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A NEW PRECISE GUITAR TUNING METHOD

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A b s t r a c t

In this article is discussed a new method for tuning the guitar. This method is more precisely than other standard tuning methods considered in classical guitar methods. By this tuning method guitar is perfectly tuned in the open position.

Key words: *classical guitar, tuning*

Few guitarists can tune their instruments precisely;
even professional concert artists are at times offenders in this respect.
Until one has heared the sweetnes and freedom from rough edges of chrds played on a correctly tuned guitar,
one cannot realize how much is lost through failure to tune with absolute accuracy.

Maestro Emilio Pujol

1. INTRODUCTION

Generally speaking the guitar tuning is one of the most important need for every guitar student, but it is also one of the bigger barriers which it must be overcame by every guitar student much earlier in his/her education process. According to its weight, in every guitar method this problem takes essential place and for its temporary solution guitar teachers very often recommend use of an electronic tuner. Precise guitar tuning without an electronic tuner is not lesson which students may understand in one pass or maybe from some ***overnice guitar method*** during one night. It needs a lot of practice and takes time, until the student's hearing becomes good enough to recognize tones clearly.

Here, i would like to stress out that so–called a *new tuning method* given in (WILLARD, 2006) it is a well–known method since a long time ago as a *relative tuning method* (NOAD, 2002).

Ideally the purpose of tuning an instrument is to produce the most consonant sounds from the consonant intervals so that the chords in all keys will be pleasing and harmonious and so that modulations can be made without unpleasant effect. Unfortunately, this ideal is unattainable on instruments of fixed intervals and can only be secured on the bowed instruments, the trombone, and the human voice. With these the musician can constantly make the minute adjustments necessary to keep the intervals consonant in every key.

Why is this? Briefly put, here is the explanation, omitting many important and significant details, but containing enough truth to serve our purpose.

Let us look back at an ordinary diatonic major scale, for instance: C, D, E, F, G, A, B C. Pythagoras first demonstrated how suitable notes could be found for such a scale by mounting a string on a box with a movable bridge to divide the string into two parts. Whenever the note emitted by string on one side of the bridge bore a consonant relationship to the note emitted by the portion of the string on the other side of the bridge, the numerical relationship of the two parts yielded a point within the octave wherein a note of the diatonic scale could be fixed.

Tonic (base note unison) 8:8	5th note 3:2
2nd note 9 : 8	6th note 5 : 3
3rd note 5 : 4	7th note 15 : 8
4th note 4 : 3	8th note (octave) 16 : 8

Here are ratios for the notes of a diatonic scale starting with the unison and running through the octave.

The tonic ratio, 8 : 8, is the whole length of the vibrating object or the complete number of vibrations of the note forming the tonic of the scale. The second vibrates 1/8 times more than the tonic, 3rd note vibrates 2/8 times more than the tonic (5 : 4), etc., until we arrive at the octave which vibrates at exactly double the speed of the tonic, or at the ratio of 16 : 8. This relationship of ratios remains constant through the diatonic scale no matter what the tonic note may be. Thus, if the tonic note is vibrating 24 times per second, the 2nd note of the diatonic scale will vibrate at the rate of 27 times per second or 9/8 times the tonic, etc.

Let us now examine a set of vibrations for every tone of a diatonic scale. For simplicity's sake let us assume that the tonic of an imaginary C Major diatonic scale is vibrating at the rate of 24 times per second. Using the set of ratios given two paragraphs ago we arrive at the following calculations:

Tonic C	D	E	F	G	A	B	Octave C
24	27	30	32	36	40	45	48

Now let me show you that the notes of the above C Major scale that also form part of the D Major scale will not be precise unless slightly altered. To do this we need only check the consonant interval of the perfect fifth whose 3:2 ratio appears in our list ratios. In the above C Major diatonic scale we find that indeed the ratio between the 5th and the tonic is 3 : 2 (36 : 24). But what of the ratio between the fifth of D (27) and A (40)? A rapid calculation will show us that in order to achieve an precise 3 : 2 ratio between a D vibrating at 27 times per second and its perfect fifth, the A will have to vibrate at the rate of 40 & 1/2 times per second. So we see that the note A is vibrating 1/2 vibration too slow, and would consequently sound 1/4 of a semitone flat if played, say, as part of the D Major chord.

Most instruments – piano, organs, guitars, banjos, etc., have fixed intervals and yet they must be playable in every key. How is this achieved?

If the notes or the frets are so fixed that the instrument is perfectly in tune in any *one* key, it will be out of tune in *most* of the other keys. To overcome this obstacle the instrument is *never* made or tuned to be perfectly in tune in any *one* key. Instead, it is so made and tuned that no *single* key is *exactly* in tune, but *every* key is *almost* in tune.

2. PRELIMINARIES

The guitar is an instrument with fixed intervals: these intervals are fixed 1º by the tuning of the open strings, and 2º by the placing of the frets, bridge and nut. The guitar must be playable in all keys. We will show in due course that if a musical instrument has *fixed intervals* it must be tuned so that those intervals are *equally tempered*. If these intervals are not *tempered* the instrument will be in tune in some keys and frightfully out of tune in others. Why this is so, we will also explain.

