7.14 Vibration-undamping

Does the sound of an electric guitar improve if it is subjected to loud music for a day? Apparently so: more than a few people use this process to shorten an extended “playing-in” process. Others send their guitar off to Emil Weiss (G&B 12/08), who subjects it to a high vibration load (not without charging 770 €) – and voilà: the body can resonate much more freely. The basis of this shaking of guitars is a process that **Gerhard A. von Reumont** had patented in 1980 (German patent no. 27 12 268): *Process and apparatus for improving the resonant behavior of resonance bodies in musical instruments*. Mr. Weiss does not really explain in detail what he does to the guitars, and he does not mention Mr. von Reumont as the originator, either. However, the pictures published in G&B do have a striking resemblance to those in von Reumont’s book [ISBN 3-87710-173-9]. The latter does cite a publication co-authored by E. Weiss and A. von Reumont – thus it’s probably the same process. The underlying patent for the process “*has by now expired*”, as von Reumont states in his book published in **1996**. Correct: the patent office confirms that the protection became void in **1984** due to lack of payment of the fees. Which is by no means an indicator for bankruptcy but could have been connected to the annually rising patent fees.

Von Reumont writes that the transfer of the string vibration to radiated airborne sound is improved by the **vibration-undamping** – he does not mention electric guitars or basses. His investigations relate to upright bass, cello, acoustic guitar and piano, i.e. instruments the efficiency of which depends on resonances of the instrument body. We learn that wood would be strongly deformed during the construction of the respective instrument, and that this deformation hampers free vibration. *"The effect of the vibration-undamping is based on relaxation processes caused by frequently repeated over-stressing."* The over-stressing is taken care of by an electric motor fitted with a heavy spot (i.e. artificially unbalanced) and mounted to the bridge of the instrument such that the latter is given a good shake for hours on end. Does that actually work? Apparently so – the evaluation by musicians was “*entirely positive*”. Given such overwhelming evidence we certainly can grant, for once, an advance in terms of trust – but we still kindly ask for some quantitative data. These are found, as well: e.g. for an acoustic guitar, *"14.5% decrease in damping at 85 Hz"* are noted. The **damping**, that’s the resistive component in a resonating system – in textbooks we also find the damping constant, or the degree of damping, or the damping coefficient; mechanical engineers have created different terms, and on top of them the electrical engineers, as well, and the physicists, too … it’s almost a little Tower of Babel. For the term damping, the Schalltechnisches Taschenbuch (Pocketbook of Sound Engineering) references *“irreversible processes that transform part of the motion energy into heat (-losses)”*. That is not something you want in a musical instrument, and therefore the damping is reduced via vibration – by exactly 14.5% for the example mentioned above. How does one measure this value with such accuracy? By measuring the power consumed by the electric motor, advises von Reumont – before and after the treatment. If, after a 2-hour shake, the power consumption falls by 14.5%, the instrument has been un-dampened by 14.5% (at this frequency). Good riddance, then? Not quite, there is some truth in this – a tiny truth, but still …

Electric motors are electro-mechanic transducers that transform electrical energy into mechanical energy. Not exclusively, because heat also is generated – but mainly it is mechanical energy. The latter is needed to overcome friction in bearings, swirl the surrounding air, or – if there is a load – to create torque at a connected shaft. All these mechanical energies do not appear out of thin air but are drawn from an electrical source (battery or mains power supply), and thus the following holds: if the mechanical load changes, so does concurrently the electrical power consumption.

From this energy balance, von Reumont derives the assumption that the reduction of power consumption of the electric motor observed over hours can only be due to the decrease of the power drain, and that this can only be due to the reduction of the damping in the instrument material. So, if the power consumption falls by 14.5%, the damping in the instrument must also have reduced by just this 14.5%. Enter: the devil's advocate.

1) The power consumption also depends on the resistance of the motor winding (copper wire); this resistance changes as the motor heats up – by +5% for a temperature rise of a mere 13°C.

2) The friction losses in the motor bearing are temperature-dependent, as well, and anyway also dependent on wear – given the unbalanced loading not an unimportant aspect. Von Reumont reports frequent motor changes, and service lives of only 150 hours.

3) Suppose the mechanical power does actually decrease by 14.5% – why would then only the undesirable losses (the damping) have dropped? It could also be that the desirable power – the radiated sound-power – has decreased, couldn't it?

To prove the effectiveness of his process, von Reumont cites an **investigation by the PTB** (Physikalisch Technische Bundesanstalt – a governmental technical/physical authority in Germany), in which an upright bass was analyzed before and after treatment. Result: in several narrow frequency bands, there is a rise in level by about 3 dB, and at 2.5 kHz it's even 5 dB. Unfortunately, the PTB does not measure the power fed to the bass, but merely operates the LDS-shaker from a constant voltage source. That is too bad: in 1978, the Type 8001 impedance head by B&K had been on the market for years – it would have been a hassle-free measurement. Still: there's more output – now officially confirmed.

Because of the extremely strong vibrations remove the tensions dwelling within the instrument, *"the wood now sounds as if it had been seasoned for a long time."* Whether the bridge has been slightly moved as the eccentric tappet was mounted, and whether the sound post within the instrument has shifted a bit – no, that is unfortunately not checked. But let us by all means insinuate that there are indeed changes of some kind in the wood. Five hundred enthusiastic musicians can't be wrong. Also, the errors that von Reumont made in terms of the physical magnitudes are not the end of the world: on a global scale they are more a petitesse (3 dB does not indicate doubling of the SPL, and energy is not current x voltage, and Watt is not the unit for energy, either).

