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Bass Tuning, Part 1: General Problems, Coincident Partials, and The Stretch Interval Set

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This series of articles describes one way to tune the bass aurally. The series has three parts:

1. General tuning principles and the Stretch Interval Set.
2. Tuning octaves below the temperament, down to and including the lowest bichord.
3. Tuning the single bass strings.

Bass intervals can be difficult to tune, partly due to the large number of partials that are audible. When tuning the top treble octaves, technicians often advocate tuning pure 2:1 octaves because the fundamentals themselves are already so high that the higher partials are virtually inaudible. Bass intervals, especially low bass intervals, are not like this. Many coincident partials are audible, and they can't all be pure. This series describes one way of dealing with them.

While this series will not necessarily give you the secret to getting the bass to sound perfectly in tune (after reading it you may understand why this is impossible anyway), it will provide you with fewer confusing options to choose from, faster tuning, and good accuracy.

General Concepts

Before diving into the specifics of the tuning in the bass, we need to discuss a few aspects of tuning theory. Some are conventional, and some are unique to my own system. Every string produces a series of frequencies above a fundamental or first partial. When two notes are played, two series of partials are produced. When the notes share a partial, it is called a "coincident partial." When those shared partials have the same frequency, the interval is called "pure" relative to that coincident partial, and it will have no beating at that partial. The 4:2 may be wide, and the 6:3 may be narrow, but when we play the tests, the test beat rates sound the same speed to our ear. If the interval is not pure at that partial, there will be beating at that partial.

I use a method of tuning midrange octaves so that they sound as clean as possible by first measuring the inharmonicity aurally. For the purpose of this article, we will discuss the most common midrange octave sizes: the pure 4:2 and pure 6:3, which have what I call "small-scale" inharmonicity. (In this case, "small-scale" refers not to the scaling or size of the piano, but to the fact that the 4:2 and 6:3 octaves can both appear to exhibit equal beating. If the 6:3 were to audibly test a little narrow and the 4:2 a little wide, that would be an example of "medium-scale inharmonicity," and an even greater discrepancy would be "large-scale inharmonicity." For more on this topic, see my article "Tuning Accurate Equal Temperament and Ideal F3-F4 and A3-A4 Octave Sizes Using Rapid-Beating Intervals" in the June 2015 issue of the *Journal*.)

Here are a couple of examples. When checking whether A3-A4 is a pure 4:2 octave, we use the test note F3. Play F3-A3 and F3-A4 (the M3/M10 test for the 4:2 octave). If the beat rates sound the same, it is defined as a pure 4:2 according to the test. When checking if A3-A4 is a pure 6:3 octave, we use the test note C4. Play A3-C4 and C4-A4 (the m3/M6 test for the 6:3 octave). If the beat rates sound the same, it is defined as a pure 6:3 according to the test.

We are all born with the ability to hear different beat rates, according to my experience, to a range of about +/-5% accuracy. Beat rates within that range sound the same to our ears, whether we are tuners, musicians, or non-musicians. Pianos that test as low inharmonicity have mid-range octaves that are tunable as pure 4:2 or pure 6:3 octaves as far as our ears can tell using the octave tests described above. (For more information on listening to and evaluating beat speeds, see my article "A New Way to Measure Beat Speeds" in the June 2021 issue of the *Journal.)*

Tuning Accuracy and Precision

Accuracy is the correctness of a setting. Precision is the ability to reproduce the same setting, whether it is correct or not. As piano tuners, we want to be both accurate and precise, if possible. When moving into the bass from the F3-F4 temperament octave, for example, we have some choices as to what to prioritize. Higher accuracy and precision can result in more notes being correct and a more accurate tuning, but at a cost: It will take you longer, and you will need to learn the procedures. The second and third parts of this series will discuss how to achieve different levels of accuracy and precision.

However, before we discuss that, we need to explore what I call the "Stretch Interval Set," which I refer to as the SIS (Figure 1). Before delving into how to use it for the bass, I'll show how it works in the middle range. The SIS works well for the following reasons:

1. It is a set of notes in which one note is the check note, and the intervals it makes with all the other SIS notes produce beats at the same note: the top note of the set. It's easy to remember and easy for the ear to focus on the beating because every interval always beats at the same note.
2. It is used to tune and confirm many pure intervals.
3. An interval can only be pure if its notes are pure unisons. Therefore, a pure interval proves pure unisons, and pure unisons are the number one criterion for a fine tuning.
4. Pureness is proven by equal-beating check intervals that have a range of about +/-5% accuracy. Any beat rates less

than 5% different will be heard as equal by most people. Tuning multiple pure intervals would not be possible unless each had a range in which they would be considered pure. Defining pure intervals by beat rates allows this.