On the piano, the tuner makes a slight adjustment of the pitch of each string thereby obtaining *equal temperament*. On the guitar, however, where only the open string notes are tuned and rest are made by the pressing of the string against the frets, the tempering of the tuning of the notes is shared between the guitar maker on the one hand (who should fit the frets in position which will equally temper the intervals between the notes) and the guitarist on the other, who must so tune his open strings that he does not ruin the good work of the precise guitar maker. A truly tempered guitar, in fact, requires three things: first, an precisely fretted guitar, whose nut and bridge are precisely positioned; second, good strings that are not *false* in the note they produce at different parts of their length; and third, a guitarist who knows how precisely to tine the open strings. If our methods do not enable you to play in tune at any position, except the first position, your guitar is at fault or your strings are false, and we will learn how to determine whether this is the case in due course. However, before proceeding we must define the world *interval*.

An interval is the musical distance between one note and another; simply count the number of note names (counting each letter only once) and you have the interval name. For instance

from C to G there are five note names: C, D, E, F, G, the interval is a fifth;

from C to C there are eight note names: C, D, E, F, G, A, B, C, the interval is an eight or an octave.

Each interval (second, third, fourth, etc.) is met in several forms according to the number of semitones in it. For instance, C to B is a major seventh; C to B♭ is a minor seventh; C♯ to B♭ is a diminished seventh.

Some intervals sound more harmonious to the ear than others. This is because the two notes that make up the interval bear a comparatively simple ratio one another. As an example, in the most consonant (harmonious) interval, the octave, the higher of the two notes is vibrating twice as fast as the lower one (at a ratio of 2 : 1).

The most consonant intervals and their ratios are as follows: Octave – 2 : 1; Perfect Fifth – 3 : 2; Perfect Fourth – 4 : 3; Major Third – 5 : 4; Minor Third – 6 : 5; Major Sixth – 5 : 3; Minor Sixth – 8 : 5.

3. GUITAR THEORY

3.1. Equal temperament basis

In this case of the interval we have tested, the note A might be tuned to vibrate 40 & 1/4 times per second. Vibrating 40 times per second it would be in perfect tune for the C Major diatonic scale. Vibrating at 40 & 1/2 times per second it would be in perfect tune for D Major diatonic scale. At 40 & 1/4 vibrations per second we have a compromise: it is not quite right for the C scale, and not quite right for the D scale, but it will serve well for both and for all other keys!

What is actually done in practice is to tune the instrument (and fix its frets in the case of classical guitar) so that every semitone on either side of it.

In an *absolutely* tuned diatonic scale there are *large semitones*, and *small semitones*. In a diatonic scale that is tuned to *equal temperament* all of the semitones are the *same size*, or as nearly so as is possible.

Below is a chart showing the actual variations in a scale starting at lowest C on the piano keyboard and progressing through the octave.

	Low C	D	E	F	G	A	B	C
Absolute Diatonic	32	36	40	42.66	48	53.33	60	64
Tempered Diatonic	32	35.92	40.32	42.71	47.95	53.82	60.41	64

This variation becomes more apparent in scale of higher pitch, where there are more vibrations per second.

	C	D	E	F	G	A	B	C
Absolute Diatonic	512	576	640	682.6	768	853.3	960	1,024
Tempered Diatonic	512	574.7	645	683.4	761.1	861	966.5	1,024

Of course, there is a great deal more to *equal temperament* than we have covered in this brief synopsis. I have said nothing of the *mean-tone* system, or of the historical development of temperament.

3.2. The phenomenon of beating

Among the intervals which appear in our list of the consonant or harmonious intervals there are two which are prefixed by *perfect*; the *perfect* fourth and fifth. These intervals are called perfect because when sounded, the vibration emitted by the notes that make them up interact smoothly and do not conflict with each other. When the vibrations of *tone*–*waves* are not interacting smoothly, our ears perceive this as a dissonance. When they interact smoothly our ears perceive a consonance.

In a simple two note interval, dissonance is recognizable by a phenomenon known as **beating**. The speed of sound waves is too great for us to perceive them individually, but we do hear them as continuous sound. When an interval is dissonant, the waves or vibrations of the higher note *catch up* with the vibrations of the lower note which is emitting fewer waves, and this can be distinctly heard!

If you have a piano, ask your tuner to tune two notes to a strong clear *beat*; once you have heard it, you will never again fail to recognize it. If you do not own a piano, ask your guitar teacher to tune a beating interval on your guitar until you can recognize the characteristic sound. It is somewhat similar to the *tremulant* device in a cinema organ, or the *vox humana* stop in a church organ: it is a wavering wa-wa-wa-wa sound which appears to be within the musical note itself: it does not change the pitch of the note, but it is like a variation of note's intensity such as we perceive in the hum of a spinning top. You can produce it on your own guitar by tuning, say, the ⑥ string to its usual note and then lowering the pitch of the ⑤ string until it is also in E. You will find that you will not be able to tune the perfect unison, but will get the *beating*. This is because the ⑤ string will slowly rise in pitch owing to its having been more tightly stretched when it was previously tuned to A. As the pitch of the ⑤ string rises you will be able to hear the *beating* begin if you keep striking the two strings simultaneously, and that *beating* will increase in intensity as the pitch rises.

