

CHAPTER 12

OVERTONE SERIES

A sound source vibrates as a whole unit, in halves, thirds, fourths, fifths, sixths, etc., continuing on indefinitely by fractions. The sounds these fractional vibrations produce are called *overtones* and are generally present in varying strengths.

The vibration of the whole unit produces the *generating tone* (because it generates overtones) and its pitch is called the *fundamental*. All the pitches produced are called *partials*. The fundamental is the first partial. It has the lowest frequency (pitch) and, commonly, the greatest amplitude (intensity). The partials above the fundamental are of greater frequency and vary in amplitude depending on the physical nature of the sound source.

CHARACTERISTICS OF A VIBRATING STRING

The characteristics of a vibrating string illustrate partials and their relationships. When a string tuned to Great C is set into motion it vibrates as a whole unit, producing the pitch Great C (fundamental - first partial). The string also vibrates in halves (second partial) producing small c; in thirds (third partial) producing small g; in fourths (fourth partial) producing c^1 ; in fifths (fifth partial) producing e^1 ; in sixths (sixth partial) producing g^1 ; and in smaller sections producing higher pitches. Lower partials have more amplitude, which decreases with the higher partials.

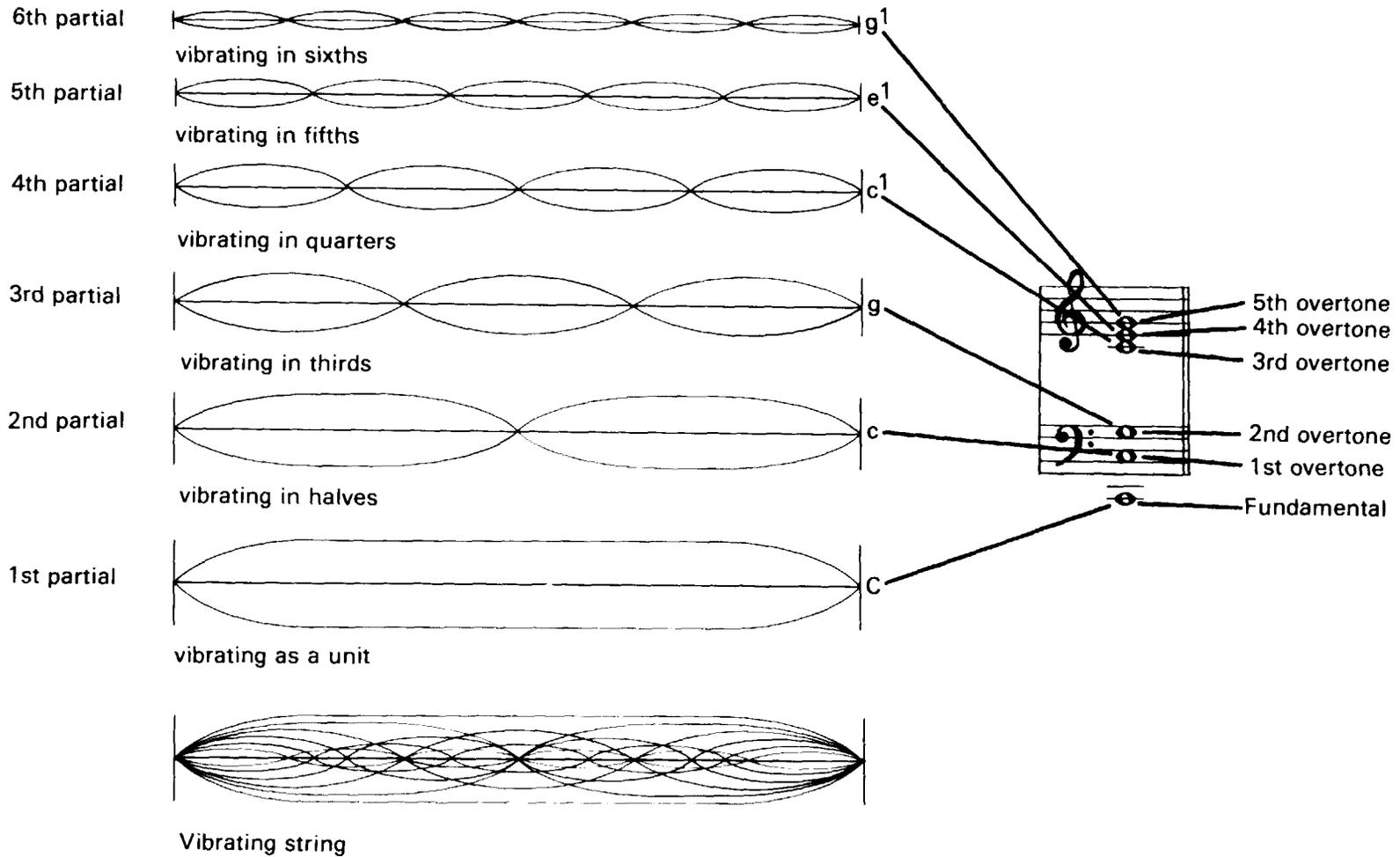


Figure 12.1: Characteristics of a Vibrating String.

THE OVERTONE SERIES

Although the overtone series continues with complex vibration indefinitely, it is necessary to put an upper limit on the series for practical purposes. The first sixteen partials are the ones most commonly used in music.

The relationship between partials and scale degrees is illustrated in figures 12.2 and 12.3. Understanding their relationship allows the formation of partial groupings, from which individual partials can be extracted for musical performance.

