Piano Tuning Considerations

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Draft Version of 11 November 2020

This is my third article in a series about various aspects of piano tuning. Piano tuners undergo a lot of education and training, and most of us are continually in the process of refinement and upgrading of our techniques as we exchange information with our peers. This article focuses on a small key sub-set of considerations that go into tuning a piano that I find are of frequent interest in the profession. All of the considerations presented will be targeted to the piano tuning professional, but many will also be of interest to our piano playing and owning clientel who wish to take the best care of their instruments. Finally, this discussion is certainly not complete; all suggestions, additions, and/or corrections are welcome.

I. Tuning Hammer Technique

The piano's musical strings are terminated at one end at a tuning pin, which the piano tuner-technician adjusts during a tuning to achieve the appropriate sound. He or she places a tuning hammer (a wrench) on each pin to adjust the string tension. The tuning pins are anchored in a block of (usually) wood, known as a pin block (or wrestplank), that is usually constructed of multiple (laminated) layers.

This Section I, on tuning hammer technique, addresses four sub-topics concerned with proper handling of the tuning pins and with maintaining the integrity of the pin block so that the pins will maintain their tightness over a long period of time. A pin block and the piano that it is in should last much more than half a century. When you tune a century-old, non-rebuilt classic Steinway that still holds its tuning well, you know that the preceding tuners have at least obeyed the first two hammer technique rules that follow, on smoothness and pin bending. A pre-eminent piano tuner, the late Bill Hupfer[1], taught me these techniques. Bill was a concert tuner and the head tone regulator at Steinway Hall in New York City.

I.1 Smoothness. Use a smooth tuning technique; no impact (or jerky) tuning, whether via manual technique or via use of an impact tuning hammer. Wooden pin blocks have fibers at their micro-level, and smooth techniques always treat fibers better than sharp blows. Just think about how you can break a thin piece of twine more easily with a sharp snap than with a slow pull. Avoiding sudden tuning hammer movement is a must for preserving the life of the piano. That said, you still need to be prepared for exceptions, such as a rebuilt piano with very tight pins, where you could determine that a basic stable tuning will require impact techniques to best set the pins.

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1. Bruce Bliven, Jr., "The Finishing Touch," Dodd, Mead, and Company, 1978, Chapter 4, "Piano Man: William Hupfer."

I.2 Pin Bending. Minimize bending the tuning pin while tuning. This rule is always true, with the objective of reducing stress on the pin block; and is particularly important for any piano that does not use a bushing sleeve where the tuning pin passes through the metal plate. Section I.3 on "Hammer Placement" provides some assistance in this regard. From a practical perspective, some pin bending is unavoidable, but a tuner must at least strive to minimize any bending of the tuning pins toward the speaking length of the string. For example, for a note that is just a bit too high in pitch while tuning, do not give the tuning pin a little bend toward the speaking length of the string; instead re-set the pin and string correctly (see the stability section below).

I.3 Hammer Placement. As a corollary to the preceding sub-section on pin bending, I tune grand pianos right-handed, with the normal (L-type) tuning hammer at approximately a 3-o'clock position, and I tune uprights left-handed with the tuning hammer at approximately a 9- or 10-o'clock position. This approach minimizes the pin bending toward the string speaking length when increasing string pitch or tension, which is the more stressful operation, versus a pitch decrease, relative to the "compression" forces on the pin block. Some tuners find that for some grand pianos a 12-o'clock hammer position is appropriate for ease of tuning or tuning stability purposes, but my personal preference, at least when raising pitch, is still the 3-o'clock position for the reason given. Yes, the upper section of a grand is also an exception, with options of tuning left-handed or standing to the side, but string tension is less there so less resultant forces are at work bending the tuning pin.

I.4 Stability. Tuning stability is very important, so that the tuning is not changing as you are walking out of your customer's house. The tuner quickly learns that this is a task involving (a) "**setting the pin**," whereby you turn the pin a little farther than desired and then let it untwist and perhaps ease the tuning pin back a little more, and (b) "**setting the string**," whereby you stabilize the string movements past its multiple bearing points[2]. These two related skills are an important acquired capability that all of us learn with experience. You mentally learn to factor in considerations such as tuning pin twist, pin bending, string tensions in speaking-length and non-speaking-lengths, and more.

