Lutherie

Trade Secrets: A tool to measure string tension

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How luthiers can create a device to find the optimum tension of a string – and a few good reasons to use it
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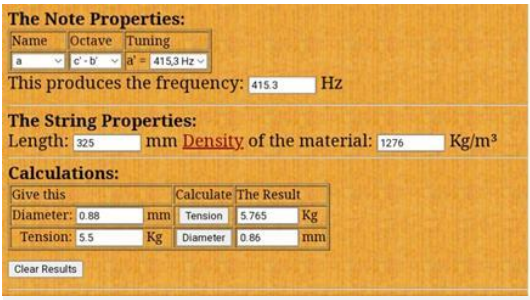
All violin makers and musicians who play stringed instruments, be they plucked or bowed, know that string tension is one of the fundamental features of their instrument. Modern string makers offer a wide variety of products, and the diversity of technologies and materials used follows the trends in musicians' tastes and needs. But the whole gamut of tension is generally reduced to a choice between low, medium and high, even when different string sets are substantially different. When I broadened the scope of my work to include 'historical' instruments such as violas d'amore and Renaissance violins, the issue of tension took centre stage. Like many of my colleagues, I started to use a small electronic 'tension calculator', which quickly became an all-important tool. But its inherent limitations soon prompted me to devise another, mechanical in nature and very simple in design.

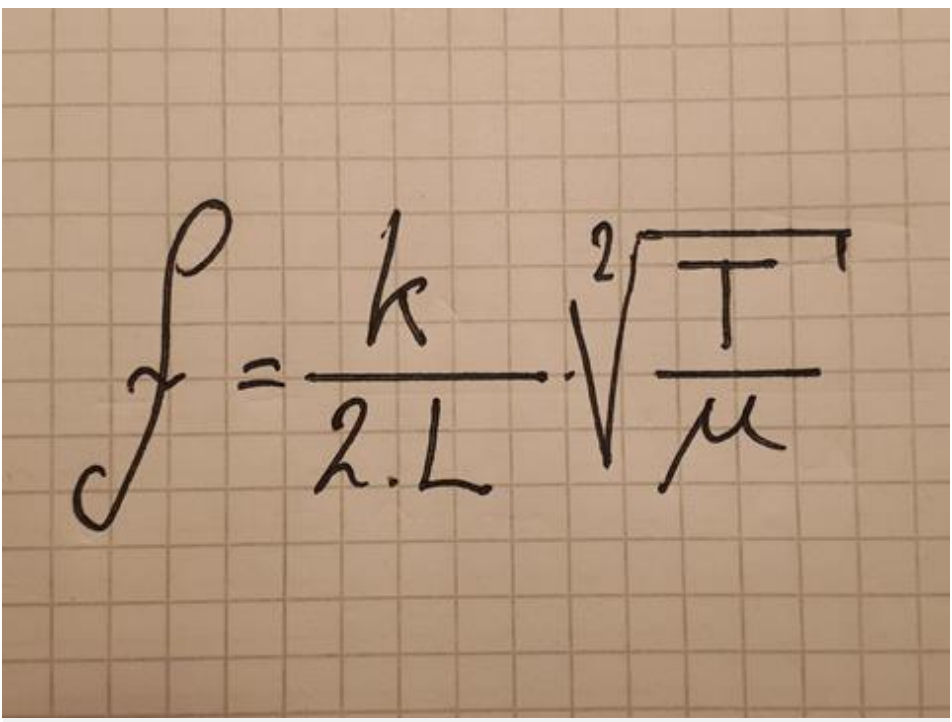
Both instruments turned out to be complementary and essential for selecting the strings and setting the sound on all kinds of bowed stringed instruments, as well as for winding gut strings.



