

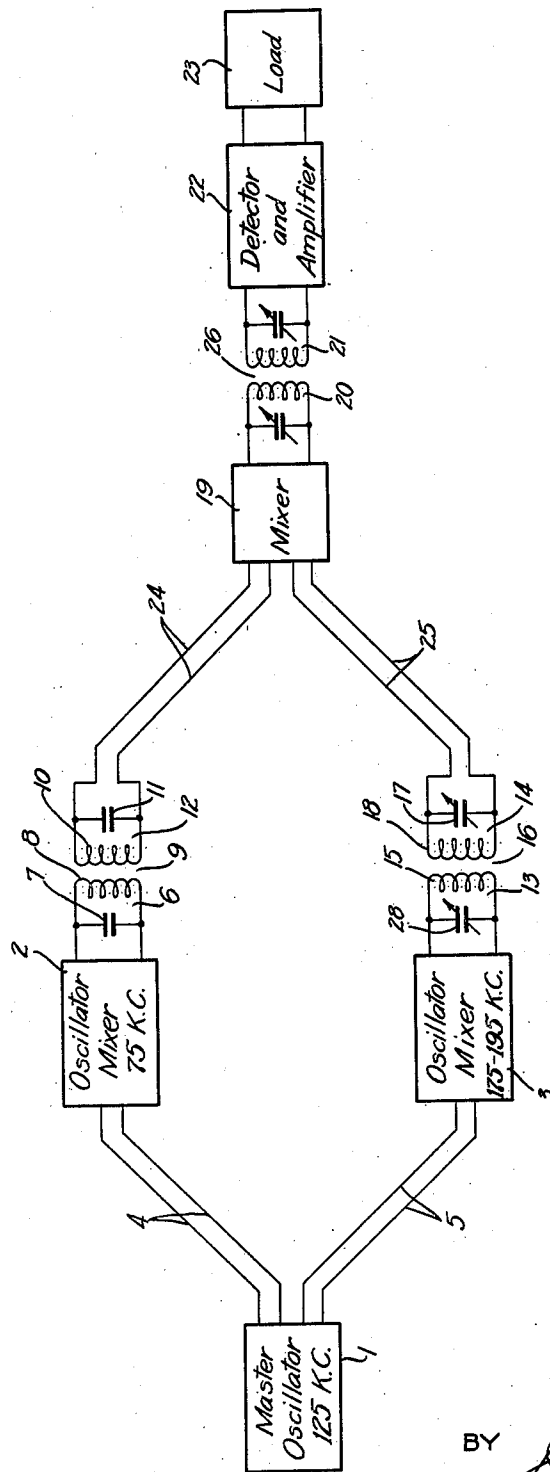
July 1, 1941.

H. C. DAILY

2,247,544

APPARATUS AND PROCESS FOR GENERATING SINUSOIDAL CURRENTS

Filed Nov. 29, 1938



INVENTOR
Harold C. Daily
BY *John Flam*
ATTORNEY

UNITED STATES PATENT OFFICE

2,247,544

APPARATUS AND PROCESS FOR GENERATING SINUSOIDAL CURRENTS

Harold C. Daily, Monterey Park, Calif.

Application November 29, 1938, Serial No. 242,961

6 Claims. (Cl. 250—36)

This invention relates to a system for producing pure notes by the aid of sinusoidal electric currents.

Such systems are of use in connection with testing or measuring technique. Ordinarily, the frequency range is required to be about coextensive with the range of audibility; say from zero cycles to twenty thousand cycles.

While it is possible to provide a single oscillator system using electronic emission devices, adjustable to cover this range, yet such a system is bulky and costly. It has been found to be simpler and easier to utilize a pair of heterodyning oscillators, to produce the desired beat frequency. The theory of heterodyning is now well understood; it may be broadly stated that when a circuit is fed with electrical energy from two sources of differing frequencies, the resultant current in the circuit includes a component having a frequency corresponding to the sum of the two source frequencies, as well as a component having a frequency corresponding to the difference between the two frequencies.

It may appear that it would be a simple matter therefore to arrange a pair of oscillators feeding a common circuit, in which one oscillator has an adjustable frequency, and then select the "beat" frequency out of the circuit, the oscillators having frequencies such that the resultant beat frequency is the desired sinusoidal frequency in the audible range. However, such an arrangement has been found to have many difficulties, rendering the application of this simple principle involved and impracticable for obtaining pure sine waves of current.

One of the major difficulties encountered is that due to the observed phenomenon of the reaction of one oscillator upon another when they generate currents fairly close in frequency, and when (as they must be) they are coupled together. Thus it has been found that the oscillators of the electronic emission type strongly tend to pull each other into step so far as frequency is concerned. This causes inevitably, serious distortion and disturbances in the beat frequencies.

