Repair report: Microphone of Sennheiser MD 441

Translation from German to English provided by David Every, Sydney, Australia in June 2018

INTRODUCTION

Many people know how to deploy an MD-441 on the stage or in the Studio. But obviously very few seem to know how to fix them. This may either be because the 441 is so resilient, that they almost never break down, or that they look so complex that nobody dares to try. Perhaps - it is all three. I have in any case, hardly been able to find any information on the Internet as to what exactly is inside the MD-441.

The microphone, which I now have on the bench, shows the following problem: when I carefully move the microphone back and forth - it makes a noise on the inside like a child's rattle. Surprisingly, you still get audio from the microphone if you speak into it.
The transducer itself seems at least to be in some kind of electrical order such that it makes sound. So, we have some hope.
Nevertheless, in this state you cannot use the 441 and it may be only a matter of time until even more harmful effects are caused by the parts tumbling around inside the case.
It is due for repair! (First and foremost, we need to say: the MD-441 will suffer a bit in the case of its "cosmetics", but the main thing is that the function is again working!)

Figure 1: Sennheiser MD-441 (Source: www.sennheiser.com)

2 Troubleshooting

You can find how exactly to open a MD-441, after much searching on the NET.
In my version (MD441-2) it goes as follows: with a pair of tweezers, carefully remove the metal plate, which sits directly below the bass switch in a plastic frame. Be careful – it is PLASTIC!. Removing the glued(!) shield of the plastic frame can break it immediately of course, but that's my smallest problem at the moment.
An M3 screw can be found under the metal plate. Unscrew it, then you can remove the black cover (including a part of the silver microphone basket) quite easily (push forward and then remove upwards). Now we can see inside and we are amazed!
The interior consists of two cylindrical metal drums between two vibrating elements, These are floating and can rock back and forth in the longitudinal axis.

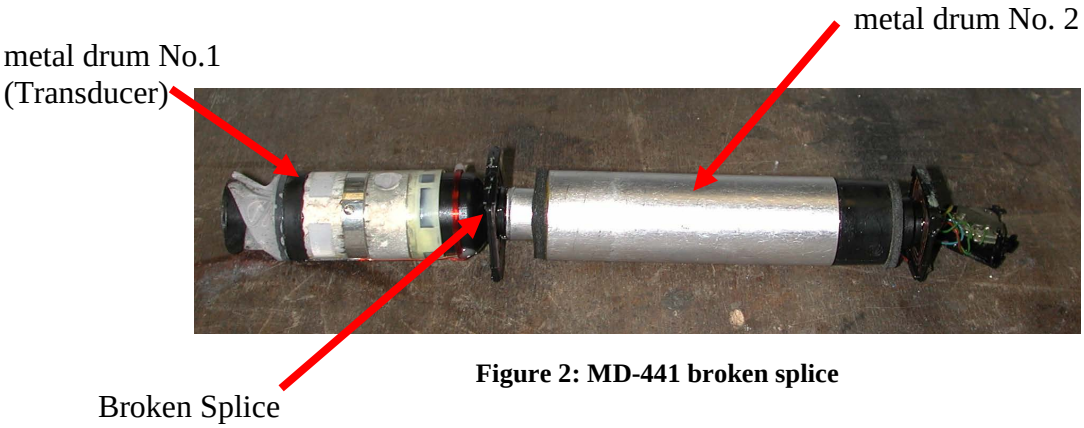

Figure 2: MD-441 broken splice

The bonding is torn in the middle (at the junction of the two 'metal drums')
and so is metal drum No. 1 (= the transducer) is simply dropped off and rumbles around in the speech input basket.

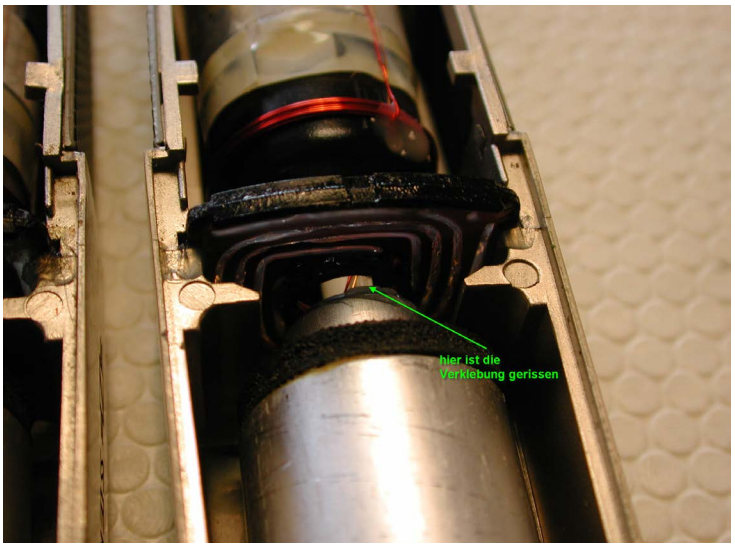

Figure 3: Bonding Torn

Unfortunately, the acoustic foam is inside the cone of the microphone capsule,
which is probably also already somewhat old and is constantly beaten against the body and thus was compressed down to a bunch of sticky mass.

d
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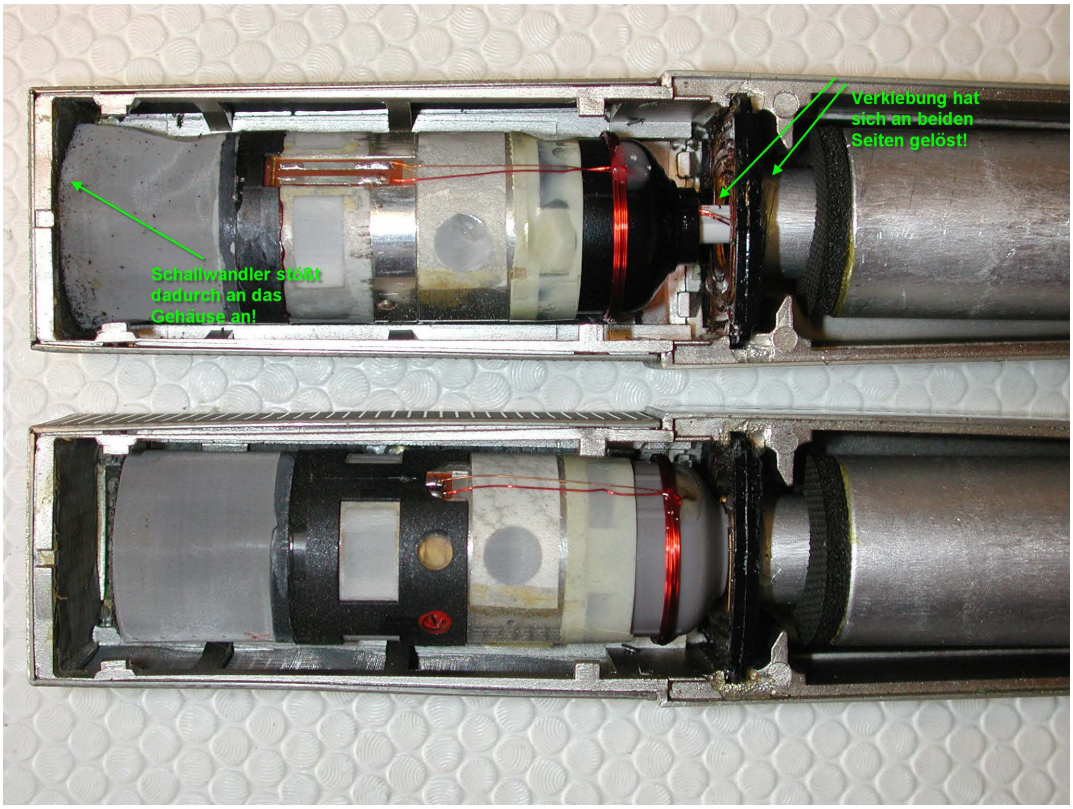