All photos Robin Jousson

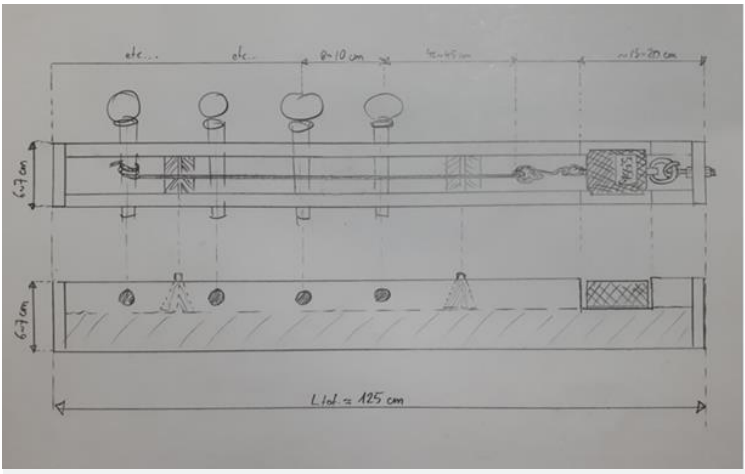
1a The tension calculator. 1b Non-homogeneous strings: wound; half/semi-wound; high-twist or catline

1 A tension calculator will calculate the tension of a string based on four different parameters: vibration length, frequency, diameter and density. The one shown in 1a can be found at **bit.ly/3lWtrxy**. Since the formula concealed inside the calculator uses the linear density of any given material, it is of no use when dealing with composite strings, or strings that are not completely homogeneous (1b).



Marin Mersenne's string frequency formula

2 It is also worth recalling Marin Mersenne's equation, published in his 1637 work Harmonie Universelle, which makes explicit the proportions between the different parameters. We see, for example, that frequency (f) is inversely proportional to vibration length (L). However, the relation of tension (T) to those same parameters is not proportional because its value, together with that of linear density (μ) is the product of a square root. Tension is therefore proportional (and linear density is inversely proportional) to the square of the frequency.



3a Diagram showing the measuring device. 3b This example measures 125cm

3 As shown in the diagram (3a), dimensions can be set according to intended use and available material. Since the measuring device is so long and thin (3b), it would be impossible to give a diagram that is both proportional and to scale.

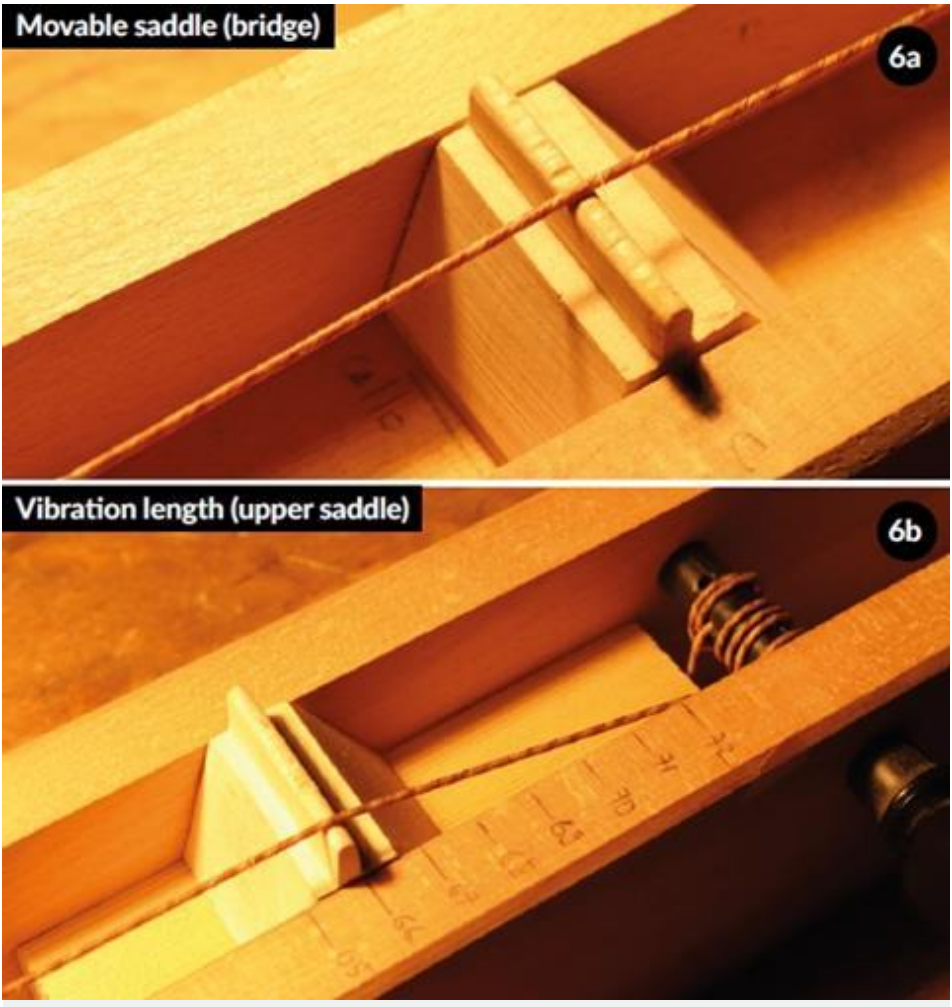
Saddles are mobile, and the location of the pegs can be adjusted according to the instruments worked on by the maker. Note that although four or five holes are necessary, a single peg will do the trick.

