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MORE ON "THE HUM"

Here is a follow-up in a previous Webnote: http://electronotes.netfirms.com/ENWN31.pdf

I once argued with a school friend that if I see the color red and he sees the color red, we don't really know if we see the same thing. He didn't buy it. But I wonder with the HUM if we are all talking about the same perception. Clearly, in some cases, NO. For example, "tinnitus" (high frequency) is clearly something fundamentally different (vast difference of pitch). And many people hear something that is apparent only temporarily, not chronic. Most often it seems to be described as virtually identical to an idling truck engine. That's how I first heard it and still do today (even as I write this!). I have recently recognized that a good approximation to the hum I hear can be achieved by plugging (lightly, but completely) the ears with your index fingers. (Almost certainly you have done this.) There is a "rumble" attributed to involuntary tremors of your muscles. I wonder if this "explains" the HUM! For me, it is VERY similar to the HUM, although, with the fingers, the spectral weight is slightly higher (although still very low) and does not seem to surge as much. Oh – and it works with just one finger, and the rumble can be increased in intensity by tightening the fist. The fact that you hear this with the ears blocked in the orthodox sense has considerable significance! In fact, you find this finger-induced-rumble discussed on the internet such as at:

https://www.quora.com/What-is-that-sound-we-hear-when-we-close-our-ears

In as much as I suspect the HUM is a common, spontaneous, somewhat variable, background rumbling of the auditory system, internal to the individual "hearer", I further suspect a lot of folks will be very disappointed if the phenomenon is that mundane rather than fantastic. How much better if it were a scan of a pending extraterrestrial alien invasion, a military spy scheme (spying on YOU specifically), or the rumblings of a hollow earth. If it's just the haphazard dithering search of nerves and muscles waiting for something better to report to the brain, then that's not very interesting. Surely "THEY" are hiding something.

There seem to be no actual properly documented audio recordings or scope displays (is this true?). (There are some artificial demos contending to be something similar in someone's opinion and experience.) Of the actual purported recordings: audio/video postings on the web, these are not convincing in my view (does anyone know of any they highly recommend). But this issue is complicated.

A particular problem comes up here: If you are in a position to evaluate an example, you need to be a "hearer" in order to make a comparison evaluation, and this confounds your listening. Specifically, if you are trying to hear an actual recorded example made by someone else, or even playing back your own attempted recording, you likely have a quiet listening environment to use. In such a case, you, as a "hearer", may be "making" a current version of the HUM on the spot, indistinguishable from what might have been recorded. If you are a "hearer" and you listen to a proposed recording and react "YES – there it is" you must pause the playback to see if the hum stops. It probably will continue. If you are not a "hearer" how would you adjudicate a recording? Very tricky.

