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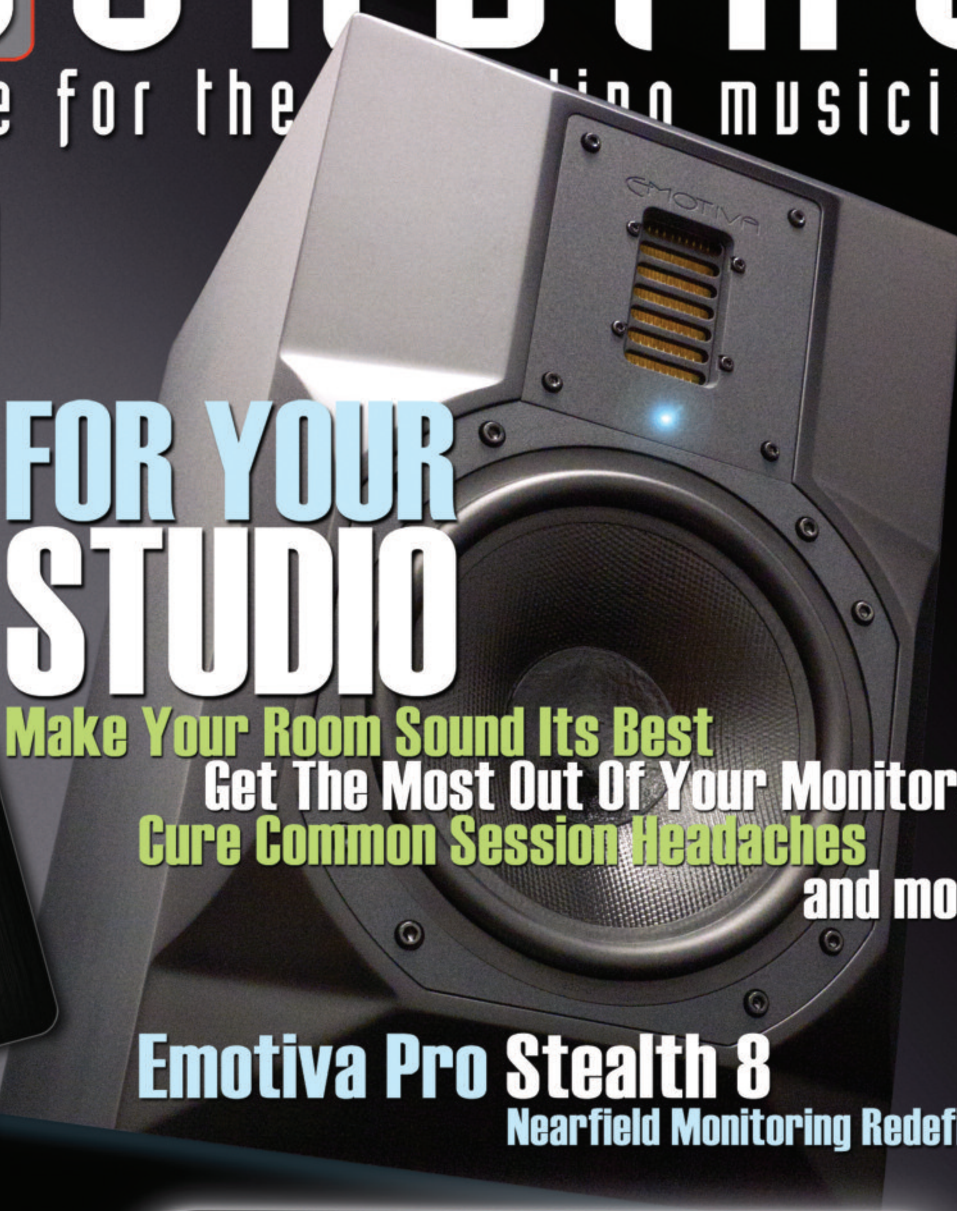

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STOP SOUND LEAKAGE!

Simple tips for beginners on stopping the scourge of the home studio • By Bruce Black

So you've been put on notice—the sound from your studio or music room is bothering others and you've been told it has to stop. It could be family members, it could be neighbors, it could be the local gendarmerie doing the talking, but the message is clear and noncompliance is not an option.

But what if you make your living with sound? Talk about being stuck between a rock and a hard place! You can't shut down, but you have to fix the problems. The good news is that there are things you *can* do to reduce or eliminate sound leakage and improve the acoustic isolation of your room, and many of those fixes are simple and easy to do. A little bit of home improvement skill will go a long way here. (And by the way, these remediations can also be applied to a home theater.)

