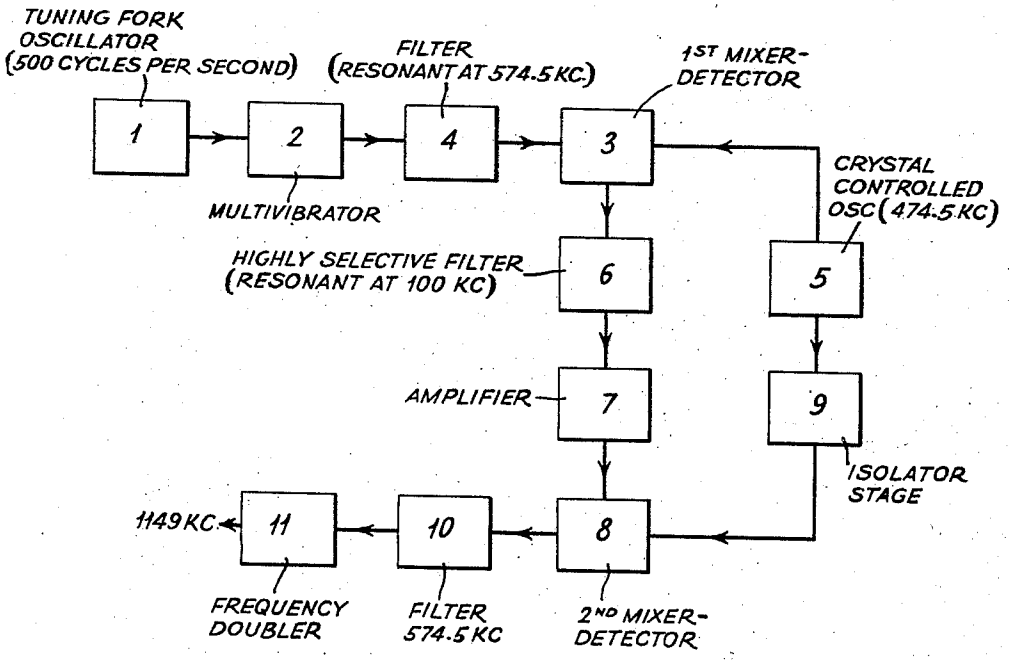
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OSCILLATION GENERATOR AND FREQUENCY MULTIPLIER

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OSCILLATION GENERATOR AND FREQUENCY MULTIPLIER

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This invention relates to frequency selective circuits and more particularly though not exclusively to frequency multiplying electrical circuit arrangements and has for its main object to provide improved frequency multiplier arrangements which shall be cheap to construct, flexible in use (i. e. such that any of a wide range of frequencies may be obtained by multiplication of the frequency of the oscillations from a given source of frequency), reliable, compact and easy to adjust.

The invention, though of wide application, is advantageously applicable to systems requiring a relatively high frequency for driving a radio or like transmitter. The high frequency is obtained by multiplying a relatively low frequency, such, for example, as that produced by an audio frequency tuning fork or similarly controlled source.

It is to be particularly noted that the invention may be also advantageously used for the selection and isolation of any one of a spectrum of frequencies whose separations are small compared to the frequencies themselves, this selection being accomplished for the purpose of obtaining a relatively high frequency from the heterodyning of a low frequency with a local crystal controlled source. The desired frequency may be any one of these frequencies in the spectrum, although the local source itself may be adapted to deliver but one frequency and the frequency multiplier which is used under control of a single tuning fork is one which delivers output energy rich in harmonics.

According to this invention, a frequency selective electrical circuit arrangement comprises a source of energy including one desired frequency, a first detector having an input circuit selectively responsive to said one frequency, a local oscillator for feeding to said first detector a frequency which varies only by a small amount and which differs from said one frequency by a relatively large amount (relative to the variation) a filter selective to said large amount and fed from the output of said first detector, a second detector fed from the output of said filter (if desired, after amplification) said second detector being also fed from said local oscillator, and a further frequency selective circuit selective to said one frequency and fed from the output of said second detector. The principal application of the invention is to frequency multipliers, and for such application, said source is one which is rich in harmonics and said one frequency is a desired upper harmonic.