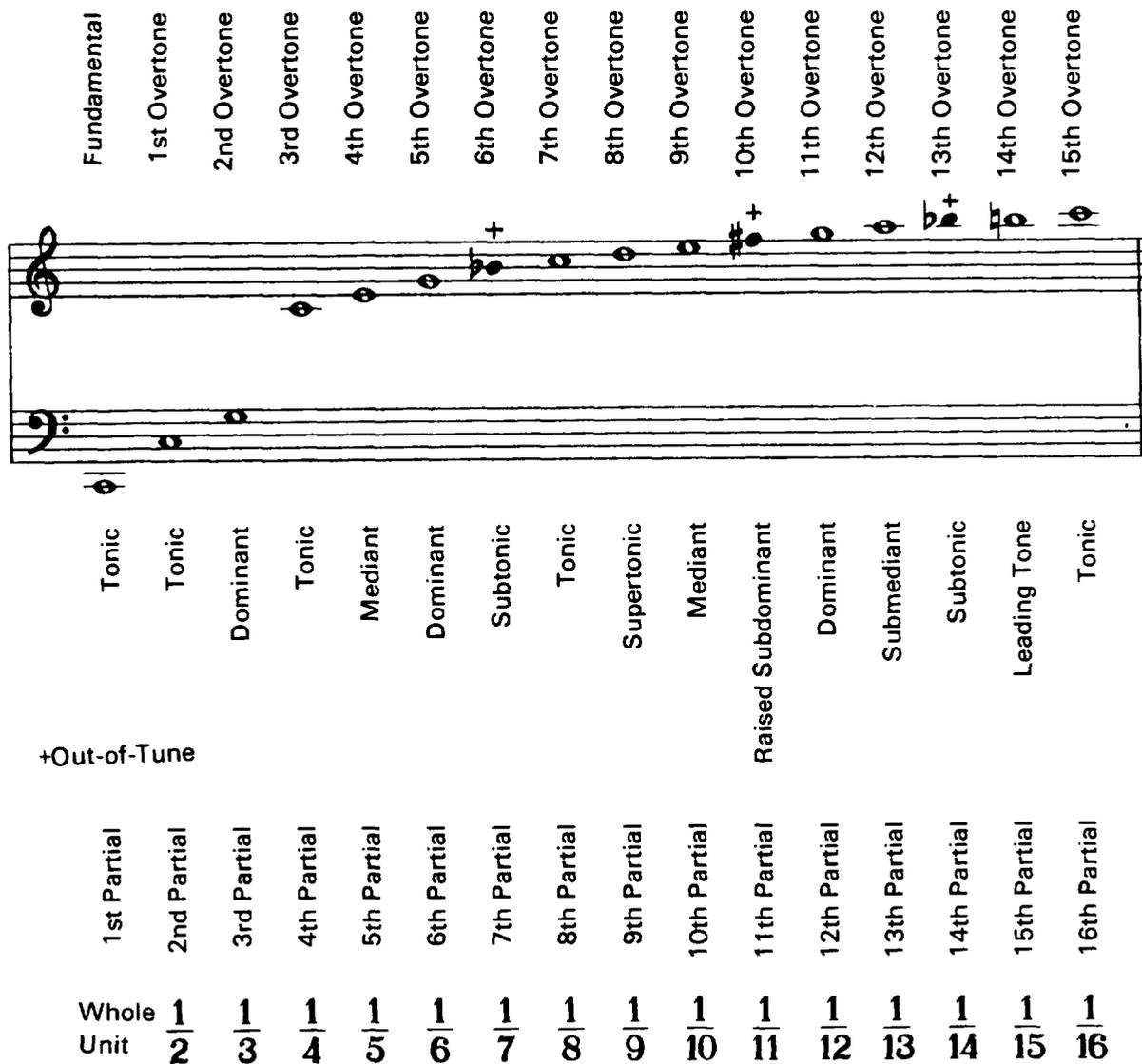


Figure 12.2: C Overtone Series.

	Tonic	Tonic	Dominant	Tonic	Mediant	Dominant	+Subtonic	Tonic	Supertonic	Mediant	+Raised Subdominant	Dominant	Submediant	+Subtonic	Leading Tone	Tonic
Scale Degree:	1	1	5	1	3	5	b7	1	2	3	#4	5	6	b7	7	1
Partial:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

+Out-of-Tune

Figure 12.3: Scale Degrees of Partial.

Tonic Partial

The first, second, fourth, eighth, and sixteenth partials are the tonic degrees in successive octaves. The tonic degrees are derived by doubling partial numbers starting with the first partial.