How sound gets from here to there

The first step in conquering this problem is to understand how sound leaks out. There are three paths that sound can use to migrate to places where it is not welcome.

First and foremost is *airborne leakage,* where sound energy in the air leaks through openings. Because sound is created by small changes in air pressure, even the smallest opening will leak—any opening in your room is a place for sound to get out! And it doesn't take much of an opening to let a lot of sound out. This means doors, windows, gaps in the wall, holes for electrical outlets and switches, openings from age-related changes in a building—these all leak sound. They are referred to as "penetrations" in the acoustics industry.

But sound can also leak from your room through its *physical structure*. With the second path, sound strikes a wall, imparting some of its energy to the surface panel. This makes it vibrate. This energy is then transferred through the structure of the wall framing to the panel on the other side, which then vibrates. This happens through something you may have heard of in a school science class—the Newtonian laws of physics, for conservation of momentum and energy in a mechanical system.

You've probably seen these laws of physics at work in a popular executive toy called "balance balls", known more formally as "Newton's Cradle" (see Figure 1). Five or six metal balls are suspended in a cradle, then the ball at one end (call it Ball 1) is lifted and released, striking Ball 2. Balls 2, 3, 4, and 5 don't move, but ball 6 flies up and out. Even though no motion is seen in the middle balls, the kinetic energy still transfers to the sixth ball, where, unfettered, the energy is released as motion. (Visit http://en.wikipedia.org/wiki/Newton%27s_cradle to learn more.) This is how sound travels through a wall's structure. Things may not be moving, but they're still transferring energy, in sufficient amounts to be significant.

The third path is for sound from a source to travel by means of *direct contact* with the room's structure. This is what happens when a speaker or subwoofer is sitting on the floor, or on a shelf that is attached to a wall. Some of the speaker's vibration energy transfers directly into the floor or wall, and, again, is carried throughout the structure using conservation of momentum and energy. This direct contact is *very* efficient.... and once the sound energy is in the structure, it can travel great distances with very little attenuation and reappear where you least expect it.

This is particularly true of low frequencies. Since they require more power to play at a particular perceived level, they pack more wallop. This explains why sound leakage is often heard as thumps and rumbles, making woofers and subs the biggest sound leakage offenders.

So where should we start this quest to reduce the sound making its way out of our studio?

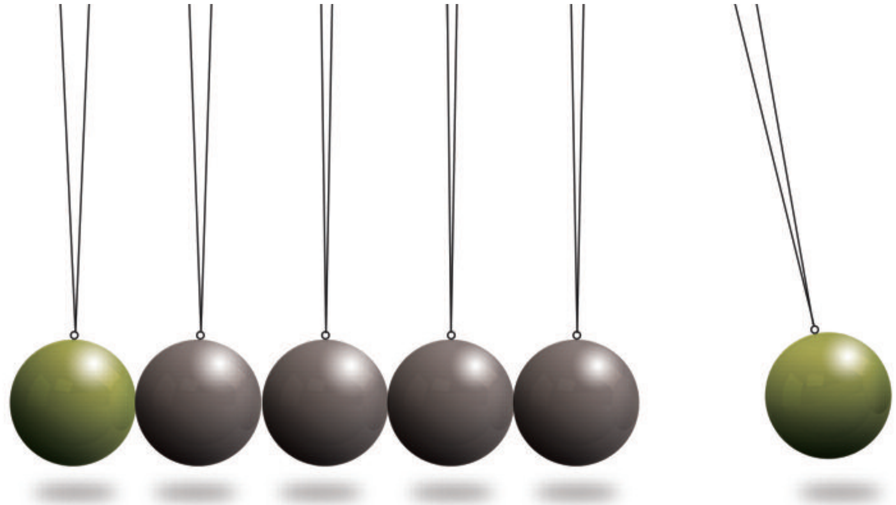

Figure 1. Newton's Cradle. The balls in the middle don't move, but the ball on one end transfers energy through them to make the ball on the other end fly upward. This is how sound is transmitted through solid objects, like walls and doors.

Take the test

Before you start in on this project you should purchase a Sound Pressure Level (SPL) meter. You can find them online from around $20 on up, but remember that the better the meter, the more repeatable and accurate the results. Radio Shack makes an inexpensive one that is popular. There are also SPL apps for iOS and Android devices using smartphone mics, but their accuracy is sometimes questionable—get real hardware!

Play some low-frequency-heavy material at a level that you know will bother the complainers (be nice and warn them beforehand). Make sure you write down what source material you play, what level you play it at, and where you take your measurements so you can accurately replicate your test later.

