Tuning the initial A4 to an A-440 Pitch Source

All this about tuning ***ONE*** note? ***Yikes!!!***

There is *much* to understand about using an electronic pitch source as opposed to using a tuning fork. What nobody is telling you is that if you use F2 as a test note, it will almost always cause you to tune A4 by at least one cent flat which would immediately eat up all the tolerance of the tuning exam. That leaves you with only two more cents to work with before you fail.

Here is why: There is *more than one set of audible coincident partials*! The A4 string of the piano has a very clearly heard *second partial* which most people are more likely to focus upon than the first partial (fundamental). The fifth partial of F2 is coincident with (matches in the approximately same range) as the first partial of A4 but as it is normally tuned, is 14 cents flat of the A4 fundamental tone. Therefore, the F2-A4 seventeenth beats rapidly.

In order to test the accuracy of the A4 pitch, you are supposed to tune F2 approximately, to where it creates a rapid beat with A4 , a widened seventeenth (never a narrowed one). The exact rate of beating is not critical but the more rapid it is, the more easily you may be able to detect a difference. If the interval beats slowly, you may not be able to discern any difference but if it is too rapid, you may not be able to discern a beat at all or the “sour” sound of a very wide interval may be distracting.

The problem is that F2 also has a clearly audible tenth partial which is coincident with the second partial of A4 (at the approximate pitch of A6). Neither the tuning fork or the electronic tone have inharmonicity but the A4 piano string certainly does and it will be approximately one cent sharp (but can be more). You may THINK you have a perfect unison between the tone and the A4 string but what you may well be doing is matching the second partial of A4 with the second partial of the tuning fork or electronic tone and that will cause A4 to be about one cent or more flat.

For many years, I was under the impression that a tuning fork had no partials, only the pure, fundamental tone. That is not true. A tuning fork has a second partial and just like the electronic tone, it has no inharmonicity. The only other partial that a tuning fork has is a sixth partial, which is the *ping!* that you hear when you strike it. That partial is wildly sharp but it fades quickly and is therefore, not a problem nor a factor when tuning the A4 pitch.

If you mistakenly match the second partial of either a tuning fork or an electronic tone with the second partial of the A4 piano string, the difference will be small enough that the beat between the two fundamentals may not be heard as it would be only about one beat every four seconds. The F2-A4 test may make you think you have it right but the reason you can't be sure is, that it is producing its own

confusing feedback. If you are having trouble sorting it out, it's not you, it's the two sets of audible coincident partials that are just far enough apart and at the same time, still close enough to thoroughly confuse you! There are certain things that cannot be found in books or in the usual Piano Tuning course and this is one of them.

The F2-A4 test is perfectly fine as stated for beginners when using a tuning fork and that is where it came from. It's in all the books but hardly anyone who ever used it could produce a perfect 0.0 result on the PTG Tuning Exam, including me. It is only assumed that an electronic tone is better because it plays at whichever volume you like and for as long as you like with no decay. The fork has its own drawbacks because you have to hold it to your ear. If you touch it against something to make it more audible, it then sets up its own coincident partials with their own inharmonicity. It decays quickly. You have to use the Sostenuto pedal (which you should in any case) to hold the A4 string open so you have a free hand. It will read at 0.0 only within a very narrow temperature range. An aluminum fork is louder and sustains longer but it is extremely volatile to temperature. A steel fork is far more stable but it still will change pitch slightly within a few degrees Fahrenheit (about half that for Centigrade).

I have been back and forth any number of times between recommending the traditional tuning fork and the electronic tone and those are the reasons for my own uncertainty on the issue. Neither has a clear advantage over the other. Nevertheless, an electronic tone can be useful and you can get dead on, 0.0 accurate results within mere seconds if you know what you are doing and most importantly, have practiced it thoroughly.

The Magic Bullet!