It is one of the objects of this invention to provide a beat frequency system in which these disadvantages are overcome. More particularly, the oscillators utilized in accordance with this invention are so arranged that they operate independently of each other and without danger of any reaction of one oscillator upon any other.

It is another object of this invention to make it possible to create sinusoidal currents in a sim-

ple and effective manner, within the range of audio frequencies.

This invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of one embodiment of the invention. For this purpose there is shown a form in the drawing accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawing:

The single figure is a diagrammatic representation of a system incorporating the invention.

In the embodiment of the invention illustrated, use is made of three oscillator systems, having widely separated frequencies. The master oscillator 1 is indicated in the present instance as generating an oscillatory current at a frequency of 125 kilocycles. Another oscillator 2 is arranged to generate an oscillatory current at a frequency of 75 kilocycles.

In the present instance, both the master oscillator and oscillator 2 are fixed to oscillate at a predetermined frequency. This may be accomplished readily by well known methods. Each oscillator may comprise electronic emission devices of well known characteristics. The fixed oscillator 2 is utilized also in a well known manner as a mixer. The difference frequency of 50 kilocycles is present as a beat frequency in the output circuits of the fixed oscillator and mixer 2. Of course, other values for the fixed frequencies may be utilized. It is only necessary that there be a considerable spread in the frequencies; 50 kilocycles is a sufficient difference to ensure against any reaction between the oscillators. The output of fixed master oscillator 1 is shown as connected by the conductors 4 to the input of oscillator 2.

Similarly, there is an adjustable oscillator and mixer 3 which is arranged in any appropriate manner to be adjusted to generate oscillations of any frequency between 175 kilocycles and 195 kilocycles. Here again the difference in frequency between the oscillators 1 and 3 is sufficient to ensure against any harmful reaction between the oscillators 1 and 3. Connectors 5 are utilized to impress the output of master oscillator 1 upon the input of oscillator mixer 3.

Use is made of selector circuits for selecting the difference beat frequency of 50 kilocycles pro-

duced by the combination of the oscillations of the master oscillator 1 and the fixed oscillator 2. Thus the output circuit is shown as connected to a fixed tuned circuit 6 including the condenser 7 and the primary 8 of a transformer 9. The secondary 10 of the transformer and the fixed condenser 11 shunting the secondary 10 form a tuned selector circuit 12, to select the beat frequency of 50 kilocycles. The resultant output current therefore has an accentuated modulation of 50 kilocycles.

Similarly, the difference beat frequency of 50 to 70 kilocycles present in the output side of the oscillator 3 can be selected as by the aid of the tunable circuits 13 and 14. The tunable circuit 13 may include a variable element, such as the adjustable condenser 28, which bridges the primary winding 15 of a transformer 16. The tunable selector circuit 14 may include the adjustable condenser 17 and the secondary winding 18 of the transformer 16. The condensers 14 and 17 may be arranged to be simultaneously adjusted with the adjustment of the frequency of the oscillator 3.

The selected fixed beat frequency of 50 kilocycles is transmitted through the selector circuits 6 and 12, and connections 24 to a mixer system 19. This mixer system may include one or more electronic emission devices with provisions for receiving currents of different frequencies and to cause these frequencies to mix to provide a resultant beat frequency.

Similarly, the adjustable beat frequency currents in selector circuits 13 and 14 are transmitted through connections 25 to the mixer 19. The mixer 19 accordingly causes a resultant beat frequency to be produced by a composition of the two component beat frequencies. This resultant beat frequency is arranged to be the difference between the two component beat frequencies. Thus if the oscillator 3 is adjusted to 175 kilocycles, the resultant beat frequency would be zero, since both component beat frequencies would be equal; that is, 50 kilocycles. However, as the oscillator 3 is adjusted to higher frequencies, the resultant beat frequency is made to increase up to as high as 20 kilocycles.

As the resultant beat frequency is obtained by a combination of component beat frequencies, it is not material that these component beat frequencies are somewhat close together. There is no oscillator to be deleteriously affected by virtue of the fact that the component frequencies are quite close in value.

The output circuit of the mixer 19 thus has a carrier component of between 50 to 70 kilocycles, which carries a modulation current corresponding to the resultant beat frequency within the audio frequency range, and variable from zero to 20 kilocycles. The selector circuits 20 and 21 are arranged to be fed from the output of mixer 19 and may be tuned to this carrier frequency. These selector circuits may each include a variable tuning condenser and respectively one of the windings of a transformer 26. Thereafter the resultant modulating beat frequency may be detected and amplified as through a detector or amplifier system 22, the output circuit of the detector and amplifier 22 carrying the desired sinusoidal audio frequency current. This current may be passed to any appropriate load 23, such as a sound reproducer or the like.