When you have learned to perceive *beating* you are ready to apply here offered method of tuning based on the removal of *beats* from the perfect intervals of the open strings. When the open strings are so tuned that there is no perceptible *beating* between one string and the next, then the guitar will be perfectly (absolutely) tuned in the open position. Since the frets have been placed as to produce equal temperament, we will be able to play in any key we may choose without undue dissonance.

We must begin by getting one string, the first or upper E string, to proper pitch. If your guitar is an inexpensive one, it does not matter very much (to almost a semitone either way) whether your instrument is strung to *concert pitch*, unless you want to play with a singer, pianist or instrumentalist who might be led astray by your faulty pitch. But if own a fine guitar, you **must** tune to concert pitch or you will *not* realize the potential of the instrument. If tuned two low, the tones will be dull and lifeless. If tuned too high, the tones will be stiff and hard. This is because, whereas an inexpensive guitar has a thick, insensitive soundboard, a fine concert guitar has a thin, flexible belly which is so built that when the strings are tightened to concert pitch, the various stresses are equi-poised and belly can vibrate freely.

4. TUNING THE GUITAR

The first string to tune is your upper E string. If you own a piano, check with your tuner to find if he has the instrument tuned to modern *concert pitch*. If this is the case, tune your top E string with the E above middle C, on the keyboard. If you have no piano, or if your piano is not up to the *concert pitch*, secure a good tuning fork (A 440) and use that to tune your E string with.

E (1) to E (6) a double octave	tune the ⑥ string to the ① string
E (1) to A (5) a perfect fifth	tune the ⑤ string to the ① string
A (5) to D (4) a perfect fourth	tune the ④ string to the ⑤ string
D (4) to G (3) a perfect fourth	tune the ③ string to the ④ string
E (1) to B (2) a perfect fourth	tune the ② string to the ① string

Now we must tune the other strings to perfect intervals, using our tuned top E string as the basis. All the intervals we will tune will be perfect intervals, and they *must* be tuned so that they are *free* of *beats*.

Here are the perfect intervals. The numbers following the notes indicate the open string to be tuned to that note.

All of the above tuning must be carefully adjusted until the notes emitted are pure, and without wavering or beating. You cannot tune the ③ string G to ② string B because this interval is a major 3rd and imperfect. It will always beat.

When you have tuned your guitar in this manner, begin all over again and make sure that the strings have not stretched or contracted again leaving the intervals beating.

Now make a further series of octave test as follows, being careful not to pull the strings sideways as these are **stopped** intervals and must be gently fingered so as not to put them out of tune.

G (6) at the 3rd fret with G (4) at the 5th fret
C (5) at the 3rd fret with C (3) at the 5th fret
E (4) at the 2nd fret with E (2) at the 5th fret
A (3) at the 2nd fret with A (1) at the 5th fret

Above tuning method supplements other tuning methods considered in classical guitar literature (BARREIRO, 2002), (NOAD, 1998), (PARKENING, 1999) and (WALDRON, 2003).

5. CONCLUSION

All of these are the most perfect of intervals (octaves) and should be completely free of beats. If some of them do beats, you must go over your open string intervals once again. If after this you are convinced that your open string intervals are correct, then your guitar is 1º wrongly fretted, 2º bridged incorrectly, 3º improperly tuned, or 4º strung with one or more false strings. If you are not sufficiently skilled to determine the cause yourself, take the instrument to master guitar-craftsman for diagnosis.

Even if there is something basically wrong with your guitar, it will still sound better and give you more pleasure if it is tuned as nearly precisely as possible by beats, instead of haphazardly by ear.

When you have your open strings in tune, and have tested them by the various octave tests, play a simple major chord over the six strings (such as E Major chord in the 1st position). You will be astonished to hear how smooth and pleasing the sound is, and how much better your guitar is than you thought it was! Some of you will say that it takes to long to tune your guitar by this method. I can only tell you that once you have mastered the technique you will be able to tune with greater speed and accuracy than you would have thought possible. Give the method of tuning by beats a fair trial, and you will never go beck to tuning by ear.

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NOVA PRECIZNA METODA UŠTIMAVANJA GITARE

S a ž e t a k

U ovom se članku procjenjuje nova metoda za uštimavanje gitare. Ova metoda je preciznija od standardnih metoda uštimavanja uzimajući u obzir metode klasične gitare. Pomoću ove metode gitara se savršeno uštimava na otvorenoj poziciji.

Ključne riječi: ***klasična gitara, uštimavanje***

UN METODO NUOVO E PRECISO DI ACCORDARE LA CHITARRA

R i a s s u n t o

In questo saggio si valuta un nuovo metodo di accordare la chitarra. Questo metodo è più preciso degli altri metodi standard usati per accordare la chitarra classica. Con questo metodo si può accordare la chitarra in modo perfetto in posizione aperta.

Parole chiave: chitarra classica, accordatura