To practice using an electronic tone, you will need to do this first: Find the note E6 on your piano which corresponds to the 3rd partial of A4. Use your Electronic Tuning Platform (ETP) in the Tune Mode. That is, no program: only theoretical values. Set the ETP to +2.0 cents to compensate for the built-in -2.0 cents of the tempered fifth. Using a wedge mute placed between the center and right strings so that only the left string will sound, tune the left string of A4 as precisely as you can on its first partial (fundamental tone) using the ETP set at +2.0.

Now, go to the note E6 and using a wedge mute, place it again between the center and right strings so that only the left string will sound. Tune that string to E6 to its theoretical value provided by the ETP. (It will be significantly flat by several cents of where any calculated tuning program or aural tuning would place it). Now, take a second wedge mute and place it on both sides of the unison so that that only the middle string will sound. Set the ETP to read or "hear" the note E6 on its fundamental, the first partial, or Partial 1, however the program defines it. Play the A4 note which has been previously tuned to an exact +2.0. Tune the middle string

of E6 so that it halts the display pattern exactly when playing A4 (not E6). This will produce a pitch several cents higher than where you tuned the left string.

Now, remove the left wedge mute but leave the right so that the left and center string of E6 will sound. Play the note, E6 and you will hear a moderately rapid beat of approximately four beats per second (but no need to try to count those beats!). Just listen to that beat. It will reveal the difference between the first partial (fundamental) of the A4 string and its third partial.

[If your ETP is one of the very advanced type that will find a note virtually anywhere on the keyboard when you play any key, anywhere, you will need to disable that function and use the platform only in the basic Tune mode for this exercise].

You should first try to perceive the rapid beat that will occur when the A4 key is played and the A4 string is tuned electronically at 0.0, as read on the first partial (fundamental) and the electronic tone is also sounding. Set the volume control of the electronic tone to a fairly quiet sound so that you have to listen carefully and that it does not overpower the faint sound of the third partial of A4. Play the previously tuned E6 for a clue from its beating unison, the sound you are wanting to hear and then listen again to A4 and the electronic tone sounding together until you can hear that faint and moderately rapid beat reliably. Then, tune A4 electronically to -1.0 cents. You will hear that the clear rapid beat is gone. You will hear also that that the unison between A4 and the electronic tone is less distinct, even if you cannot clearly discern the very slow beat that would inevitably be there.

Now, to try to practice tuning A4 to the electronic tone, you will need to detune A4 flat by -4.0 cents. This will be the amount that it will be detuned at the tuning exam. Some ETP exam programs will make it flat, some will make it sharp so you have to be prepared for either. I suggest that you first try tuning A4 at -4.0 cents. From A4 tuned at -4.0, sharpen A4 until it crosses into being obviously sharp, then gently lower it until the pitches approach the point of matching. Then, focus your ear on the fundamental pitch only and try to ignore any partials. This will be the exact opposite of what you are usually told to do and what you naturally do when you perceive any beating in any other intervals. You are going for a perfectly matched unison!

When you approach the point of an exact match, however, a faint but rapid beat will *emerge*! You should clearly hear, as you get close to an exact match from the sharp side, a rapid beat: *beep-beep-beep-beep! .* Then as you approach an *exact* match, you will hear the very same but faint rapid beat as you heard when you play the E6 unison that you previously set up. About four beats per second. Listen very carefully! There will be an exact and beatless match between A4 and the electronic tone but now, at the same time, a faint, rapid beat emerges as if out of nowhere. The exact beat rate is not so important. It will be the same as the example you set up with the note, E6. It can vary a little from piano to piano but really, very little.

Practice this until you are sure about it. It is your "*signal*" that you have a perfect match! A *perfect* 0.0 reading!

If you perform the technique correctly, you cannot be more than one cent off, even on a piano with which you are not familiar nor have you performed the E6 exercise. The reason is that the A4 string will most likely be approximately the same speaking length and have the same wire diameter on virtually any type of piano. If taking the PTG Tuning Exam, the piano will not surprise you with any significant difference. This is indeed, the "*magic bullet*" technique!