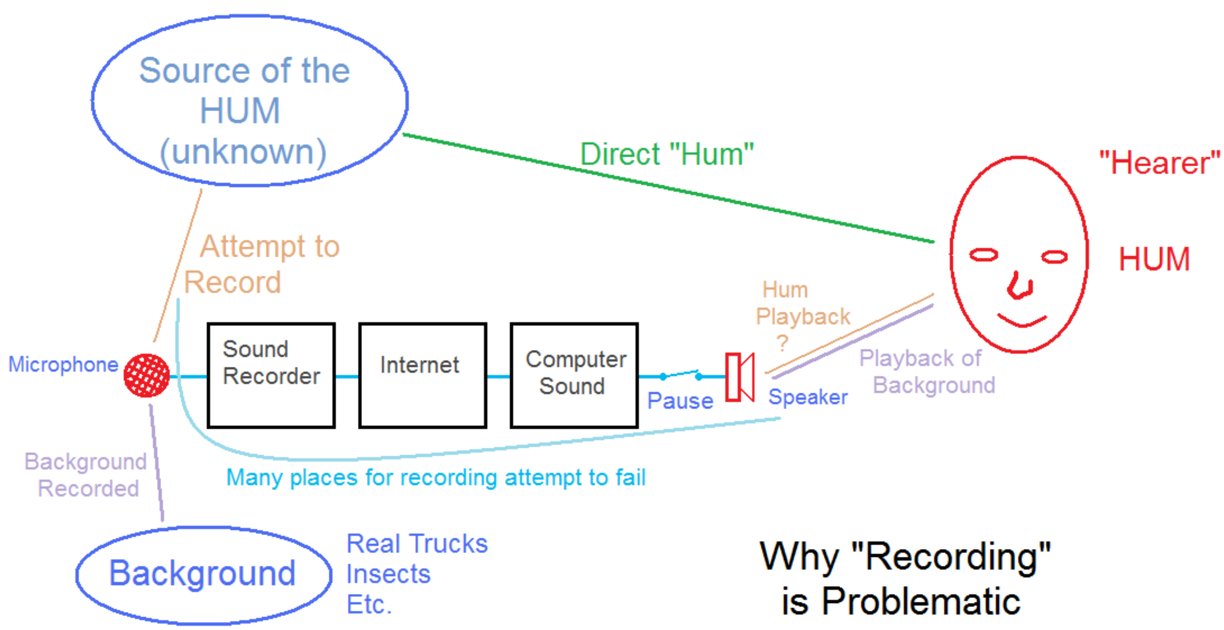

Fig. 1

The figure shows a typical attempt to hear a recording. Because we assume the listener is a "hearer" the green direct path must be considered to be there. The alternative lower path collects up a background, and the Hum, if this is possible, records it, sends it over the internet, and plays it through the computer speakers. Let's say the listener perceives a hum. Two things to consider. (1) Does the listener hear at least some background to assure that the playback is working. (2) when the pause switch is opened, does the hum component stop (tan path interrupted). If the hum continues, then it's the green path, obviously.

There are a multitude of ways the recording could fail (light blue path). The Hum may not exist as an acoustic (mechanical) phenomenon. The microphone may not have a low-enough frequency response. The sound recorder may be likewise inadequate (most cell phones would be found wanting). Further the internet sound format may not support the low frequencies, although, surprisingly, the computer speakers would probably serve well enough. This fact about the speakers can be determined by listening to some of the "synthesized" signals said to demo the general idea of the Hum.

Thus, audio recordings are not likely to be of much use. What would be of potential use would be a recording presented as an oscillogram: that is, a visual display of a time-domain waveform. Such a display is easily obtained with most modern oscilloscopes acting in a sampling mode. Note that for this to be credible, we would have to record directly to the scope from a suitable microphone and low-frequency-capable amplifier (easy), NOT from a standard audio recording. This is because we expect the standard audio recorder may well be inadequate.

Likely this absence of good audio recordings is because there is no audio signal in the air. This is not to say you can't find posted audio/visuals – just that there is nothing to "hear". Does anyone claim they have recorded and played back the same thing? No. People record while they fully believe they are hearing, assuming it would be picked up. [Not untypically people underestimate the difficulty of doing a proper audio recording, even of just speech or music. The human ear/brain has a fantastic ability to "concentrate" (including directional clues) on a particular sound source while microphones (or sound recorders) have no such processing.] Thus when the recording comes back, effectively silent (or insects, etc), the failure is ignored or blamed on recording difficulties (we just said it was hard). It is not audio in the sense of physical vibrations in air or some other medium, but possibly arrives in an end location in the brain that is accustomed to receiving audio.

The notion that it is RF driven is first ruled out by the fact that, as I have described, the individual can shut it down for a half second or so by moving or grunting. Why would this grunt shut off a RF transmitter in the Midwest (!) or even a local acoustic source? If you are shutting down a VLF submarine radio by snorting, register as a secret weapon!

One might argue that it is only the interruption (of RF or AF) that is created by the individual. That is, some signal is rattling the hearing mechanism beyond the eardrum, and the grunt temporarily silences it. Possibly so – but what would be the nature of the signal. I don't believe it is acoustic for the reasons stated above. If the source is RF, then what "transducer" (like in the inner ear) is responding to a feeble RF signal, and how?