II. Aural Tuning

The decision of piano tuner-technicians to tune by ear or to tune using an Electronic Tuning Device (ETD) is addressed by all of us during the development of our career. I personally favor aural tuning since it is easy to learn and understand, it has high accuracy, and a piano is an acoustical device, so the judgment of our tuning quality is by necessity done aurally. For those tuners who also do aural tunings, or are still considering it, the following are a few considerations.

II.1 Musical Intervals. The association of musical intervals with instruction in aural tuning is unavoidable, but be sure to primarily associate the physical intervals of the partials with each

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2. Arthur A. Reblitz, "Piano Servicing, Tuning, and Rebuilding," Second Edition, 1993, page 219.

musical interval's name to facilitate a true understanding. The table shown below ("Table of Intervals"), or an equivalent but condensed one shown in Wikipedia[3], illustrates this association. The wide versus narrow labeling relates to the Equal Temperament in which pianos are tuned. For example, in setting a starting A49 note using a tuning fork, you might be instructed to use a tenth (F33 - A49) or seventeenth (F21-A49). But why? It is because the tenth represents a 5:2 ratio for the interfering coincident partials, and the seventeenth is 5:1; in both cases you listen for the beats at the virtual "1" top note (A61 for the tenth and A49 for the seventeenth). So when you are told a third or tenth or seventeenth, the important thing to remember is the 5:4 (third), 5:2 (tenth), and 5:1 (seventeenth) partial ratios to assist in understanding why that ratio is in use and where to listen for the beats. The above is referred to as setting a 4:2 octave, and now you can see why. Similarly, in setting a 6:3 octave, one will use a 6:5 interval (minor third) with a 5:3 interval (major sixth), with the common interference point being at the virtual "1" top note. Hopefully this paragraph has given you a basic understanding of these commonly used musical intervals.

Table 1, *Table of Intervals*[4]

Interval	**Number of half-steps in the interval**	**Where to listen for the beats from coincident partials**	**Alternate Description [and if widened vs narrowed]**	**Musically known as**
1:1	0	At fundamental + higher coincident frequencies		Unison
6:5	3	Two octaves above the "4" in 6:5:4	[narrow]	Minor Third
5:4	4	Two octaves above the upper note	[wide]	Major Third
4:3	5	Two octaves above the low note	[slightly wide]	Fourth
3:2	7	One octave above the high note	[slightly narrow]	Fifth
8:5	8	Three octaves above the low note	[narrow]	Minor Sixth
5:3	9	Two octaves above the "4: in 5:4:3	[wide]	Major Sixth
16:9	10	Four octaves above the low note	[wide]	Minor Seventh
2:1	12	At high note + its octave + more		Octave
5:2	16	One octave above the high note	Octave + Major Third	Tenth
3:1	19	At high note + higher coincident frequencies	Perfect 12th / Octave + Fifth	Twelfth

3 Wikipedia, article on "Piano Tuning," table on "The Pitch of Beatings." https://en.wikipedia.org/wiki/Piano_tuning.
4 Norman Brickman, Potomac Piano Service Web site, tuning article "Use of Beats in Tuning," *Table of Intervals.* https://potomacpiano.com/tuning-articles

4:1	24	At high note + its octave + more	Double Octave	Fifteenth
5:1	28	At high note + higher coincident frequencies	Double Octave + Major Third	Seventeenth
6:1	31	At high note + higher coincident frequencies	Double Octave + Perfect Fifth	Nineteenth
8:1	36	At high note + its octave	Triple Octave	Twenty-Second

II.2 Amplitude of Partials. In the use of musical intervals (or ratios of partials) in aural tunings, be sure to factor in the amplitude of the partials (and their associated beats) that you hear on the actual piano. You have a choice of partials upon which to base your tuning, and one consideration (in determining which to make use of) will be the louder partials, which are usually the lower-numbered ones.