Take a bunch of SPL readings at various positions outside your room, using C weighting and slow response on the meter, writing down the reading along with the locations. The closer you can take the reading to a complainer's location, the better.

Once you've done the work to improve your sound leakage problems, you can duplicate this test and see what improvement you've made. Remember to write down *everything* you do in the first test so you can accurately repeat your actions in the second test. And because there is great variation in the response of SPL meters, even between ones of the same model, be sure to use the same meter each time to take a measurement.

Start at the bottom

The biggest culprits in sound leakage problems are the low frequencies, so we'll start with them.

Low frequencies have the most power behind them, and so travel the greatest distances. Once low frequencies get into a structure, it is pretty much impossible to get rid of them. Isolating them by breaking the physical connection is the most important thing you can do to stop sound leakage.

So the best way to control low frequencies is to prevent them from getting into the structure in the first place. Some people try to accomplish this by using what is known in the industry as an *inertia block.* The idea is to place a vibration source on something really dense and heavy, like a concrete block. The more something weighs, i.e. the higher the mass, the more energy it takes to make it move, right? The problem with using an inertia block, though, is that the same conservation of energy and momentum mentioned above applies; the energy still passes through the block without it ever being set in motion. And if there's no motion, the inertia of a heavy block never comes into play.

Figure 2. Some of the sealing products I use for jobs like this. The "Window & Door" foam is best because it's flexible, so it will stay sealed.

Figure 3. The air gaps and holes around fixtures like this light switch all leak sound. Seal them!

Figure 4. Acoustical foam should be applied around the electrical box to seal it up tightly; be careful to do this only with power turned off at the junction box!

But there is one thing that these vibrations can't pass through: properly selected and installed resilient isolators. This is something squishy that goes between your speaker and whatever it is sitting on. It acts like the shock absorbers on your car, but in three dimensions. While neoprene, foam, and other products can be used, by far the best material to use is Sorbothane (www.sorbothane.com). It was invented exactly for this kind of application.

But like so many things in life, Sorbothane (and even neoprene, foam, or what have you) must be applied properly, or you get little or no benefit from it. You have to match the weight of your speaker (or other vibration source) to the quantity and hardness of the resilient isolator. And for stability, it's best to support your speaker at four points. Sorbothane's off-the-shelf small, round domes give the added advantage of supporting your speaker with the smallest amount of surface contact, further enhancing the isolation through what's called "high loading" (more of the speaker's weight on less of the absorber).

"I'm fixing a hole..."

Obviously, the next order of business is to patch any holes in your room's surfaces, such as those that appear the morning after a particularly rambunctious party. Inspect the ceiling, floor, and all the walls looking for any holes; look behind pictures and other hanging decorations to make sure there aren't any hidden holes there. Carefully repair these, ensuring they're sealed and airtight. Most walls these days are made of gypsum board ("drywall") and are pretty easy to patch.

Any decent handyman can repair drywall or plaster, or you can check out a website like www.familyhandyman.com, search for "drywall repair", and do it yourself. So there's no excuse—roll up your sleeves, jump in, and get those holes sealed up!

The next places to seal up are actual gaps in the wall. You'll have to dig a bit to find these, as they're often hidden behind trim, but the effort is worth the improvement in sound leakage.

Using a small pry bar, and prying against a piece of wood to protect the wall, carefully pull off the trim around the doors and windows and see what's there. You'll reinstall the trim when you're done, so be sure not to damage it, and remember which each piece goes where. Again, The Family Handyman has how-to information on removing and reinstalling trim carefully.

With the trim off, you'll most likely see gaps around the door and window frames. Seal the *entire* gap with acoustical sealant. Larger gaps can be filled with an aerosol expanding foam, like you can find at home centers.

Note that expanding foam can be pretty messy to work with; it sticks to everything and is difficult to clean off whatever it gets on. So it's best to experiment with it beforehand. Try squirting some into a cardboard box or on some newspaper to get an idea of how much it will expand and just how sticky it is. And trust me—don't get any on ya!

Rather than common caulk products, be sure to use an acoustical sealant. It won't harden or shrink, remaining pliable, and therefore sealed, for many years. It's also wise to use one that's nonflammable, for reasons that should be obvious.

My personal favorite is OSI SC-175, by Henkel Corp. It's permanently flexible, paintable, nonflammable, cleans up with soap and water (you should still wear gloves), and inexpensive. You can find this at some home centers and online. Other acoustic sealants are available from the usual retail outlets like Full Compass, Sweetwater, Markertek and B & H Photo. See Figure 2.

