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OSCILLATION GENERATOR

Filed April 22, 1938

FIG. 1

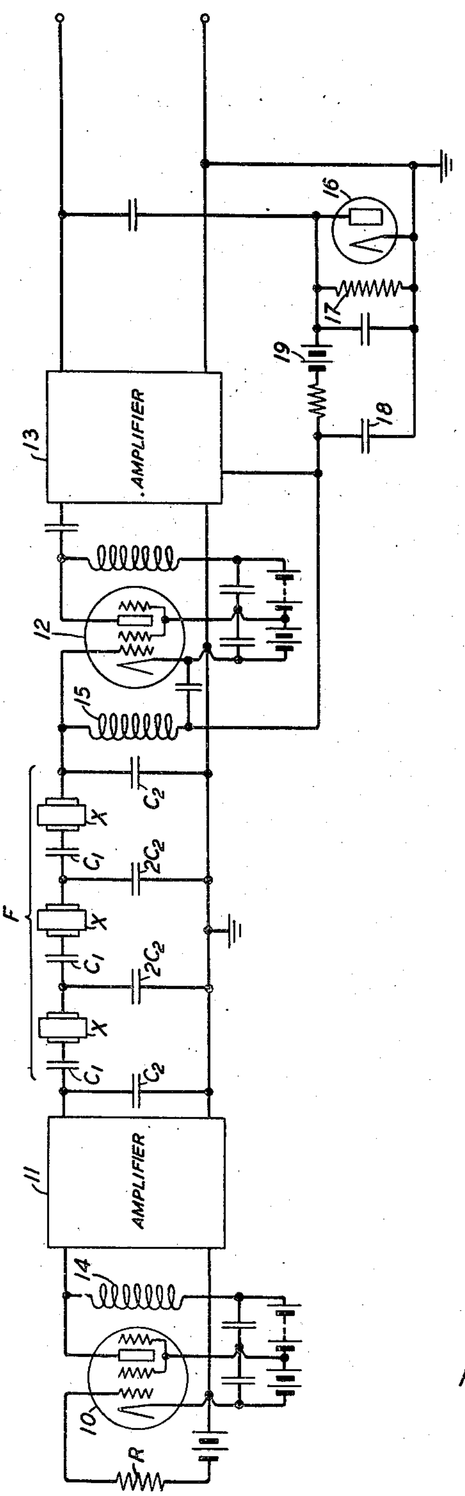
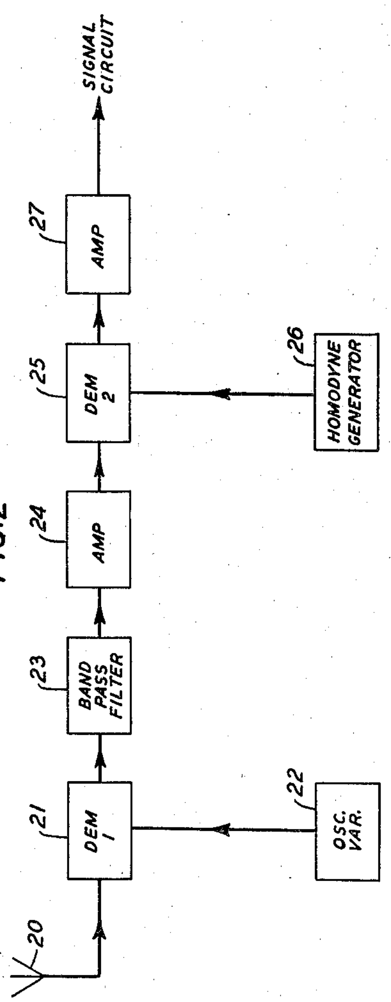


FIG. 2



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OSCILLATION GENERATOR

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5 Claims. (Cl. 250—36)

This invention relates to oscillation generators and more particularly to high frequency generators for use in radio receivers for demodulating signal modulated carrier waves.

In accordance with the invention, the primary source of the oscillations may be the thermal agitation of free electrons in a resistive impedance or the random fluctuations of the electron current in the space path of a therminoic vacuum tube. It is well known that resistive conductors or therminoic electron discharge paths behave as though there were sources of alternating electromotive forces of all frequencies in a continuous range from zero to at least several megacycles per second and of substantially uniform amplitude. We have found that, by amplifying the thermal agitation voltages and sharply selecting from the amplified oscillations those lying within a very narrow band of frequencies, a substantially pure sinusoidal oscillation is obtained having a frequency approximately equal to the mid-frequency of the selected band. The amplitude of the oscillation tends to vary somewhat and in a rather irregular manner, but by the use of an amplitude limiter or other amplitude controlling means, the greater part of the variation may be suppressed. Our experiments have indicated that the amplitude variations tend to become slower as the band width of the selecting device is reduced and that the range of variation, even without amplitude regulation, is not such as to diminish the utility of the generator for many purposes such as the demodulation of high frequency signal waves.

A satisfactory approximation to a sinusoidal oscillation for the demodulation of speech signals can be obtained by selecting from the source a band of frequencies of width as great as fifty cycles per second located in the superaudible range. Usually a narrower band will be preferred, but if the width is too small difficulties may arise from the reduction of the total energy of the selected band. Band widths down to at least five cycles per second are practicable and provide resultant oscillations that are both purer in wave form and less subject to rapid amplitude variations. The location of the selected band in the frequency scale is subject only to the practical restrictions pertaining to the design and construction of narrow band filters. By the use of piezoelectric quartz crystal elements suitable band widths may be obtained at frequencies from thirty kilocycles per second up to several megacycles per second.

Particular features of the invention will appear from the following detailed description and from the accompanying drawing which illustrates one embodiment and its application in radio reception. Of the drawing, Fig. 1 shows the circuit arrangement of an oscillation generator in accordance with the invention and Fig. 2 is a block schematic illustrating the application of the invention in a radio receiver.