f
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Figure 4: top: MD441 defective; bottom: MD441 fixed

Here it can be helped only by scratching out this mass and trying to replace it with new acoustic foam as a replacement.

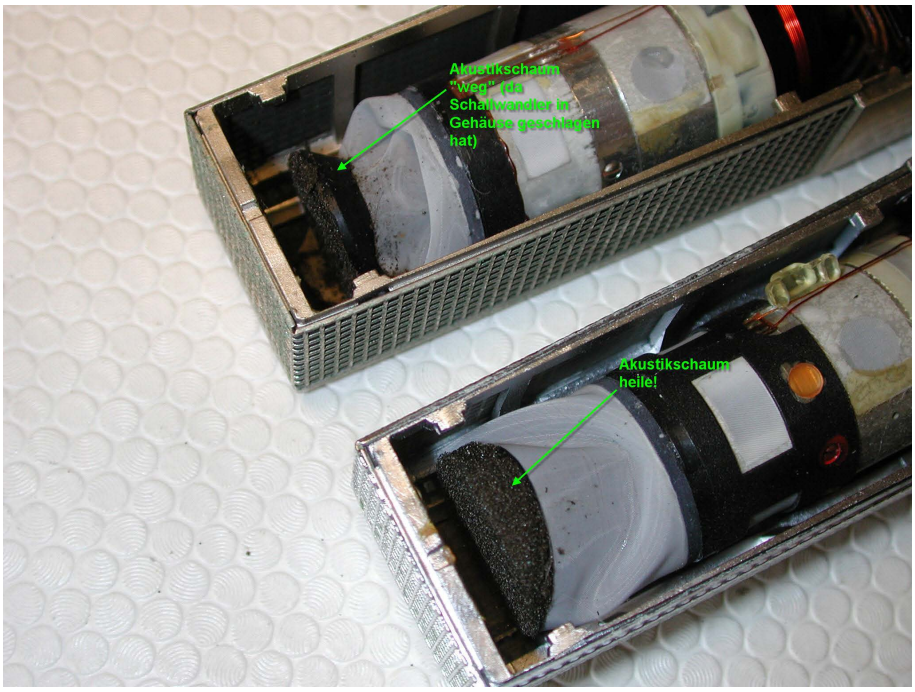

Figure 5: top: compressed acoustic foam. bottom: fixed

My guess is that the foam is an integrated pop and wind protection with no other sound influencing properties. If this is true, then any other windscreen foam should do the job, you can buy another foam type for the microphone and can use the scissors to get it into the right shape.
But this is for later - the broken bond is the bigger issue.

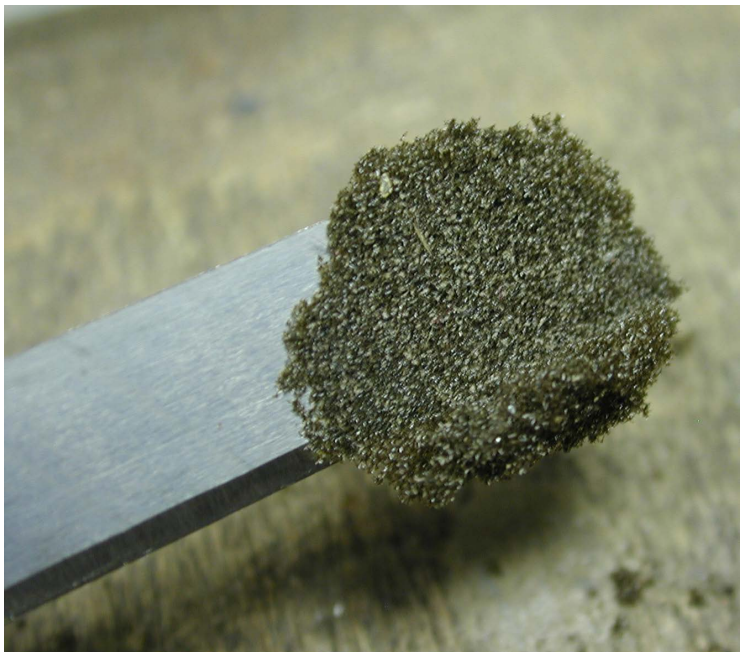

Figure 6: sticky remnants of acoustic foam on a carpet knife

3 Adhesive Attempt No.1

Of course, I want to first try to mend the bond. To do this, I pull out the complete interior upwards (the two vibrating elements together). The microphone body is only loosely connected, I remove it and put it on the bench. The original fixing seems to be a kind of silicone adhesive, so I opt for repair for silicone rubber from the tube (ELASTOSIL).

Figure 7: Inner workings (cone is on the left)

With a joint vice I vertically align the whole set of parts and pour

the glued surface generously with silicone rubber.

Figure 8: gently clamped in the vice

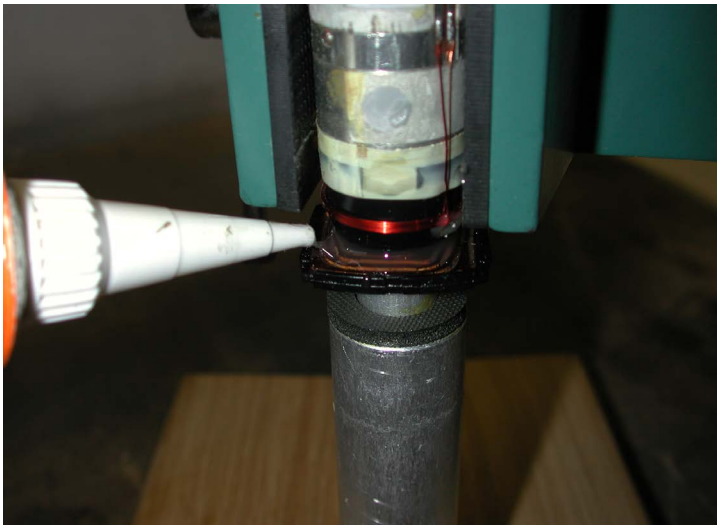

Figure 9: silicone rubber (ELASTOSIL)

A day later there is a whole new crappy experience for me when removing it from the holder again, as I discover that the silicone particles from the vibrating element have discolored a strange pink color (although the used rubber is actually colorless). I suspect strongly that a chemical reaction with the original adhesives of manufacturer's must have taken place. It's maybe also a certain explanation that the joint has not set properly. It is therefore clear: If I want the repair to be successful, I must take out the vibrating element and completely clean it (E.g. in the ultrasonic bath).