The data on the geographic location of “hearers” is not what one would expect from a single source (RF or AF) or a small number of sources. Rather it looks like a population density map emphasizing areas where media is likely very active. If there were a point source, it would be very intense near the transmitter, and fall off as r^2 (or at least as r if the signal were somehow beamed close to the surface).

AN EXPERIMENT

I believe it was about 20 years ago that I did an experiment to see if I could display the Hum on a scope. I have just repeated this experiment as simply as possible. Fig. 2 shows the sophisticated apparatus! The “microphone” is a stereo speaker, the same as I used 20 years ago (apparently others did this too [1]). Because of the low

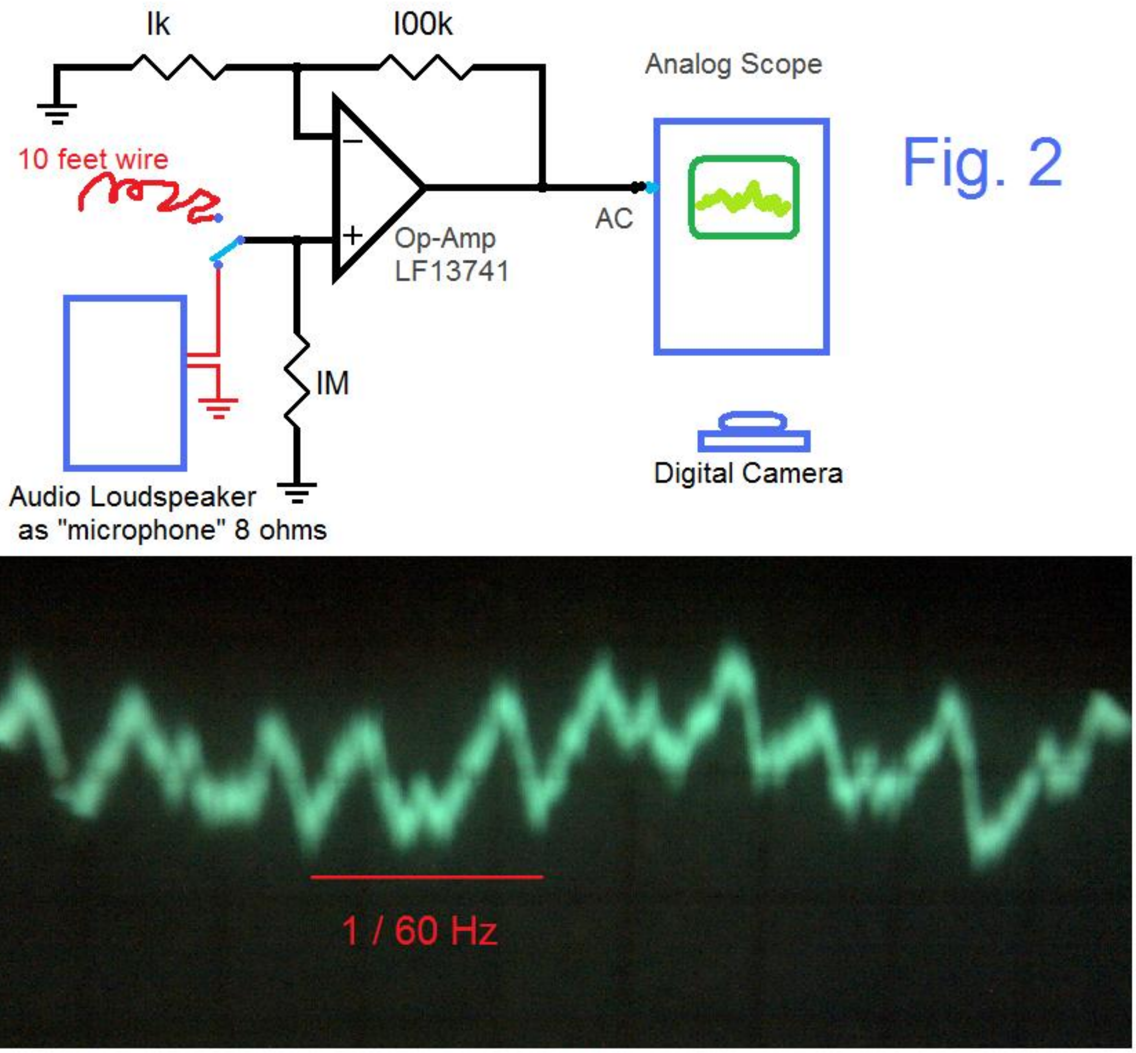

Fig. 2

frequency response desired, this was direct coupled to an op-amp non-inverting amplifier of gain 100 (101 to be technical: 1+ 100k/1k)).   The speaker was 8 ohms and essentially grounded the (+) input except for the voltage developed across the voice coil. The 1M resistor is in parallel with the 8 ohms and had no effect except as it provides a "DC path to ground" for the (+) input when the speaker is replaced by a length of wire (see below). The output of the op-amp goes to an ordinary analog scope, which was first DC coupled. But with the scope gain turned up, the DC offset at the output of the op-amp "pinned" the scope trace. Accordingly, the op-amp output was fed to the scope first with a 0.1 mfd series capacitor, and then using the build-in AC coupling feature, to similar effect. Instead of fighting with the storage scope, I just took some snapshots with a digital camera.