More holes to fill

Likewise, if you carefully pry back the baseboard at the bottom of your walls the same way, you're also likely to see a gap at the bottom. Same deal—seal it up nice and airtight with acoustical caulk and/or expanding foam, and reinstall the baseboard.

The next penetrations that we'll attack are the cutouts for light switches and electrical outlets. Note: You need to ensure the electricity is shut off to the switches and outlets you'll be working on, to avoid getting shocked or worse.

When you remove the cover from an electrical switch or outlet you'll see a space around the electrical box; there may also be openings in the box itself. See Figure 3 for a typical example. Apply the same acoustical sealant in the gap around the box if it's not too wide. You can also squirt some expanding foam in the gap and the void behind the electrical box, as shown in Figure 4.

Install those gaskets sold at home centers for sealing switches and outlets for energy conservation, shown in Figure 5. Yep, they also work for sound isolation too. Now reinstall the covers.

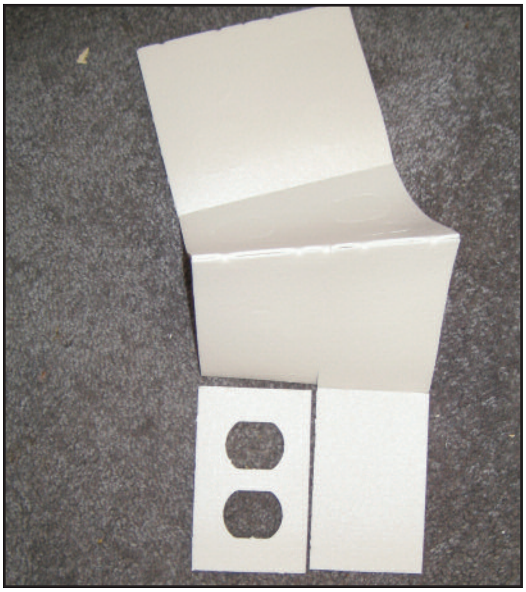

Figure 5. These gaskets go under the decorative plate. They're intended to help save energy by blocking drafts, but they'll also help block sound from leaking through the wall.

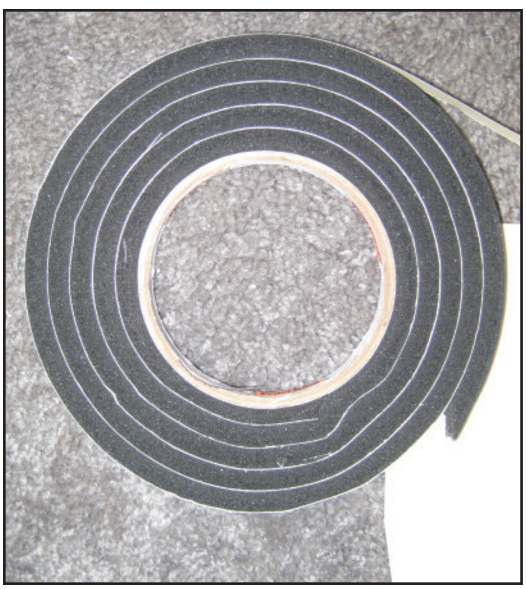

Figure 6. Self-adhesive weatherproofing tape works wonders for acoustic sealing of doorways.

Don't let the door hit you on the way out

Big sound leakage culprits are doors and windows. Hollow-core doors and single-pane windows (common in some homes and offices) are only marginally better at blocking sound than hanging a piece of cloth over the opening to the room. There's a lot of room for improvement.

For doors, the best bet is, of course, a sound rated door. But switching to a solid core door that mates flat against the door jamb will help a lot, and it costs a lot less.

Next, use an acoustical sealant to seal the entire joint between the door frame and the jamb; any incomplete sealing here will compromise your efforts. Be sure to apply the sealant on the side opposite from where the door mates with the door jamb. This will make sure it doesn't interfere with the door closing, and will allow the installation of gasketing where the door meets the jamb, which is the next step.

Now install self-adhesive, closed cell weatherproofing tape (Figure 6) on the door jamb where the door meets it. That's right—the same stuff you have around to weatherproof your home. Nice that it works out that way! You'll want it thick enough to fill the gap, but not so much that it's difficult to close and latch the door. Install it so that the closing door compresses it against the jamb, rather than on the door frame where the door would wipe across it (as shown in Figure 7—picture A on the left is correct, pictures B/C at center/right are incorrect). This will help the gasket last longer. Be very careful not to leave any gaps—these will compromise your efforts to stop sound leakage.