4 Sennheiser Service

This is unfortunately not so easy. I do not know about the inner structure of metal drum **No. 2**, and the actual concept of its design inside the MD-441. All I know is that such a high-quality microphone (some say that the MD-441 is "the best dynamic microphone in the world") has complex and delicate sound tubules and tubes inside, to invoke certain acoustic properties. Plucking it apart could destroy what is essentially Sennheiser’s masterminded and painstaking considerations.

I need help, no question. So I decide to try the Sennheiser Service. Through one can read much positive information on the Internet and there is often much truth reported on it. And I must say: Sennheiser features here completely as one of a series of professional manufacturers, one of many that I have had excellent experiences with in the past; such as Rohde & Schwarz or Brüel & Kjær. I hope at some point anyone who reads this praise can forward this compliment to the correct people inside Sennheiser's organisation**.**

After only a single telephone call, a friendly man greets me who seems to come from the development section of Sennheiser. In any case, he knows the microphone very well, and sends me technical data more or less "out of the gun" and "suffers" in unison with me, that the complete "new renovation" (replacement) of my MD-441 with new parts simply for cost reasons is for me totally out of the question. Nevertheless, he helps me: I know that inside of ' metal drum Nr. 2 there is a small circuit board with electronics sitting on it and the bass cut switch is in reality a treble switch. Unfortunately, I know too, that the inner workings are available only as a complete spare part, but individually would cost more than twice as much on eBay than a used (Resurrected) MD-441. What a pity!

And here would I appreciate those who give themselves praise, with a suggestion along the way: spare parts such as E.g. the acoustic foam, the acoustic converter, or even the PCB inside, could be offered as a single replacement part, because with some skill you can replace some of these parts. And all parts that can be changed, should be offered as spare parts. In a car, normally it's the same: If the water pump is broken, I order a water pump only - and not a complete replacement engine.

5 Adhesive Attempt No. 2

The bad news put me off so strongly that I put the MD 441 away as spare parts store in the closet. But it was not long before the allure of the new discovery finally saw me soon with a pipe wrench and a vice set up in the basement and I plucked the plastic cap back out from metal drum No. 2.

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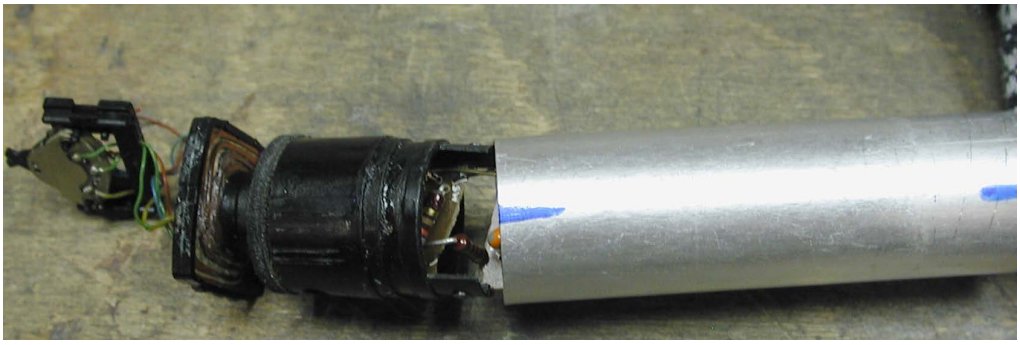


Figure 10: No. 2 cap by metal drum removed
(Blue strokes with felt-tip pen to mark the correct installation location.)

6 ELECTRONICS

I was promptly greeted with a broken circuit board inside the metal drum No. 2; the other half was caught in the just-removed cap. I twiddled both parts out and eyed the damage. The circuit board is a passive crossover; 1 layer PCB with normal wired components fitted. So, basically it should be possible to repair with some home remedies only.

Figure 11: Cap is off - but the resistor also ;-)

I then fished out a cotton ball from metal drum No. 2, as well as a metal sleeve, which I later will identify as extra shielding... By the way: we will fix this PCB now!

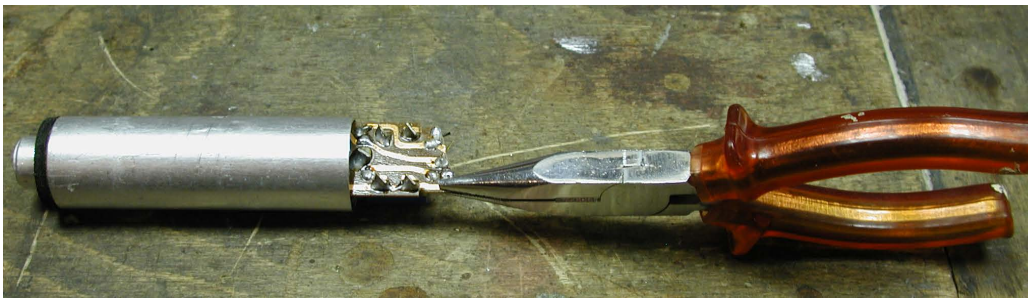


Figure 12: Pull out the remnants of the electronics

Figure 13: Items from metal drum No 2

Oh yes, we are of course pursued by an independent auditor (of just a few weeks in his new job at our works) always very interested in all my repair steps...

Figure 14: an independent auditor at work...

So I touched it with a dollop of 5-minute epoxy, and put both parts together again

and spoiled a big mouthful of the adhesive from the top around the breaking point of the PCB. The next day, I patched the broken tracks/traces on the bottom side of the PCB, and drowned it again in 2-component epoxy resin in a lake. On the third day, after the PCB was patched, a subsequent frequency response measurement is on the agenda.
Before I assemble everything again, I must be sure that everything works!