II.3 Setting The Temperament. There are several temperaments available for aural tuners to use in setting an initial octave (or more) and from there to expand to tune the entire range of the piano. Some approaches require the tuner to set one or more intervals to a particular value, such as setting F3 – A3 to 7 beats per second. Instead, choose an aural tuning approach that only requires relative comparison of different intervals based on recognizing (a) equal beat rates and (b) one interval beating at a less-than (or greater-than) rate than another.

One good aural tuning approach is described by John W. Travis[5] and is based on the Grabau-Travis Tuning Theory. The temperament octave that he presents begins with a series of major thirds tuned upward from the fundamental and fifths that are tuned downward.

The actual beats to expect in a temperament octave are shown in the following Table 2 from Wikipedia (and would be halved for the next lower octave). But again, I suggest choosing a tuning temperament approach where relative values are in use, not the absolute values shown.

III. Additional Considerations

Finally, the following are a few additional important considerations for all tuners to follow.

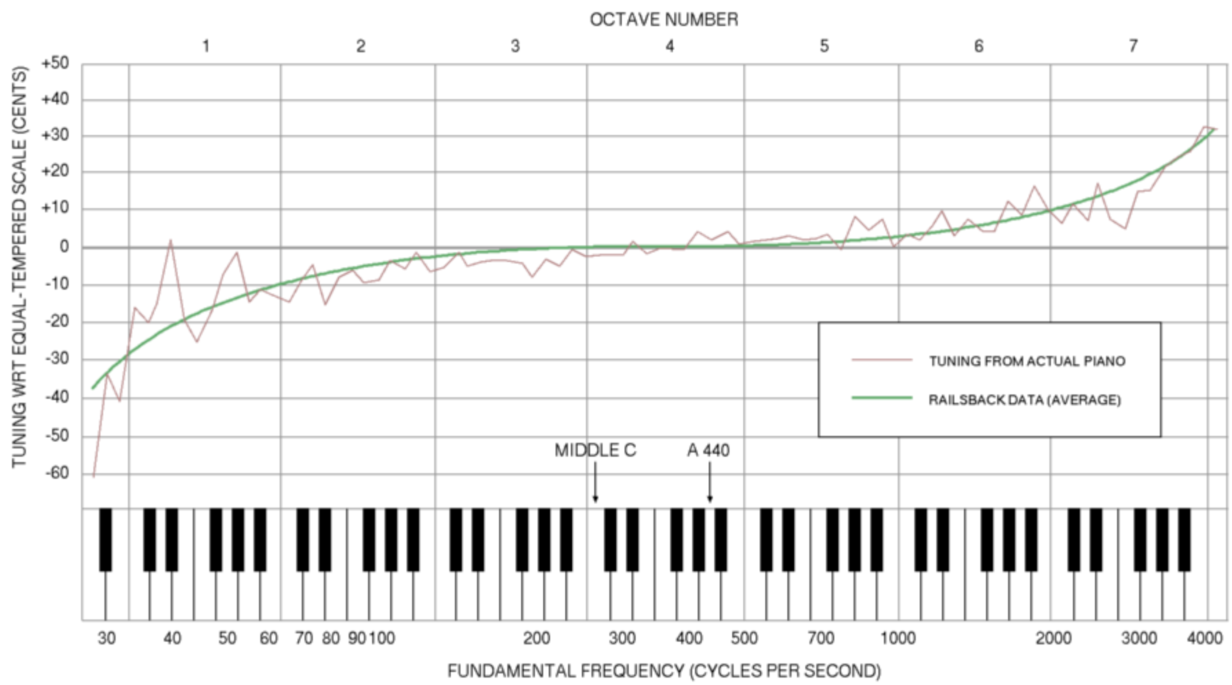
III.1 Normal Blows. The piano tuner should not play each note loudly, referred to as “hard blows.” There are tuners who believe that the multiple hard blows of the key are necessary to set the tuning well, but that is not true. With experience and careful attention, you learn to set the tuning using the techniques described above in the section on “Stability,” using only modest test blows to hear the tuning results. As Mark Cerisano discusses in his Tuning Stability class[6], “hard blows . . can damage your hearing, joints, the piano, and create unwanted fatigue . .”.

