

Combination of Tones



There are other Phenomena which are caused by the Simultaneous Production of two tones apart from the beats or Throbbing Sensation. Whenever two tones are sounded simultaneously under certain conditions, the ear can discern not only the two primary tones but also other musical tones resulting from the combined effect of the two primary tones. Such additional tones are known as the Combination tones. Combination tones are classified into three parts which are named below:

1.) Difference Tones:

The combination tone whose frequency is equal to the difference in the frequencies of the two primary tones is called difference tone.

For example, if m and n are the frequencies of the primary tones then the frequency of the difference tone is $m-n$. This combination tone itself can form difference tones with either of the primary tones in addition to this difference tone, which is known as the difference tone of the first order. This can result in difference tones of the second order and so on.



2) Summation Tones :

It is more challenging to obtain summation tones having frequency $n+m$ compare to the combination tones. Higher-order summation tones beyond the first can be obtained by combining the first order summation tone with one of the primary tones, and so on. We have assumed that the displacement of any particle caused by the two wave system is so small that the force tending to restore the particle to its position of rest is precisely proportionate to the displacement if the results of the superposition of the effects of the two wave systems are considered in air or any other medium.

However, if the wave-systems become so energetic, and the displacement of the particle so large in the medium that proportionality no longer holds then according to Von Helmholtz, there will be two secondary wave systems whose frequencies are $n-m$ and $n+m$. In addition to the two primary wave systems of frequency m and n , these secondary systems will represent the difference tone and summation tone, respectively.

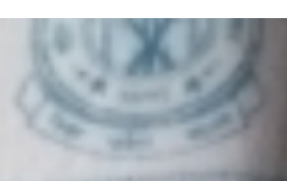


According to Von Helmholtz, the two primary tones cause the same body or portion of air to vibrate violently. Both Von Helmholtz and Prof. Rucker have demonstrated that when the two primary tones are produced by these sources, the summation and difference tones have the ability to cause a suitably tuned resonator to "speak". Therefore, it appears that the vibrations produced in the air when the two tones are produced by a siren or by two harmonium reeds are violent enough to cause the formation of the combination tones.

The body that produces these tones may also be the ear itself, since the small bones and membranes that transmit sound from the outer drum to the nerve terminations, are arranged in such a way that, when violently disturbed, the restoring force would no longer be proportional to the displacement accurately.

③ Beats Tones :-

Koenig has demonstrated that two tones can combine to form a combination tone, or beat tone, if their rhythms are very fast.



There will be two series of these beat tones.

- i) one corresponding to the inferior series of beats of frequency $m-n$, and
- ii) other belonging to the superior series having a frequency $bm-n$.

It will be observed that the inferior beat tone and the difference tone have a frequency correspondence. According to Koerig, this indicates that the difference tone is actually a beat tone which implies that it is produced when the beats become very fast to form a tone. - Apart from this, he also explains that if the primary tones are truly pure, the summation tone is never audible and that the beat tones that are produced between some of the higher partials of the basic notes are the cause of any ~~and~~ audible summation tones.