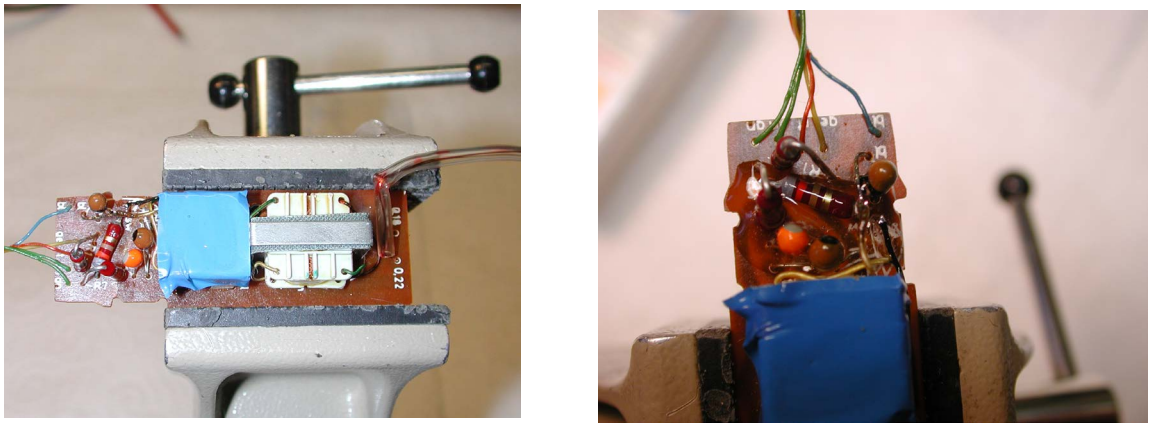


Figure 15: electronic board glued with epoxy resin

To check, I'm using a lab test software called “LabView”. It’s a specially written control program that takes a Rohde & Schwarz UPA Audioanalyzer, frequency range from 20 Hz to 20 kHz, and gives me the plot on the screen. This is how it looks:

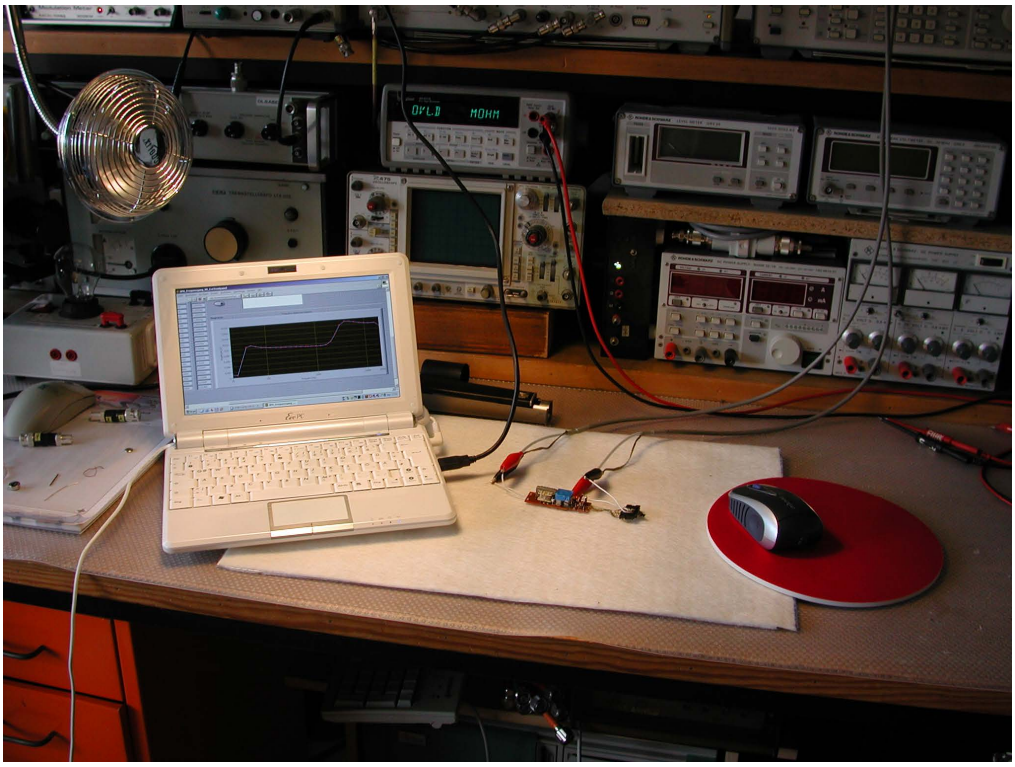


Figure 16: frequency response measurement with LabView

6.1 Frequency response in “flat” position

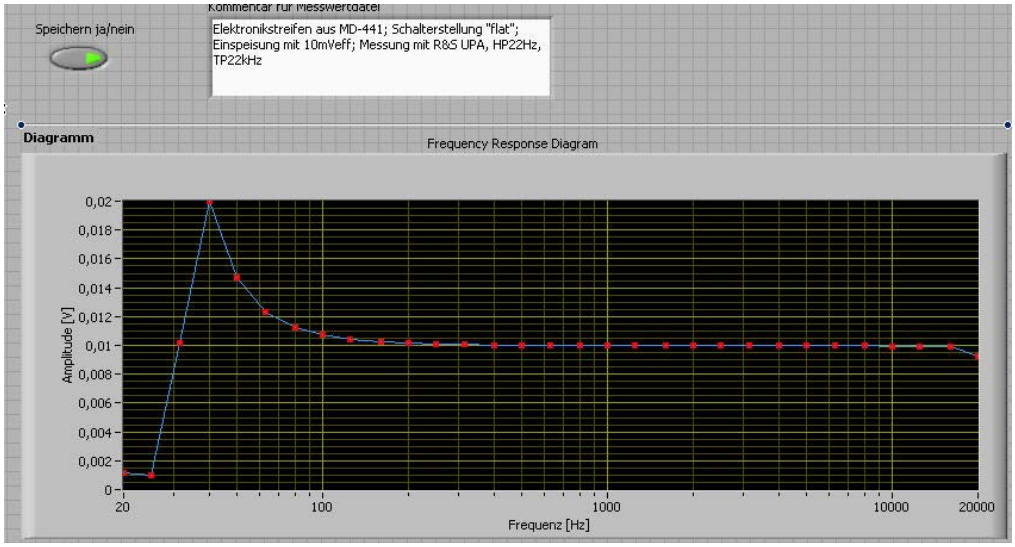


Figure 17: "flat" position frequency response

Ha! Sennheiser adds an increase in the bass range at around 40 Hz! Right there, where a Bass (Kick) Drum typically has its "oomph" (some do not know for sure, the "Kick" itself however is about 4-5kHz!) and where the most PA systems normally have their lowest cutoff frequency. Smart, smart!