Luggage scale

4 This little electronic gadget is a simple luggage scale. When buying one, be attentive to two things: suspension points and range: 0–40kg will be amply sufficient.

5a A ring is used to attach the string to the scale.
5b Holes of different diameters are drilled into the ring

5 Fastening the string to the luggage scale is made easier by using a little ring pierced with holes of different diameters (1–6mm). A section of a steel tube will work just fine. Fastening the string with a simple knot, instead of a loop, allows one to preserve its length.

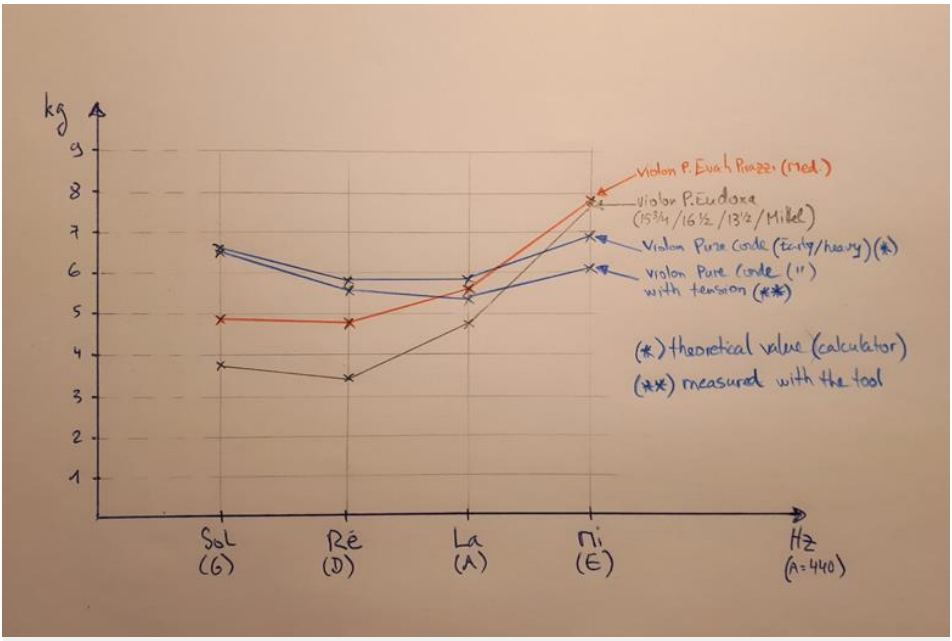


6a Movable saddle (bridge). 6b Vibration length (upper saddle)

6 The two movable saddles shown in diagram 3b can easily be positioned to obtain the desired vibration length. This variable is indispensable since, as we saw with Mersenne's equation, it determines either the tension or the frequency. The angle of the string at the saddles is quite flat, so the string will not suffer any deterioration. To make the positioning of the saddles easier, measurements are shown on the side of the instrument.

Adjusting the frequency with a tuner

7 The string frequency can be easily measured with a tuner. When applying tension, it is worth letting the strings rest for a while and, as with an instrument, tune them again a few times. This is because strings will elongate under tension. The thinner the string, the more noticeable this phenomenon will be.



Examples of force distribution in three violin string sets

8 This tool has many practical applications, including:

• Understanding combinations of string tension present on a given instrument. It is not just the structure, materials or overall tension that determine how a set of strings will perform, but also the distribution of forces among them

• Perfecting the tension of each string, allowing you to create your

own combination successfully

• Providing accurate orientation when winding strings

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