Dominant Partial

The third, sixth, and twelfth partials are the dominant degrees found in the second octave (3rd partial), third octave (6th partial), and fourth octave (12th partial) of a given series. The dominant degrees are derived by doubling the partial numbers starting with the third partial.

Mediant (Major) Partial

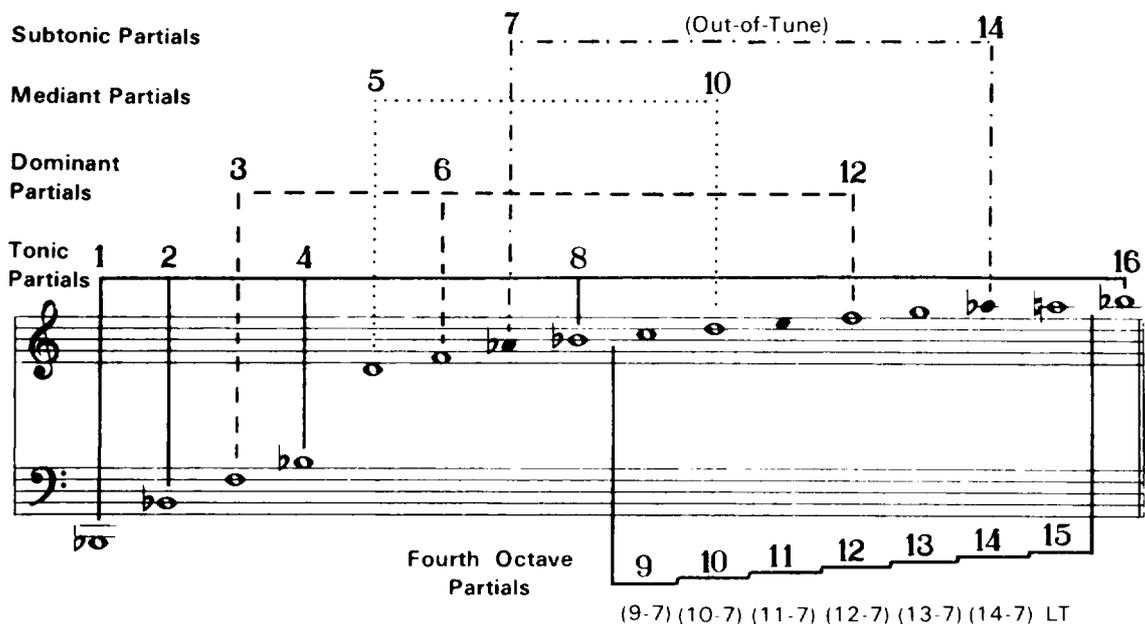
The fifth and tenth partials are the mediant (major) degrees found in the third octave (5th partial) and fourth octave (10th partial) of a given series. The upper partial is derived by doubling the lower partial.