5. The SIS confirms and/or tunes the following intervals:
   - Wide P4.
   - Narrow P5.
   - Pure 4:2 and 6:3 (small-scale) octaves.
   - Pure P11 (octave plus P4).
   - Pure P12 (octave plus P5).
   - Pure P19 (two octaves plus P5).
   - Pure P22 (triple octave).

   Note that the double octave is not pure; the 4:1 is wide, while the 8:2 is narrow.
6. We only use a subset of the SIS if we don't have all the notes tuned or don't want to use all the notes.

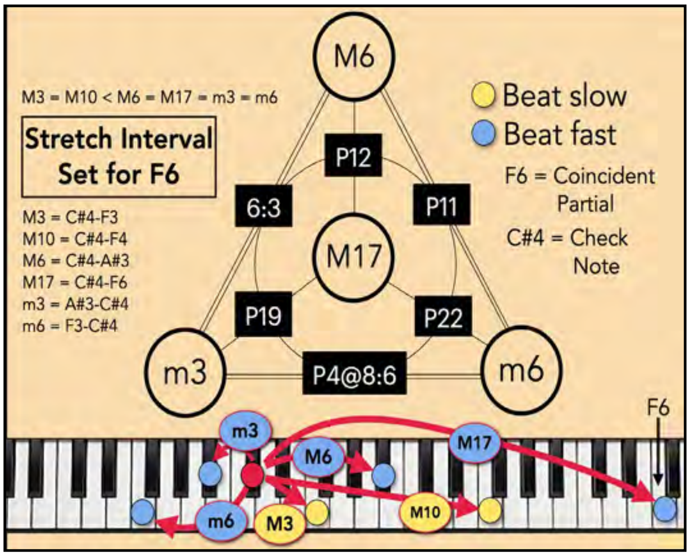

Figure 1: An example of the authors's Stretch Interval Set.

Here's how to use the Stretch Interval Set: Play the check note (the lone note not repeated, C♯4 in Figure 1) with any other note. Listen to the top note for the beating. Pick any two notes and play them back and forth with the check note. You will be testing the interval that makes up those two notes. For example, in Figure 1, take F3 and A♯4. Play C♯4 with each (F3-C♯4 and C♯4-A♯4.) You are testing the interval F3-A♯4, the P11. The Stretch Interval Set works when we tune the middle two groups of four notes at the same speed and all the others slightly faster. This produces a pure 4:2, pure 6:3, pure P11/12/19/22, and pure P4 at the 2nd coincident partial. You can use subsets of the full set when notes haven't been tuned yet.

There are a few ways to produce the SIS.

The Three-Note Method:

1. Start at the top note. Take four of those spanning three octaves. (Example: F6-F5-F4-F3)
2. Go up a P4 from the bottom note. Take that note and the note an octave up. (A♯3-A♯4)
3. Go up a m3 from the P4 in step 2. Take that note. (C♯4)

The Minor Chord Method:

1. Create a minor chord in second inversion. (Example: F3-B♭3-D♭4.) [Editor's *note*: Flats are used for clarity in the spelling of chords.]
2. Take four notes of the fifth of the chord. (F3-F4-F5-F6)
3. Take two notes of the root of the chord. (B♭3-B♭4)

The Reversed Harmonic Series Method:

This method builds a harmonic series backwards, down from the top note to partial eight as the bottom note, skipping the seventh partial.

1. Start at F6, then go an octave down to F5.
2. Then a fifth to A♯4.
3. Then a fourth to F4.
4. Then a M3 to C♯4.
5. Then a m3 to A♯3.
6. Skip the seventh partial and go right to the 8th reverse partial, three octaves below F6 (F3).

Now that we have explained some issues of bass tuning, the coincident partials, and the Stretch Interval Set, we can explore different bass tuning techniques in the next part of this series. ☐

Mark Cerisano, RPT, is devoted to improving aural piano tuning techniques. He has used his background in mechanical engineering to test the reliability of assumptions routinely made by piano tuners. He has used his training in education to develop explanations of concepts that simplify understanding of aural piano tuning. Mr. Cerisano is the author of several books and Journal *articles. He can be contacted through his website, IPTS.online.*