6.2 Frequency response in "HP" position

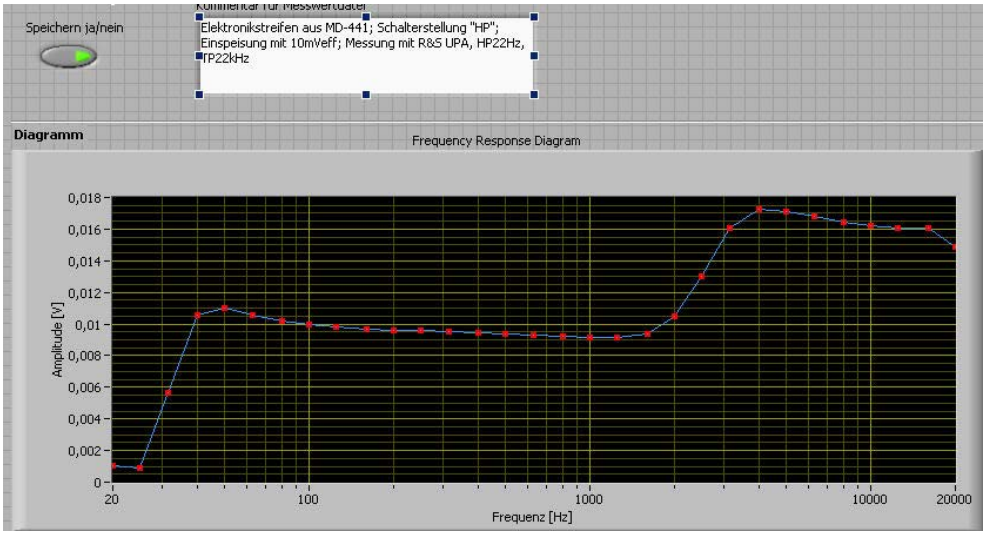


Figure 18: frequency response in "HP" position

This setting is clearly intended to be for Vocals**!** From 2 kHz it is strongly increased (approx. 6 dB).
This increases the presence of a voice or vocals. By the way: Conversion into dB I have not programmed yet (I'm still a programming novice, I ask your pardon). All voltages are specified in "Volts" here.

7 CLEANING

If you want to take advantage of the opportunity and just completely clean the MD-441, then you can do so very nicely in the dismantled condition. The entire speech input basket (the "lattice visible from the outside") can be removed in chunks.

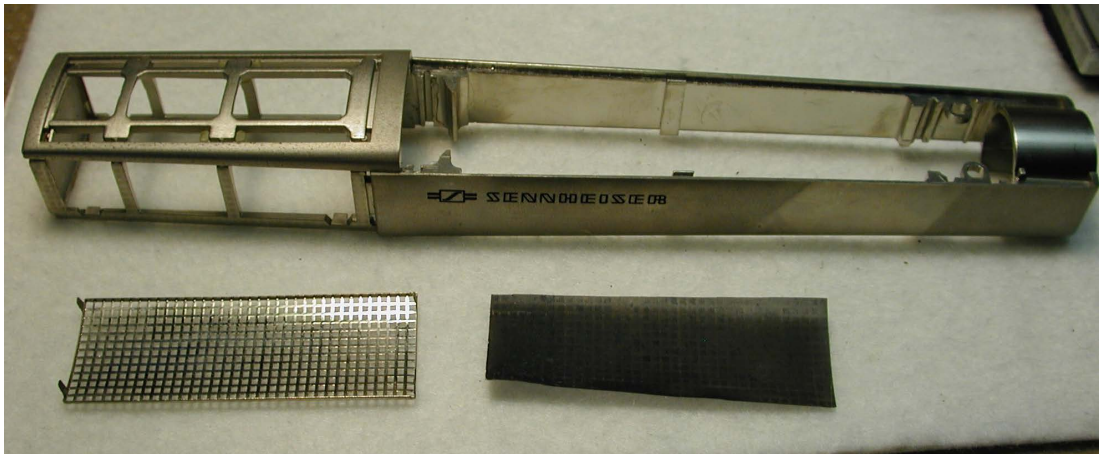


Figure 19: MD-441 frame and speech input basket with metal gauze

Just inside, the bent lugs can be bent up. Then the metal grille including the underneath dark strip of the filter can be removed. The tinsel seems to exist probably as a very fine metal mesh (gauze), another type of wind or pop shield. We can now ensure that the the metal gauze can be cleaned but make sure not to overbend it or make dents inside! I have cleaned as follows:
1. A dip in an ultrasonic bath (20 min, 60 ° C)
2. cotton swab with Kontakt60 (cleaning spray, provided by manufacturer "Kontakt Chemie")
3. liquid detergent with toothbrush

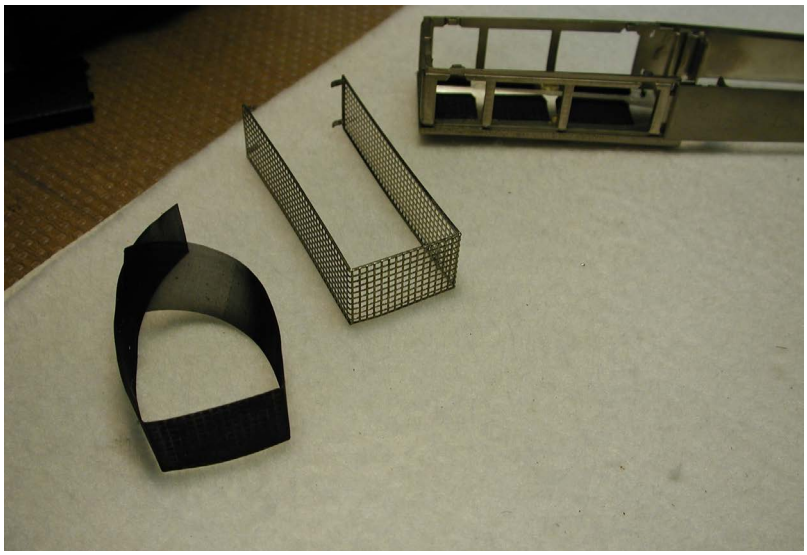


Figure 20: removed speech input basket

After that, the parts looked pretty clean. Also, if there are any bumps, then probably a drummer had used his sticks to beat these accidentally into the speech input basket, and these I could push out successfully again. After drying you can put back the parts and the lugs for the attachment to be bent back. I don't know how many times the retaining lugs can stand up to the back and forth bending process, so best not to do it too often and cause stress or breakage!
Note: Despite this intensive treatment I was not able to remove that shadow grid, as it has developed over the years in the metal gauze. So do not despair if it should also remain with you. I've decided that a shadow like that, which can even survive an ultrasound bath will not be able to be removed with home remedies. I wanted to avoid the use of harsh chemicals - don't try it; as doing so can quickly cause more damage than any benefits. Because the shadow grid is an imprint of the microphone speech input basket and will be - with reassembly – in exactly in the same position as before, and it will again align with the grid of the speech input basket - and this will be invisible afterwards.
You can also clean the microphone body with the synthetic leather shell in the ultrasonic bath as well. A subsequent drying in the sun gets the old MD-441 looking very good. I would avoid only the sharp cleaning agents, so that the synthetic leather shell does not suffer. A gentle detergent (maybe with a splash of vinegar or alcohol) is ok.
Those cleaning additives often provided good services for me and never caused big trouble.