Subtonic Partial

The seventh and fourteenth partials are the out-of-tune subtonic degrees found in the third octave (7th partial) and fourth octave (14th partial) of a given series. The upper partial is derived by doubling the lower. It may help to think of the seventh partial as a simple interval to remember its scale degree although it is actually a minor 21st from the fundamental.

The Fourth Octave Partial

If the ninth through fourteenth partials are thought of as intervals and then reduced to simple intervals, the scale degree numbers are produced. That is, the ninth partial ($9 - 7$ equals 2) is the supertonic; the tenth partial ($10 - 7$ equals 3) is the mediant; the eleventh partial ($11 - 7$ equals 4) is the out-of-tune raised subdominant (the only time the subdominant occurs it is raised and out of tune); the twelfth partial ($12 - 7$ equals 5) is the dominant; the thirteenth partial ($13 - 7$ equals 6) is the submediant (major); and the fourteenth partial ($14 - 7$ equals 7) is the out-of-tune subtonic. The fifteenth partial is not carried through the interval reduction process; it is considered the leading tone to the sixteenth partial (tonic).



Tonic Partial

1st, 2nd, 4th, 8th, 16th

Mediant Partial

5th, 10th

Dominant Partial

3rd, 6th, 12th

Subtonic Partial (out-of-tune)

7th, 14th

Fourth Octave Partial

9th 10th 11th 12th 13th 14th 15th

Supertonic Mediant Subdominant Dominant Submediant Subtonic Leading Tone
(out-of-tune) (out-of-tune) Raised

Figure 12.4: Partial Relationships.

Converting Partial to Overtones and Overtones to Partial

Overtones do not include the fundamental as a numbered part of the series. Therefore, to convert from partials to overtones, subtract one to get the overtone number; from overtones to partials, add one to get the partial number. When comparing overtones and partials in an overtone series, the overtone number will always be one less than the partial number.

Harmonics

The term *harmonic* is often interpreted as being the same as partial. That is, the first partial is the first harmonic. However, string instrumentalists often use the term harmonic as being the same as overtone. That is, the first overtone is the first harmonic. Since the term harmonic may mean partial or overtone, its intended meaning must be specified.

THE OVERTONE SERIES AND TIMBRE

Because the physical nature of a musical instrument affects timbre, the relative prominence of overtones varies with different instruments and is a major factor in producing the timbre of a particular instrument. Usually, overtones are not heard as individual pitches but as variations in the tone quality of the most prominent pitch, the fundamental.

For example, the most prominent overtones on the saxophone are the first (2nd partial), third (4th partial), fifth (6th partial), etc. The most prominent overtones on the clarinet are the second (3rd partial), fourth (5th partial), sixth (7th partial), etc. These overtones decrease in intensity as they are further removed from the fundamental and alternate indefinitely.

Overtone Fundamental 1st 2nd 3rd 4th 5th 6th

Partials 1st 2nd 3rd 4th 5th 6th 7th

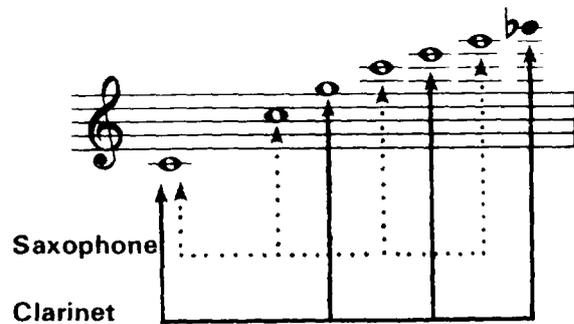


Figure 12.5: Overtone Prominence of Saxophone and Clarinet.

