator described in the foregoing can also be employed in particular for generating on a single output sidebands of modulation of 90 c/s and 150 c/s which may be usefuly employed in particular in instrument landing systems (I.L.S.), these examples not being in any way intended to be restrictive.

What we claim is:

1. A sideband generator, comprising a high-frequency signal generator of frequency \(f_5\), a circuit for generating low-frequency signals of frequency \(F=1/T\), where \(T\) is the period of a low-frequency signals \(f_5\), characterized in that it comprises a bridge with two input and two outputs forming the sum and/or difference of the signals, \(a\), \(d\), to the inputs, the two inputs of said bridge being connected to the source of high-frequency energy by means of a switchable phase-shifting means controlled by a numerically sensitive control element, connected to said circuit for generating low-frequency signals, for controlling the amplitude of the high-frequency signals fed to said bridge.

and further characterized in that the circuit connecting the two inputs of said bridge comprises an electric line fitted with a plurality of input contacts for the high-frequency signal and a numerically controlled switching circuit which switches the output of the said line, to provide at the two inputs of said bridge high-frequency signals whose phase shifts vary simultaneously with the phase of the low-frequency signals and by discrete jumps, and wherein said switching circuit of the high-frequency generator comprises a plurality of diodes, each having a first electrode connected to one of the aforesaid input contacts and a second electrode connected, on one hand, to the output of said high-frequency signal generator and, on the other hand, to one of the outputs of the associated control circuit whose inputs are connected to the outputs of a counter with bistable multivibrators of a circuit of the low-frequency signal generator, to render said diodes conducting in succession for the high-frequency signal.

2. A generator according to claim 1, characterized in that said aforementioned electric line is provided with \(n\) input contacts arranged on one side of an electric center point of said line and the electrical distance between said electric center point in any one of the \(n\) contacts is between 0 and \(\lambda/4\) frequency \(f_5\), for producing at the outputs of the aforesaid bridge squared side bands of modulation with \(n\) levels equi-time divided during a time \(T/4\).

3. A generator according to claim 2, characterized in that it comprises two numerically controlled phase-inverter circuits, connected respectively to the two outputs of said bridge in order to apply in succession a phase shift of value \(\pi\) and a phase shift of value 0 respectively during time intervals equaling \(T/2\) to the squared signals supplied at the two outputs of said bridge.

4. A generator according to claim 3, characterized in that each numerically controlled phase-inverting circuit comprises a transmission line of length \(\lambda/2\) at frequency \(f_5\), as well as control means associated with said transmission line for connecting said line in series or in short-circuit with one of the outputs of aforesaid bridge.

5. A generator according to claim 4, characterized in that the means for controlling the phase inversion associated with each inverter comprises two transistors, two first electrodes of which are connected respectively to two outputs of the low-frequency signal generating circuit, and two second electrodes of which form two outputs respectively connected to two inputs of the aforesaid phase inverter.

6. A generator according to claim 5, characterized in that each phase inverter circuit comprises a four-arm network, three first arms of which each comprise a diode and the fourth includes a diode in series with the transmission line, a first corner of which between two diodes of one of said first three arms and the fourth arm is connected to one of the outputs of said bridge, while two other corners comprised between two diodes and adjacent to said first corner are connected to the two outputs of said associated phase-inversion controlling circuit.

7. A generator according to claim 6, characterized in that each phase-inverter circuit comprises two diodes two identically polarized electrodes of which are connected in common to one of the outputs of said bridge and the two electrodes of which are respectively connected, on one hand, to the two extremities of said transmission line, and, on the other hand, to the two outputs of the associated phase-inversion controlling circuit.

8. A generator according to claim 2, characterized in that the aforementioned electrical line is constituted by a folded-back metal strip, so as to form \(n\)-1 loops and provided with the aforementioned \(n\) input contacts connected respectively by switching circuits with diodes to a central point connected to the output of said generator of the high-frequency signal, the respective distances from said center point to the said \(n\) input contacts being smaller that the impedance provided by a diode at the center point be very large.

9. A sideband generator according to claim 1, comprising a high-frequency signal generator of frequency \(f_5\), a circuit for generating low-frequency signals of frequency \(F=1/T\), where
T is the period of a low-frequency signal $F_w$, characterized in that it comprises a bridge with two inputs and two outputs forming the sum and/or the difference of the signals fed to the inputs, the two inputs of said bridge being connected to the source of high-frequency energy by means of a switchable phase-shifting means controlled by a numerically sensitive control element, connected to said circuit for generating low-frequency signals, for controlling the amplitude of the high-frequency signals fed to said bridge and further characterized in that the circuit connecting the two inputs of said bridge comprises an electric line fitted with a plurality of input contacts for receiving signals generated by said high-frequency signal generator, means by switching the output of said high-frequency signal generator to the input contact of said line, including a plurality of diodes connected between said input contacts and said high-frequency signal generator and a circuit controlled by said low-frequency signal generator, and a means controlling the period of conduction of said diodes, for varying the electrical path length of said line, to thereby provide a phase shift in portions of said electric line in discrete steps.