Preferably the further frequency selective circuit is followed by a frequency doubling circuit which may be of any kind known per se.

Preferably also an isolator is provided between the local oscillator and the second detector.

Where, the usual case, an amplifier is provided preceding the second detector, this amplifier is preferably a resonantly selective amplifier fixed tuned to said large amount.

The invention is illustrated in the accompanying drawing the sole figure of which shows in block diagram form one way of carrying out the invention. This embodiment will be described with the aid of numerical examples but it is to be understood that these numerical examples are given by way of assistance only, and that the invention is not limited to the use of the particular figures given.

In the embodiment shown it is assumed that it is desired ultimately to obtain a frequency of 1149 k. c. from an original tone frequency source 1 of 0.5 k. c. The 0.5 k. c. tone frequency source feeds into and controls a multi-vibrator 2 operating at 0.5 k. c. and producing an output which is rich in harmonics. In place of a multi-vibrator any other suitable known wave distorting circuit arrangement may be employed. The output from the multi-vibrator is fed to a first mixer 3 via a selective input circuit 4 tuned approximately to one-half the frequency ultimately desired, i. e., to 574.5 k. c. There is also fed to the first mixer 3 the output from a local oscillator 5 whose frequency may be permitted to vary by a small amount, for example, ± one part in 10,000, and whose frequency differs from the frequency to which the first mixer selective input circuit 4 is tuned by a large amount. In the example in question this large amount is 100 k. c. the local oscillator 5 oscillating at 474.5±0.4 k. c. The local oscillator could, for example, be a crystal controlled oscillator, but it need not be thermostatically controlled. The output from the first detector 3 will consist of 100±.04 k. c. and adjacent harmonics and this output is fed to a highly selective filter 6—such as a crystal filter—resonant at 100 k. c. This filter is sharp enough to reject all output frequencies from the first detector except those covered by the range 100±.04 k. c. It will be noted that the combination frequencies derived from the first detector 3 and which are outside this range will be sufficiently far outside the said range to be easily rejected by the filter. The filter 6 feeds, if desired, via an intermediate frequency thermionic valve amplifier 7 fixed tuned

to 100 k. c. and which will, accordingly, pass and amplify the range 100±.04 k. c., into the input circuit of a second mixer 8 which is also fed with local oscillations from the local oscillator 5 preferably through a suitable isolator stage 9. The second mixer output will comprise the frequencies 100±.04 k. c. 374.5±.08 k. c.; 474.5±.04 k. c. and 574.5 k. c. It will be noted that this last frequency variation ±.04 k. c. is opposed to the frequency variation ±.04 k. c. which accompanies the 100 k. c. output from the amplifier 7. These mutually opposed frequency variations therefore cancel out. The frequency 574.5 k. c. is easily selected by a tuned circuit or other simple filter 10 fed from the second mixer output and this tuned circuit or other filter is followed by any suitable frequency doubling circuit 11 as known per se, and which produces the ultimately desired 1149 k. c. frequency.

The use of a final frequency doubling stage is not necessary in carrying out the invention, but its use is preferable in order to avoid self-oscillation due to accidental feed back from the transmitter which the final frequency is to drive.

It will be observed that any desired multiple of the original tone frequency can be obtained by changing the local oscillator frequency (and also the circuits which are responsive to the selected harmonic of the original frequency) while the tuning adjustments are few in number and the filters and oscillator do not need to be very critical in frequency. If the local oscillator 5 be of variable frequency and the two selective circuits 4, 10, are also variably tunable (in such a case all three tuning controls may be ganged for single knob tuning), the selected frequency may be varied continuously without changing the frequency of the sharply tuned filter 6 or of the amplifier 7 (if provided).