However, **measurement accuracy** (or rater in-accuracy) occurring in his setup requires a close look. After all, we do learn in the basic course for instrumentation: if a result is given with three digits, the input quantities need to be similarly accurate. These input quantities are electrical voltage and current at the motor. *"The accuracy of the reading is 0.2 V for the voltage and 10 mA for the current. This is adequate for normal treatment."* The datasheet for a treated acoustic guitar shows voltages between 0,9 and 2,8 V, and currents between 480 and 1180 mA. Specifically: at 85 Hz the voltage decreases according to the measurement log (after 120 min) from 1,6 to 1,5 V; the current increases from 860 to 780 mA. Ergo: 14,5% power decrease, and thus 14.5% un-damping. However, unfortunately there is also a **measuring error range of 14.7%** – which puts things a bit into perspective. Von Reumont repeatedly notes that his instrumentation equipment is of hobbyist-grade. In itself a laudable approach: every well-versed hobbyist should be put in the position to assemble an un-damping setup. Even a source for the motors is given (*at volume less than 1 Deutschmark*), and the schematic for the power supply is included, as well. If the motor does not run smoothly, you reverse it, or give it a quick spin at high revs, if necessary.

The clutch is constituted by a valve rubber (no, that hopefully will not have a damping effect…), and if worse comes to worst, the motor is exchanged. And then you carry on measuring, don't you?

The data for the following graphs were taken from the tables published by von Reumont. For the guitar, we find a vibration-undamping of 5,1% at 10600 min^{-1} (= 177 Hz). However, given the established measurement tolerance, an un-damping of 24% could have been explained just as well, or … no effect at all.

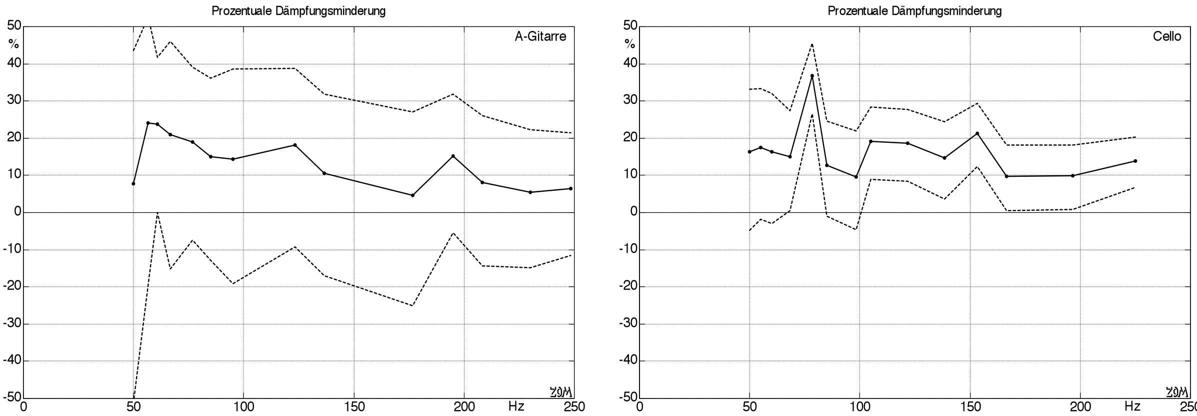

Fig. 7.151: Un-damping measured by von Reumont on an acoustic guitar (left) and a cello (right). Dashed line: corresponding maximum measurement tolerance established according to von Reumont.

As we enter the world of chance and coincidence, we of course also have to also concede that the biggest possible measurement error will not happen for every measurement. Indeed, for larger instruments and the corresponding higher motor voltages, the reading tolerances suddenly drop to the extent that a viable significance appears: yes, the power consumption does drop over time, for whatever reason. Weren't there actually not any more precise voltmeters available back then (around 1989)? There were, but on the digital display, *"the numbers were passing through so quickly that a readout could barely be taken, or even not at all."* That is because the motor shaft wobbles a bit, and the passing resistance of the carbon brushes is not time-invariant, either. And yes, here's another fact: the power consumption will also depend on the latter issue. And on the damping-losses of the bridge adapter made from small boards (with sticky velvet-foils). And on the foam material clamped below the strings. True: it is not easy to convince a skeptic. It seems it is easier to convince the upright-bass players, *"since they are rarely happy with their instruments."* And who knows, maybe the advertised un-damping process does work, after all♣.

For hollow-bodied instruments, that is – the wallings of which need to vibrate! Given that, why does Mr. Weiss include, in his reference list, Stratocasters vibrated by unbalanced electric motors? … Strats, the bodies of which are not supposed to vibrate at all (as noted by the wise Mr. Fender – and, for once, here he is correct). Only heaven knows … where, by the way, L.F. is assumed to reside according to popular belief. Santo subito – for believers. For astronomers, though: L.F.'s accommodation may be in the Leonids, rather.

Bottom line for the electric guitar: much noisy ado about nothing? Wrong: it will set you back € 770.-

♣ Once you've shelled out 770 Euro ...