The bottom of Fig. 2 shows a typical trace.   It's mostly power lines - 60 Hz, with 2nd harmonic and a few more harmonics. The time of a 60 Hz cycle is shown in red. Notice the VW pattern. This obviously is from the power mains. In this particular example, there also appears to be something like a (smaller amplitude) 15 Hz component. This did not appear to be a consistent feature.   The power mains components are no surprise and will interfere with any analysis attempts of the smaller components. Any attempt to do a better job might well involve notching out the power line signals.   We would certainly have to notch out the 60 Hz and the 120 Hz as a minimum, and perhaps to comb out many harmonics [2].

As controls, we did try various audio signals such as clapping and footsteps just to be sure the microphone was working. It was. Also, a function generator into headphones placed near the speaker showed that the response as a microphone was well below 20 Hz. To prove that the AC power signal was coming from the voice coil, we switched out the speaker and left a 10 foot wire (strewn about) attached to the (+) input with the 1M in place. Roughly there was 100 times as much signal from the wire (no surprise). And it was pretty much a 60 Hz square wave. It seems fair to say that the signal as displayed came from the voice coil, not from the speaker wires. However, we can't claim immediately that it was audio driven – it might well have been at least in part magnetic pick-up by the speaker coil.

In order to determine if there is an audio (rather than magnetic) component to the signal from the speaker voice coil we might take measures to shield the speaker from the two possible sources, in turn. This sounds difficult – well – not easy. An alternative test that takes only 5 minutes is to use a substitute for the magnetic coil that is not microphonic.   In this case, I took a familiar 12.6 volt "filament transformer" and used just the primary as a pickup. Lots of signal – much larger than with the speaker. And it is pretty much 60 Hz and harmonics of 60 Hz.

So we see that the power line signal is a confounding factor.   If I get ambitious, I may try the notch filtering and the storage scope later.