For door bottoms, there are a number of products, from thresholds with integral seals to automatic drop seals that drop to the floor when the door is closed. Visit www.kncrowder.com and look over their weather stripping, threshold, and auto door bottom sections for lots of ideas. Consider using a sealing threshold with an auto drop seal to ensure an airtight seal. If you use a threshold with your door, be sure to also apply acoustic sealant underneath it to ensure it is airtight.

I see the light!

The next item on the sound leakage agenda is the windows. Your first task is to assess the window quality. If they are older single-pane windows, seriously consider replacing them with vinyl-framed dual-pane ones. The vinyl frames seal tightly and the dual panes significantly reduce the sound transmission through the window. You'll also significantly improve your energy efficiency, by the way.

Another method to seal a window is to build a cover that fits tightly in the window. First install two strips of the same closed cell foam you used on the door around the inside of the window frame; one strip closer to the outside, and

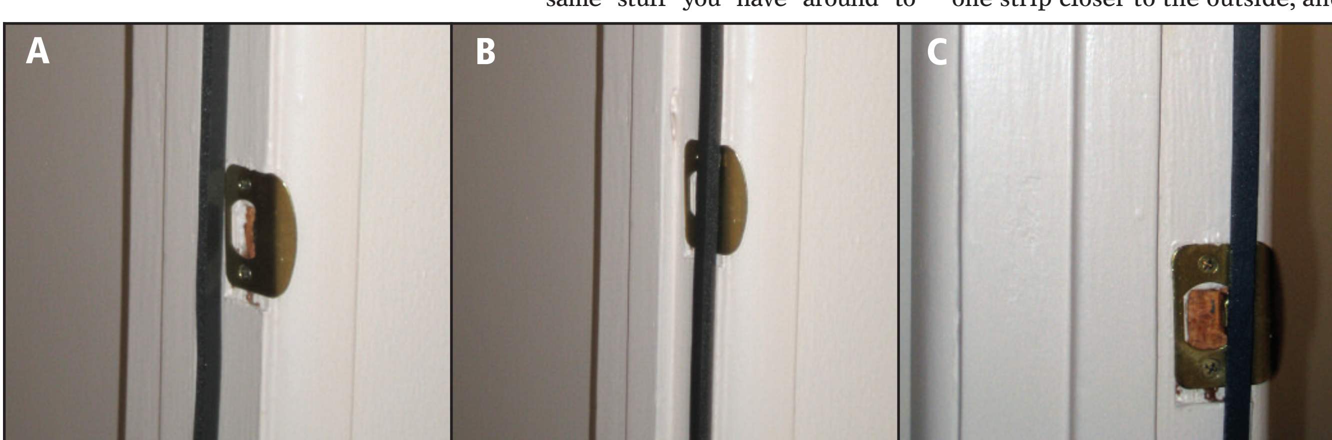

Figure 7. Install gasketing so that it's compressed by the door when you close it (A). Don't put it along the edge where the striker plate goes (B and C); it may seal tightly at first, but as you use the door, friction will cause it to eventually get torn loose.

one strip closer to the inside. Then build a wood frame that will fit snugly in the window frame, sealed by these two lines of weather stripping.

Cover the back of the wood frame (the side closest to the window pane) with plywood (the thicker the better), fill it with standard building insulation, and then cover the front with plywood. This essentially puts a piece of wall in the window frame, providing much better sound isolation than a single pane of glass. If you plan on leaving the frame in the window indefinitely, seal the gap between it and the window frame with acoustical sealant. Decorate to taste.

Take care of that which bears you...

That means "don't forget the floor." While a floating floor installation is beyond the scope of this article, an extra layer of padding under the carpet (or adding carpet in the first place) will help reduce sound transmission through to the room below.

Take the test... again

Now repeat the test you performed earlier. Be sure to use the same program material, played at the same level, measured at the same locations; no cheating, now! Use it to repeat all the measurements in all the same places as you did last time, and compare them to your initial findings (you did remember to write them down, right?). You should find a significant improvement. And if your complainers say there was no change, you can show them what the actual measured improvement is.

So you can see it's not difficult, and doesn't require any particularly special tools or skills. If you're willing to invest some sweat equity and a little money, you can make some significant improvements in how well the sound in your room is contained. Those around you will appreciate it and you won't have to move your operation... or appear in court.

Remember that the level of success in bringing down sound leakage depends on the quality of workmanship and materials. If you don't have the skill or patience to do this work carefully, consider hiring a contractor who has experience in this. The important thing is to do it, before the complaints get worse than they have already!

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