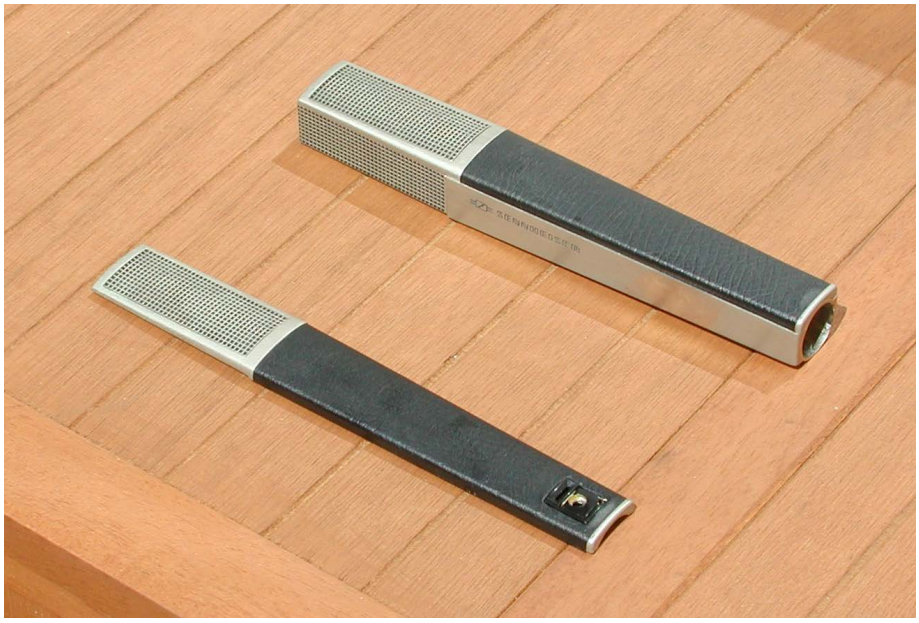


Figure 21: body parts in the sun drying

8 ASSEMBLY

We have now repaired the tracks on the PCB and electrically measured and verified the electronics, cleaned the microphone basket and the microphone housing, and meticulously cleaned the dampers, and again also extended the cut copper enamel wires of the electroacoustic transducer.
Now we go to the assembly of the microphone.

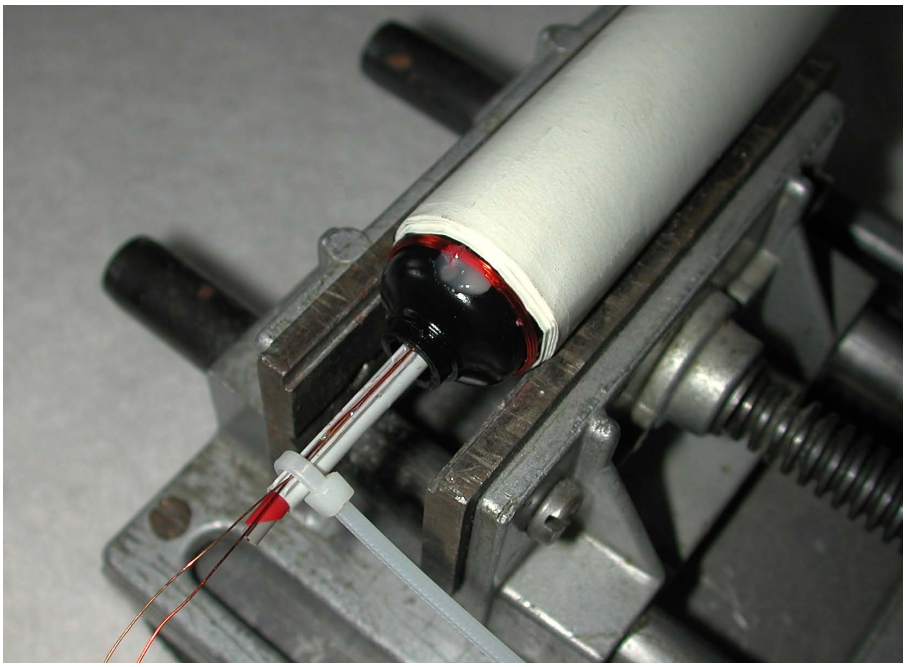


Figure 22: extended enameled copper wire connections of the microphone capsule and glued into the channel

In a preliminary trial, I have determined that my originally used silicone rubber
on the plastic surface of the microphone capsule is not reliable. A second experiment with 2-component adhesive (5-minute epoxy, available E.g. at Conrad Electronics, Hirschau in Germany www.conrad.de) looked much more promising! I'll therefore recommend the use of 5 Minute epoxy adhesive.

Figure 23: used glue "5-minute epoxy"

I have a thick sheet of paper as protection to prevent damage to the transducer - wrap the drum with multiple layers and place it gently in a vice.

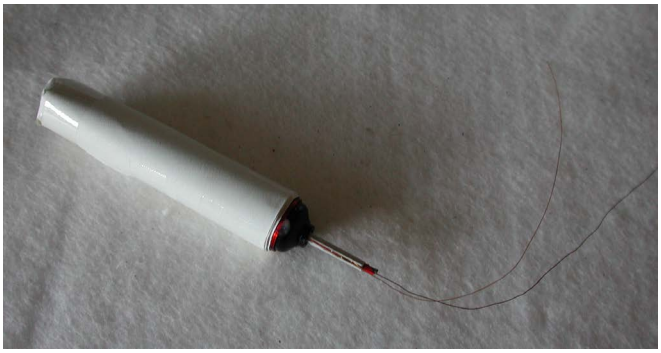


Figure 24: microphone capsule with extended wires and paper rolled up

Figure 25: microphone capsule "rolled out"

The 5-minute epoxy is mixed, and I dropped a few drops of it on the ring around the joint (be careful - not into the air gap!). The vibrating element is now also somewhat lubricated and then put from above on the bond. Very important: there is only one position, with which everything fits together again after the microphone body, so first try it carefully, move it around and find in which position the vibrating element on the capsule must be stuck! Just try the vibrating element in different positions to insert items in the slots, then you know what I'm talking about.