Considering the advantages to be derived from practicing my invention, it will be noted that a choice of output frequencies between rather wide limits is made available, even though only one tuning fork oscillator 1, or its equivalent, is provided. The harmonic components of the output from the multivibrator 2 are of considerable strength. As these harmonics approach a high order, their frequency separation diminishes rapidly. Hence the selectivity of the filters 4 and 6 becomes increasingly important when the output from the oscillator 5 is heterodyned with a very high harmonic of the tuning fork oscillator frequency. The selectivity of the filter 6 safeguards the system from frequency drift in respect to the output from the second mixer-detector 8, since any unwanted frequency components of the first mixer-detector 3 are so adequately attenuated as to exert a negligible influence on the second mixer. Furthermore, the compensating effect of selecting a difference-frequency to be passed by the filter 6 and a sum-frequency to be passed by the filter 10 has proven to be of considerable advantage in overcoming the effects of small variations in the frequency of the oscillator 5.

Although the invention has been particularly described with reference to, and is mainly intended for, frequency multipliers, it may be employed not only for harmonic selection but wherever a highly selective circuit giving an output of predetermined frequency, which may be the same as an input frequency, is required.

I claim:

1. A frequency selective circuit arrangement comprising a source of energy including, a plurality of harmonics of a given frequency, a first detector having an input circuit, a filter for passing a selected one of said harmonics to said input circuit, a local oscillator for feeding to said first detector a frequency which varies only by a small amount and which differs from said selected harmonic by a relatively large amount, a filter selective to and fed from the difference-frequency output of said first detector, a second detector fed from the output of said filter, said second detector being also fed from said local oscillator, and a further frequency selective circuit selective to and fed from the sum-frequency output of said second detector, said sum-frequency being substantially the same as said selected harmonic.

2. An arrangement as claimed in claim 1 wherein said further frequency selective circuit is followed by a frequency doubling circuit.

3. An arrangement as claimed in claim 1 wherein an isolator is provided between the local oscillator and the second detector.

4. A circuit arrangement comprising first and second oscillatory energy sources, a frequency multiplier fed with energy from said first source, a plurality of frequency selective filters, means including a first mixer stage for deriving beat frequencies between the output from said second source and a selected harmonic output from said frequency multiplier, a circuit through one of said filters for selecting a lower one of said beat frequencies, a second mixer stage, complementary channels feeding to said second mixer stage, one of said channels including an amplifier under control of beat frequency energy derived from the last mentioned filter, the other of said channels including an isolator stage fed from the second said oscillatory energy source, and means operable for causing said second mixer stage to deliver output energy representing the sum-frequency component of the energies fed thereto by the respective channels and for causing said sum-frequency to be isolated with respect to unwanted harmonics from said frequency multiplier.

5. In a system for isolating a selected harmonic frequency component from unwanted output components of a frequency multiplier, the method which comprises heterodyning said selected component with oscillatory energy from a controlled second source, filtering out a difference-frequency derivative from the heterodyning process, performing a second heterodyning process in which said derivative is combined with output energy from said second source to produce a sum-frequency component, and causing the output from said second heterodyning process to be filtered and multiplied.

6. The method of isolating one of a spectrum of frequencies whose separations are small compared to said frequencies which comprises selecting said one frequency, generating oscillations of a widely different frequency, mixing said one frequency and said oscillations thereby to produce a beat frequency that is low compared to said one frequency, filtering said beat frequency to exclude all other frequencies, and combining said filtered beat frequency with said oscillations to reconvert said beat frequency into said one frequency.

7. In combination, a source of relatively low frequency, a relatively high frequency crystal-controlled generator, a multi-vibrator controlled by energy from said low frequency source, and adapted to deliver energy which is rich in harmonics, a filter fed by said multi-vibrator and resonant to one of said harmonics, a first mixer

detector fed with said filtered harmonic and also with energy from said relatively high frequency generator, a filter fed with energy from said first mixer detector and highly selective to the difference frequency between the mixed frequencies, an amplifier deriving its input energy from the output of said highly selective filter, a second mixer detector for combining a component of said relatively high frequency generator with energy delivered by said amplifier, thereby to produce a sum frequency which is the same as said selected harmonic, a filter deriving its input energy from said second mixer detector and being selective to said selected harmonic, and means for doubling the frequency of output of the last said filter.

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