By keeping the frequencies of oscillation of the three oscillators 1, 2 and 3 widely separated,

the system can operate effectively without danger of distortion, to produce the component beat frequencies, which are later combined to form the desired audio frequency currents. The particular types of circuits utilized for the oscillators and for the mixer 19 as well as for the detector and amplifier system 22 are of no importance in the system as a whole. Any of various forms of circuits can readily be utilized.

What is claimed is:

1. The process of generating sinusoidal currents of any desired frequency within the audible range, which comprises generating master oscillations at a fixed frequency, generating oscillations at fixed frequency differing from the frequency of the master oscillations by an amount substantially greater than the desired frequency, generating oscillations at an adjustable frequency and differing in an opposite sense from the frequency of the master oscillations and by an amount substantially greater than the desired frequency, independently, combining the master oscillations and the oscillations at fixed frequency to obtain fixed beat frequency oscillations, combining the master oscillations and the oscillations of adjustable frequency to obtain adjustable beat frequency oscillations, differing by a desired amount from the fixed beat frequency, and combining the two beat frequency oscillations to produce an adjustable resultant beat frequency of oscillations at the desired value.

2. The process of generating sinusoidal currents of any desired frequency within the audible range, which comprises generating master oscillations at a fixed frequency, generating oscillations at a fixed frequency differing from the frequency of the master oscillations by an amount substantially greater than the desired frequency, generating oscillations at an adjustable frequency and differing in an opposite sense from the frequency of the master oscillations and by an amount substantially greater than the desired frequency, combining the master oscillations and the oscillations at fixed frequency to obtain fixed beat frequency oscillations, independently combining the master oscillations and the oscillations of adjustable frequency to obtain adjustable beat frequency oscillations, differing by a desired amount from the fixed beat frequency, selecting the fixed beat frequency oscillations, selecting the adjustable beat frequency oscillations, and combining the two beat frequency oscillations to produce adjustable resultant beat frequency of oscillations at the desired value.

3. In a system for generating sinusoidal currents of any desired frequency within the audible range, a master oscillator having a fixed frequency, a fixed frequency oscillator having a frequency differing from that of the master oscillator differing by an amount substantially greater than the desired frequency, an adjustable frequency oscillator having a frequency differing in an opposite sense than the fixed frequency oscillator, from the frequency of the master oscillator and differing by an amount substantially greater than the desired frequency, independent means for obtaining beat frequency oscillations respectively between the master oscillator and each of the other two oscillators, and means for combining the two beat frequency oscillations, to produce resultant beat frequency oscillations.

4. In a system for generating sinusoidal currents of any desired frequency within the audible range, a master oscillator having a fixed frequency, a fixed frequency oscillator having a

frequency differing from that of the master oscillator by an amount substantially greater than the desired frequency, an adjustable frequency oscillator having a frequency differing in an opposite sense than the fixed frequency oscillator, from the frequency of the master oscillator and differing by an amount substantially greater than the desired frequency, independent means for obtaining beat frequency oscillations respectively between the master oscillator and each of the other two oscillators, means for combining the two beat frequency oscillations, to produce resultant beat frequency oscillations, and means for selecting and detecting said resultant beat frequency oscillations.

5. In a system for generating sinusoidal currents of any desired frequency within the audible range, a master oscillator having a fixed frequency, a fixed frequency oscillator having a frequency differing from that of the master oscillator by an amount substantially greater than the desired frequency, an adjustable frequency oscillator having a frequency differing in an opposite sense than the fixed frequency oscillator, from the frequency of the master oscillator and differing by an amount substantially greater than the desired frequency, independent means for obtain-

ing beat frequency oscillations respectively between the master oscillator and each of the other two oscillators, means for selecting said two beat frequencies, and means for combining the two selected beat frequencies to produce resultant beat frequency of oscillations.

6. In a system for generating sinusoidal currents of any desired frequency within the audible range, a master oscillator having a fixed frequency, a fixed frequency oscillator having a frequency differing from that of the master oscillator by an amount substantially greater than the desired frequency, an adjustable frequency oscillator having a frequency differing in an opposite sense than the fixed frequency oscillator, from the frequency of the master oscillator and by an amount substantially greater than the desired frequency, independent means for obtaining beat frequency oscillations respectively between the master oscillator and each of the other two oscillators, means for selecting said two beat frequencies, means for combining the two selected beat frequencies to produce a resultant beat frequency of oscillations, and means for selecting and detecting said resultant beat frequency oscillations.

HAROLD C. DAILY.