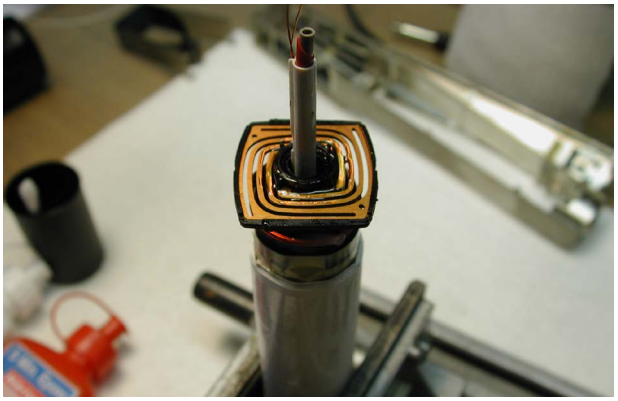
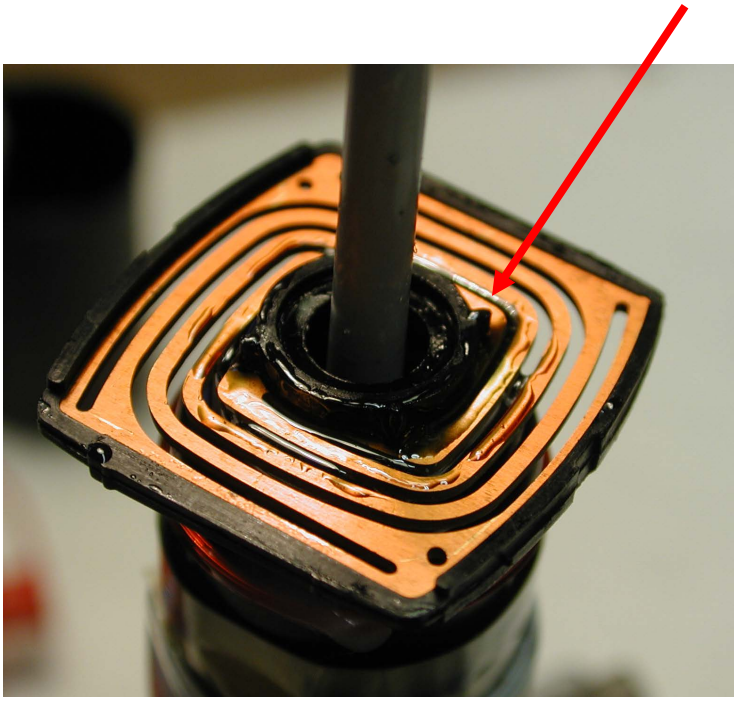


Figure 26: vibrating element attached to the transducer

I glue the small, delicate plastic ring from the top after this step also.

Same applies here also - only in one position can it fit correctly, so first try it before you glue it. The small plastic lugs must include the holes in the vibrating element!



Close-up of the adhesive joint

Then I thought it was a good idea to pour out the springs of the vibrating element with silicone rubber (something like what the Sennheiser factory has made, too). Unfortunately, this introduced an increased stiffness, so that the vibrating element was hardly able to move any more. So I had to scrape back out my silicone. Without it, it moves significantly easier, if not quite as light as the other vibrating element (that is still in the original state). Reason: probably I accidently got some 5-minute epoxy into the Micro capsule and vibrating element. This then ran into the first "threads" of the spring and she stuck together. Thus, the free swinging length of the spring was shortened - resulting in an increased (unwanted) stiffness.

too much glue runs into the spiral spring

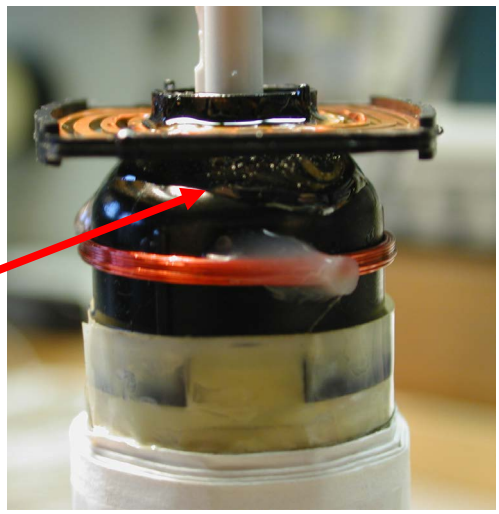


Figure 28: adhesive joint (side view)

Well, I'm going to use maybe a little less adhesive in my next MD-441-project repair. Maybe I will have a small performance loss with this microphone now in regard to

to separation of structure-borne sound. Nevertheless, this is still better than being too greedy with the adhesive, causing all the stuff to fall apart again sometime in the future.
Always remember: before, the microphone was fixed, it was only a spare parts store!

As a precaution, I will check the correct function of the electroacoustic transducer before final assembly. Its cone has a diameter of slightly less than 1 inch so I dug my Sound Calibrator off the shelf and generate a precisely defined 94dB(A) signal with sound pressure level at f = 1 kHz.

Figure 29: Sound calibrator with 94dB(A) on the microphone capsule

At the exit of the electroacoustic transducer (measured using high impedance) I can read about a good 500µV. That's probably fine for a MD-441, because two other MD-441 showed similar values. By the way: if I put the 94dB directly into the microphone speech input basket of a correctly assembled MD-441, I measure something between 200µV and 300µV. Conclusion: Reading is at least plausible; the transducer seems to be still ok. Thus we now dare to move to the Final Assembly.

Figure 30: output voltage of the electroacoustic transducer with 94dB(A) into the speech input basket

The next step is to then glue together the metal drum No 2**.** To do so, the PCB must first be plugged into the black end and and then clipped into drum no.2

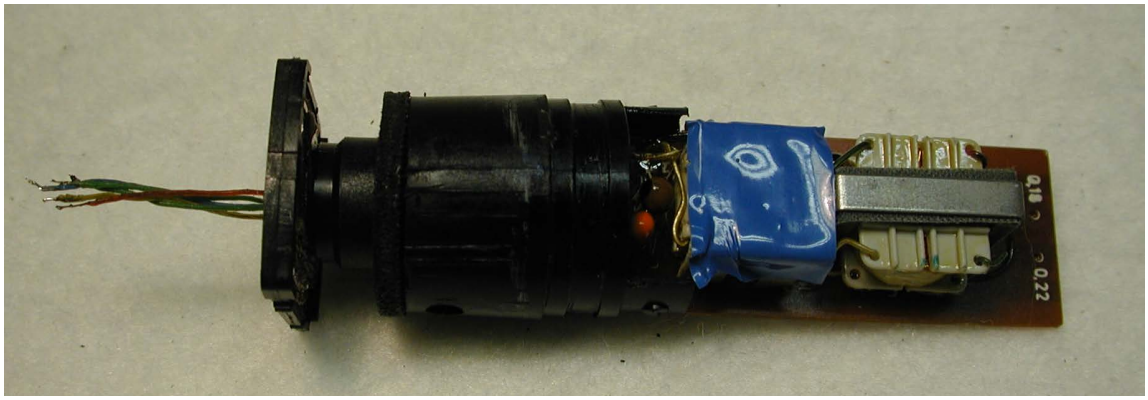


Figure 31: Plugged in electronics in plastic cap

Then we plug in the shielding sleeve front. Having done this, the assembly will then be put into the metal drum No.2 as complete unit.