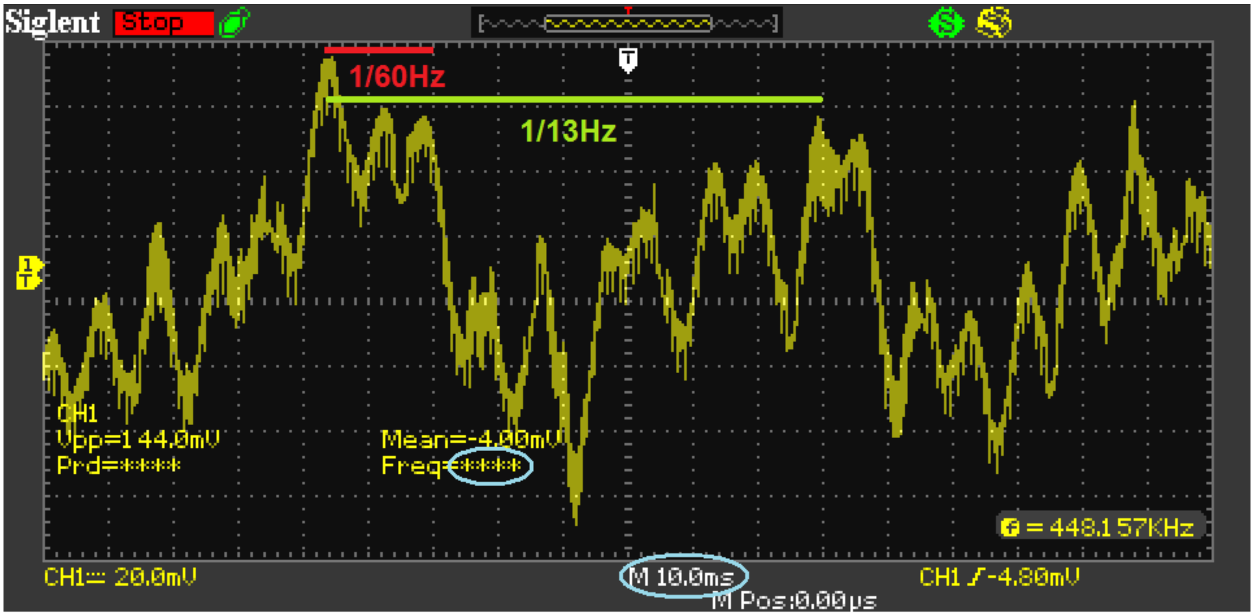

Fig. 3

Fig. 3 shows an example of a trace made and stored by the storage scope. In the sense that no single trace is going to be typical of a phenomenon so variable, this is just a second example. Indeed, we anticipate showing a representative set of examples. This one shows the power-line pickup, mostly as the 120 Hz second harmonic (red line). Along with this is a lower component of about 13 Hz (green line). Note (blue circles) that the time per division is 10 msec and that the scope is unable (****) to estimate a frequency.

What did I hear? NOTHING! Everything was intentionally as quiet as possible – ideal for "hearing" the Hum. Well, the Hum was present, and it went away (to my ear/brain) when I grunted as previously observed. Nothing changed on the scope when I grunted (of course – but I had to establish this for sure). The basement where my bench is was quiet (I had heaters and lights off and refrigerator was not running). Switching on/off lights did not change anything. I heard no acoustic power line buzz (such as one may faintly hear from a stereo system when the volume is all the way down). Computers were running, but not closer than 20 feet.

All and all, there was no evidence of an actual acoustic counterpart to the Hum. Whatever acoustic signal that may be there was below the audible range (being 10-20 Hz) and the Hum is clearly higher in pitch (although still very low). Mostly there was power line hum electrically present in the display apparatus. Nothing was seen on the scope that seemed to correspond to the Hum as "heard". We did note the highly variable, apparently acoustic component smaller than (perhaps by a factor of 3) and lower in frequency (perhaps by a factor of 3 to 4) relative to the power line component. While the power line component was very far from perfect periodicity, the secondary component was far more variable than even that. It is this secondary component that we might like to examine more closely.

Notches next?

REFERENCES

[1] Mullins, J. and J. Kelly, "The Mystery of the Taos Hum", ***Echoes*** (J. Acoust. Soc. Amer. newsletter), Vol. 5, No. 3, Autumn 1995. http://acousticalsociety.org/sites/default/files/docs/echoes/v5n3.pdf

[2] Hutchins, B. & W. Ku, "An Adapting Delay Comb Filter for the Restoration of Audio Signals Badly Corrupted with a Periodic Signal of Slowly Changing Frequency", ***J. Audio Eng. Soc.***, , Vol. 30, No. 1/2, (1982) January/February http://electronotes.netfirms.com/AES5.PDF