Referring to Fig. 1, resistance R connected between the grid and cathode of vacuum tube amplifier 10 constitutes a source of thermal agitation electromotive forces from which the ultimate oscillations are derived. Preferably this resistance has a fairly large value, from 20,000 ohms to 100,000 ohms and the grid of tube 10 is negatively biased sufficiently to make the fluctuation voltages, Schott effect and the like, in the plate circuit negligibly small.

To the output terminals of the tube is connected an amplifier 11 which should have a gain of 50 decibels or more and which may comprise three or more vacuum tube stages. Following the amplfier is a three-section narrow band piezoelectric crystal F. The filter illustrated is of the ladder type but other well-known configurations may also be used. The three sections of the filter are similar, each comprising a pair of shunt condensers of capacity C_2 and a series branch constituted by a piezoelectric quartz crystal X in series with a condenser of capacity C_1. The adjacent shunt capacities are provided by single condensers of capacity $2C_2$.

The pass band of the filter is located adjacent to the principal resonance frequency of the crystal and its width may be controlled by adjustment of the values of capacities C_1 and C_2. By making the series capacities C_1 very small and the shunt capacities C_2 large the band width may be made as small as may be desired. Preferably the quartz crystals are in the form of rectangular plates with their major surfaces in the plane of the optical and mechanical axes of the crystal as described in U. S. Patent 2,045,991, issued June 30, 1936, to W. P. Mason. With crystal plates of this type the principal resonance occurs at a fairly low frequency and is well separated from resonances representing other vibration modes. In an experimental model of the invention the crystal plates had the dimensions 45.59 millimeters in the direction of the mechanical axis, 18.24 millimeters in the direction of the optical axis, and one millimeter thickness. The principal resonance frequency was 59.966 kilocycles per second and, with values of capacities C_1 and C_2 equal to 200 and 1200 micro microfarads respectively, a band width of about five cycles was obtained. By the use of quartz crystals of the type described, filters with band widths of the above order and with very sharp cut-offs are readily constructed to operate at frequencies from about 30 kilocycles to 150 kilocycles or greater.

The output terminals of the filter are connected to the input of an amplifier, the first stage of which, tube **12**, is shown in detail and the succeeding stages are indicated by block **13**. All of the stages may be similar. Tubes **10** and **12** are shown as screen-grid tetrodes, but other tubes such as pentodes or triodes may also be used. The gain of this amplifier need not be large and may be proportioned to provide whatever output energy is desired. The plate current of tube **10** and the grid bias of tube **12** are supplied through choke coils **14** and **15** which preferably should be of sufficiently large inductance to avoid resonance with the filter capacities at a frequency close to the filter band.

Control of the output amplitude is provided by an automatic volume control circuit comprising a diode rectifier **16** coupled to the output terminals of amplifier **13** and shunted by a resistance **17**. The control voltage is developed across resistance **17** and is fed back to the grid of tube **12** and the grids of amplifier **13** through a path including a resistance-capacity timing filter **18**. Battery **19**, or other equivalent source, supplies a normal negative bias to the amplifier grids. If desired, the last stage vacuum tube of amplifier **13** may be operated under a condition of space current saturation to provide amplitude limitation.

Instead of resistance R, vacuum tube **10** may be used by itself as a source of voltage fluctuation. For operation in this manner resistance R may be reduced to zero and a positive bias applied to the amplifier grid. Under this condition the fluctuations of the electron stream in the plate circuit are emphasized.

The application of the invention to the reception of single side-band suppressed carrier signals is illustrated by the block schematic diagram of Fig. 2. Single side-band waves are received on antenna **20** and are reduced in frequency in demodulator **21** by beating with waves from an adjustable frequency heterodyne oscillator **22**. The reduced frequency single side-band oscillations are selected by band-pass filter **23** and amplified by amplifier **24**. From the output of amplifier **24** the oscillations pass to a second demodulator **25** in which they are beat with oscillations from the homodyne generator **26** which is of the type shown in Fig. 1. The demodulated signal currents are then passed to signal amplifier **27** and to the signal output circuit.

Generator **26** provides a wave of fixed frequency which for accurate demodulation of the side-band oscillations impressed on demodulator **25** must be such as to coincide with the position of the absent carrier wave. This may be accomplished by the adjustment of the first beating oscillator **22**. With a band selecting filter of the particular type described in connection with Fig. 1, the frequency of the homodyne oscillations would preferably be between about 30 and 150 kilocycles. By the use of other types of piezoelectric crystal selectors higher frequencies up to several megacycles may be used.

What is claimed is:

1. An oscillation generator comprising a band-pass wave filter having a single transmission band of width less than fifty cycles per second located in a superaudible frequency range, a high gain amplifier connected to the input terminals of said filter, and a source of thermal agitation voltages coupled to the input terminals of said amplifier.

2. An oscillation generator in accordance with claim 1 in which the said source of thermal agitation voltages is constituted by a metallic resistance element.

3. An oscillation generator in accordance with claim 1 in which the said source of thermal agitation voltages is constituted by the electron path of a thermionic vacuum tube.

4. An oscillation generator in accordance with claim 1 in which the said wave filter includes piezoelectric quartz crystals as elements determining the frequency and width of the transmission band.

5. An oscillation generator comprising a band-pass wave filter having a single transmission band of width less than fifty cycles per second located in a superaudible frequency range, a high gain amplifier connected to the input terminals of said filter, a source of thermal agitation voltages coupled to the input terminals of said amplifier, and a second amplifier coupled to the output terminals of said filter, said second amplifier including control means responsive to the output voltage thereof for maintaining the amplitude of the output voltage at a substantially constant level.

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