5. John W. Travis, “Let’s Tune Up,” 1968, chapters 10 and 11.
6. Mark Cerisano, “How To Get Superior Stability” class, https://howtotunepianos.com/how-to-get-superior-stability//

Table 2. Equal temperament beatings (all figures in Hz)[7]

261.626	277.183	293.665	311.127	329.628	349.228	369.994	391.995	415.305	440.000	466.164	493.883	523.251
0.00000			14.1185	20.7648	1.18243		1.77165	16.4810	23.7444			C
		13.3261	19.5994	1.11607		1.67221	15.5560	22.4117			B	
	12.5781	18.4993	1.05343		1.57836	14.6829	21.1538			A♯		
11.8722	17.4610	.994304		1.48977	13.8588	19.9665			A			
16.4810	.938498		1.40616	13.0810	18.8459			G♯				
.885824		1.32724	12.3468	17.7882			G				Fundamental	
	1.25274	11.6539	16.7898			F♯					Octave	
1.18243	10.9998	15.8475			F						Major sixth	
10.3824	14.9580			E							Minor sixth	
14.1185			D♯								Perfect fifth	
		D									Perfect fourth	
	C♯										Major third	
C											Minor third	

Figure 1. The Railsback curve, indicating the deviation between normal piano tuning and an equal-tempered scale.[8] (See Section III.2 below)



7. Wikipedia, article on "Piano Tuning," table on "Equal Temperament Beatings." https://en.wikipedia.org/wiki/Piano_tuning.
8. The Railsbach curve, taken from a Wikipedia article on piano acoustics. https://en.wikipedia.org/wiki/Piano_acoustics

III.2 Inharmonicity. Part of the enjoyment of listening to a stringed instrument, such as a piano, is the inharmonicity of the sounds from the strings themselves, as illustrated above in Figure 1 in what is called the Railsbach curve. An aural tuner learns to adjust each tuning to the particular piano, with smaller-size instruments often giving the most challenge to finding the best fit. I usually start with 4:2 ratios going into the treble, and 6:3 ratios going into the base from the temperament octave. Finer adjustments can become more important toward the extreme of the scale. Section II.2 Amplitude of Partials provides another consideration. My tunings usually agree with the view of Reblitz[9], with a beatless compromise of octaves and double-octaves going into the treble and tests including a smooth progression of major tenths (5:2) and seventeenths (5:1). In going down the scale into the bass, a 6:3 octave test (with minor third (6:5) and major sixth (5:3)) can take over in prominence from the 4:2 tests. The upper partials of lower bass notes match notes in the temperament area, and finally a slow decrease in beat rates for an interval is helpful – such as using the minor seventh (7:4) in the lowest octave. For the tuner using an ETD, this “stretch” of the octave is controlled by a program in the device, but the tuner should still listen to make any adjustments needed in the actual instance.

III.3 Muting and the Tuning of Unisons. I recommend use of traditional, time-tested approaches for muting the strings and tuning unisons while tuning a piano. I use felt temperament strips and rubber wedge mutes. For upright pianos I mute the entire range with felt (except just above the treble break), and I proceed to tune a single string per note across the whole piano before going back and removing the felt to tune the second and third strings per note. For grands I mute only the temperament octave, muting two of the three strings in each unison. After setting the temperament I use rubber wedge mutes to tune chromatically up and down the entire scale, tuning all the strings in each unison as I proceed. There are alternative methods for muting notes (including use of different types of mutes) and for tuning unisons (such as doing two strings at a time), but at least for beginners I suggest starting with established and proven techniques; such as the approach I described.

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9. Arthur A. Reblitz, “Piano Servicing, Tuning, and Rebuilding,” Second Edition, 1993, page 229.