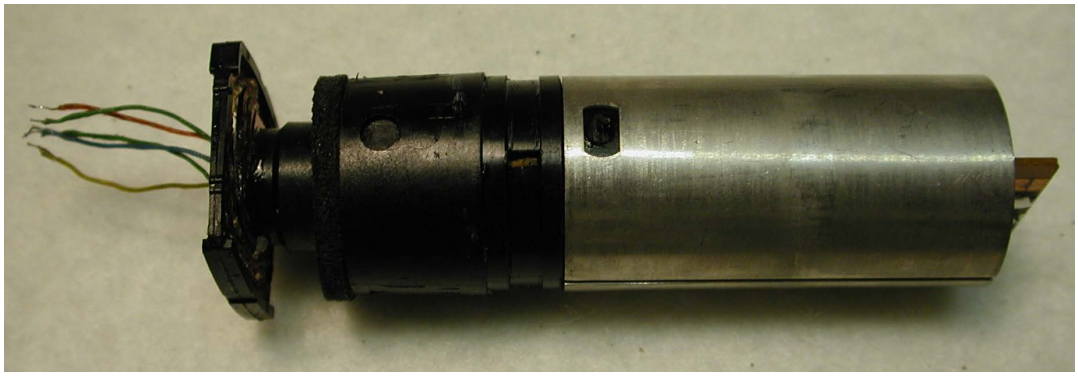


Figure 32: shielding sleeve pushed up

Of course, first solder the copper wires of the microphone capsule and the neat cotton metal drum No 2 parts. Before moving it, make sure that the vibrating element at the end of the cap has the correct orientation to the housing! (if necessary turn it until it aligns correctly with the first vibrating element).

Figure 33: Metal drum No 1 and No 2 aligned properly to each other

Now, insert this pre-assembled assembly vertically into the microphone housing. At least during this step, you will notice, if you have assembled and glued the vibrating elements in the correct orientation: otherwise, they will not fit in the guides!

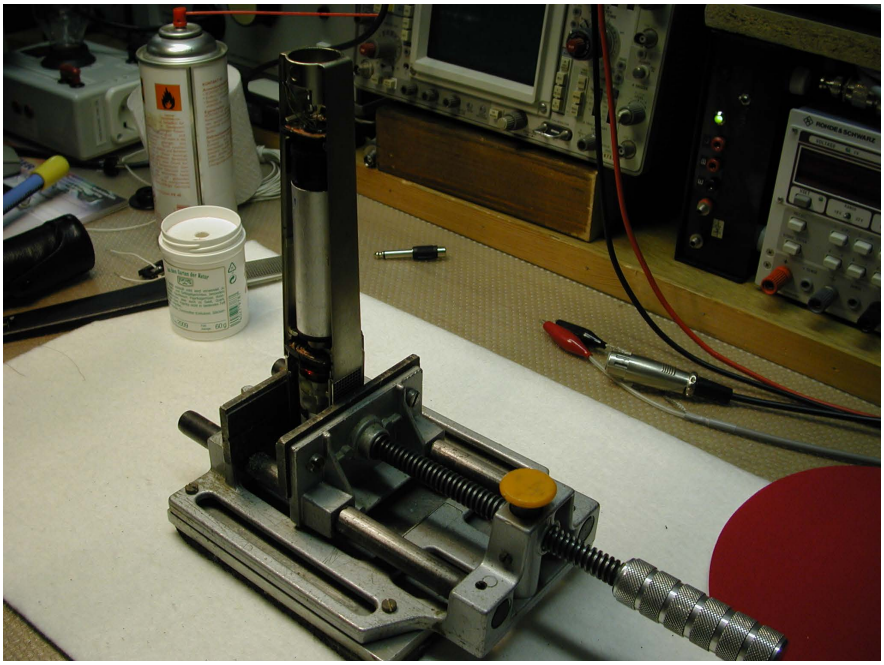


Figure 34: MD 441 vertically in a vice

I place the prepared microphone vertically in a vice (not tightly, but it only very loosely to secure against tipping!) and make sure that the inner parts of the microphone (transducer incl. metal drum No 2) can nowhere scrape or damage the internals and can swing freely without any interference. If all is good, then we again use the 5-minute epoxy and dribble it on the still unglued side of the vibration element. The next day I – again - draw the complete unit out of the housing and put some more adhesive on to the places I could not reach before assembling in the housing. The result: the unit again holds together and can be used in the microphone housing.

9 ACOUSTIC FOAM

We now recall that the integrated acoustic foam of the pop-shield had deteriorated.
Looking for a suitable replacement acoustic foam I discovered an old lavalier microphone in one of my parts boxes. It was a cheap plastic thing and was also not much good, but it had a plugged-on pop shield with exactly the correct diameter.

Figure 35: Pop shield of a lavalier microphone

By simple trimming to the right length with a craft knife I could create a usable spare part.

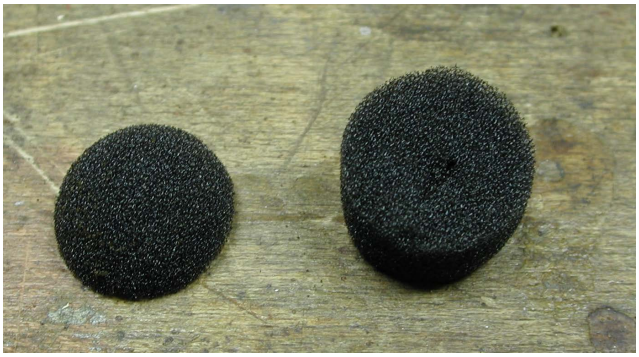


Figure 36: Pop shield cut with knife in two parts

I then placed the microphone unit vertically and look into the naked cone. The crumbled foam unfortunately left ugly, sticky crumbs. Without a shower in the bathroom sink, it will be difficult to remove.

Figure 37: cone with foam remains on the edge

I can say I will definitely not go for this kind of wet cleaning for such a sensitive transducer. I therefore prefer to reduce my cleaning to the use if forceps or a vacuum cleaner set on lowest level with a special “frontend” which is like a mini hosepipe with only 1cm diameter, to remove (only) the crumbs that lie directly in the cone. All other crumbs in the environment I will stick with, because the risk is too great that, through the clean-up, we may cause the microphone capsule harm.

Recently, I also have disassembled an old MD 412 that I gave up on trying to fix its electroacoustic transducer. The wires of the voice coil are so fine that a microscope is needed to view them! - even when soldering with a 330 °C reduced SMD soldering iron, they melt away within a few seconds. So, you can easily damage them, and once done, it is then almost impossible to repair! I suggest then that you'd better leave your fingers out of it and live with the crumbs. They affect only the visual look of the microphone, and there is a very high probability that no sound loss will result.

Since I don't know how my 5-minute epoxy responds to foam, I use my silicone rubber ELASTOSIL. Also, I am quite aware that the adhesion to the present plastic is lower than with the epoxy: the acoustic foam is light as a feather, the bond is not as strong as it claims. For this, I think the need of flexibility is far more important. So, I put on the edge a thin bead of silicone rubber and put the acoustic foam hemisphere in the funnel. Very gently, allow to harden then leave it alone for a while to set.

At the end, I pull up the white “Bride’s Curtain” again. Finished! Almost perfect, isn’t it?

Marc Michalzik

Translation from German to English provided by David Every, Sydney, Australia in June 2018. Thank you for that, Dave!

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