You really do not need any other confirmation but there is one Rapidly Beating Interval (RBI) test that can and will work to confirm it. The seventh partial of the note B1 is coincident with A4. The interval is a double-octave-minor-seventh. It is a naturally mildly dissonant interval that beats very rapidly as it is normally tuned because there is an approximate 20 cent difference between the seventh partial of B1 and first partial of A4 as they are normally tuned. It is also a widened interval, the same as the F2-A4 seventeenth.

There are a few differences however, that make it more useful for both tuning fork tone and electronic tone tuning. Once again, they won't be found in any book or manual or probably not even on the PTG website but the advice and information will be found right here in this article. The interval is naturally mildly dissonant whereas the F2-A4 interval is quite consonant. If you make the F2-A4 interval beat too rapidly, that in itself becomes a distraction.

When you create the proper mildly dissonant double-octave-minor-seventh interval between B1 and A4, the naturally rapid beat and expected dissonance create a dense palette from which the very smallest difference between the tone and piano string can easily be heard. It is not about exact beat rates between the two very Rapidly Beating Intervals (RBI). It is whether there is a *difference* between them.

A phenomenon known as *interferometry* affords the tuning of equally beating intervals with the utmost precision. It is not unlike distinguishing between two shades of color. We do not think about what constitutes the difference, only that there is a difference. Furthermore, if the two very rapid beats are played simultaneously and there is a difference between them, the slow beat which *emerges* can actually be heard more distinctly above the noise of the two conflicting rapid beats. The very slow beat can actually be detected more easily against two very rapid beats that are slightly different than it can be detected from just the tone and the A4 piano string. It sounds like a *demonic scowl*.

You should also try tuning A4 electronically at -1.0, -2.0, -3.0 and -4.0 and listen to the results of each carefully when compared to the electronic tone. Those all will give you a confusing and indistinct sound but you can sometimes hear some stray and faint rapid beats but none of them will be as clear and distinct as when you have a perfect match with the A4 string and the electronic tone.

Similarly, if you practice with the test note, B1 and the A4 pitch tuned electronically at -1.0,-2.0,-3.0 and -4.0 and compare the A4 string and B1 and the electronic tone and B1 both separately and together, you will get an idea of what you need to do when you attempt to tune the pitch aurally. In other words, show yourself what you will be listening for first, then try it completely by ear.

I must emphasize once again that none of this is easy and it cannot be mastered without diligent practice. To many musicians, if you play an A-440 tone, then stop it and then play an A-439 tone (-4.0 cents), that person will not likely notice the difference and accept them both as the same. Only some highly skilled string players and oboists may notice as those who have an unusually high pitch recognition ability will. Virtually no one could detect a mere 1 cent difference. Beyond four cents, they start to hear it. By 10 cents, most will and by 20 cents, virtually all will.

But that is not how pianos are tuned. They are tuned by sounding two tones simultaneously then perceiving, discerning and controlling the beats between them. The 1.0 cent tolerance of the tuning exam is therefore extremely small. The tolerance for Standard Pitch of +/- 4.0 cents is the amount the exam piano is detuned. If you just left it there, you would get a failing score of 70. Ten points below passing. A result of 0.75 beats per second (+/- 3 cents) is the maximum you can be off and still pass with a score of 80.

The major pitfall of the electronic tone technique can be that you are off by several cents but hear a rapid beat and think you've got it but get a pitch score of 40! You don't want that to happen but I have seen it happen more than once and it is not amusing to anyone. So, never think you have got it the first time you are successful. You must be able to do it time and again reliably before you can breathe easily at the tuning exam or any under any other circumstance where the pitch must be accurate and must be tuned aurally.

My participation with tuning exams began some 30 years ago. I never did see anyone who passed the exam *nail* a 0.0 until recently, using the electronic tone technique described above. I could not do it myself with a tuning fork until I learned the technique using B1 as a test note. Now, I can consistently get a 0.0 within a few seconds using the electronic tone. All it takes is the right information, very fine control of the tuning hammer and practice, practice, practice until you get it and then it becomes easy to do quite reliably and within a matter of *seconds!*

Bill Bremmer RPT April 2020