Soundproofing a Music Studio

Some practical solutions to noise pollution

by Gene De Smidt

My daytime job is building. But after dinner I like to turn to my nighttime profession, which is singing and writing songs. My songwriting career doesn't require a lot of space, but I do need a room that is quiet enough to let me record my work without picking up the sound of my neighbor's table saw, or my foot thumping on the floor. On the other hand, I don't want to bother my neighbor or the rest of my family with the percussion tracks from my drum machine or the occasional fuzztone guitar riff.

When I set about to build my own recording studio, I had to solve a wide variety of sound problems. What's more, I didn't have a big budget to invest in the project. I had to limit my construction details to readily available materials that could be assembled in a straightforward manner. What I discovered as I researched soundproofing techniques can help others who want to build a quiet room for music, or just want to cut down on the racket from somebody's upstairs TV.

Identifying noise—When I began planning my studio, the first order of business was to decide where it should go. I chose an unfinished section in my basement that is adjacent to an exterior wall (drawing A, facing page), and directly below my living room. Next, I had to identify all the nearby sources of noise, and find a way to reduce each one to a tolerable level.

To begin, I sat in the unimproved corner of my basement at different times of the day and night, listening for whatever I could hear. I heard airborne noises (for an explanation of sound terminology, see the glossary on p. 63)—conversations, barking dogs, cars driving by the house, a radio and a television, a vacuum cleaner, and my kids hollering at each other upstairs. I also heard water pipes knocking, the moan of the refrigerator, and balls bouncing on the floor directly above me. These were impact noises. One impact noise was especially pronounced—my 13-year-old son practicing his break-dancing moves in the attic. Each time he slammed his knees to the floor, the whole house shook.

In order to isolate my studio from these sounds, I investigated the elaborate methods used in commercial recording studios. I discovered that one studio I sang in was actually built inside another structure (and at great expense, I might add). The key to its success was that it

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completely eliminated the street noise outside and the office racket upstairs by isolating itself from the rest of the building. The studio floor was a massive slab that rested on individual pins mounted on piers. Inside, the studio walls and ceiling were equipped with sound-absorption cavities, which are baffled pockets that trap unwanted sound. Solutions like these are quite expensive, but they can certainly be adapted for use in a residential setting in economically practical ways.

The floor—Luckily, I was building a new floor in a space without one, so I didn't have to disrupt the existing structure. Borrowing from the isolated-slab concept, I began my floor with a network of concrete pier blocks placed on individual concrete pads on 4-ft. centers. Because air circulation under the floor would be minimal, I built the floor frame using pressure-treated Douglas fir. I set 4x4 posts on each pier with rubber pads at the top of each post to absorb low-frequency sounds.

The rubber pads are ¼ in. thick and 3½ in. square, the same area as the tops of the posts. I made them from sheet goods that I bought from a local machine shop. Metalworkers use sheet rubber to make mounts for their machines. The stuff comes up to ½ in. thick, but be sure to use the kind that doesn't have canvas in it.

Next I secured my 4x6 girders by toenailing right through the rubber pads into the posts. None of this framework is connected in any way to the existing house. For a moisture barrier, I spread two layers of 6-mil polyethylene over the dirt between each girder bay, and I brought the plastic up the sides of each girder (drawing B). Then I filled these cavities with dry sand to within about an inch of the top of the girder. This mass of sand absorbs a lot of the low-frequency sound coming out of the studio and improves the quality of the sound inside it.

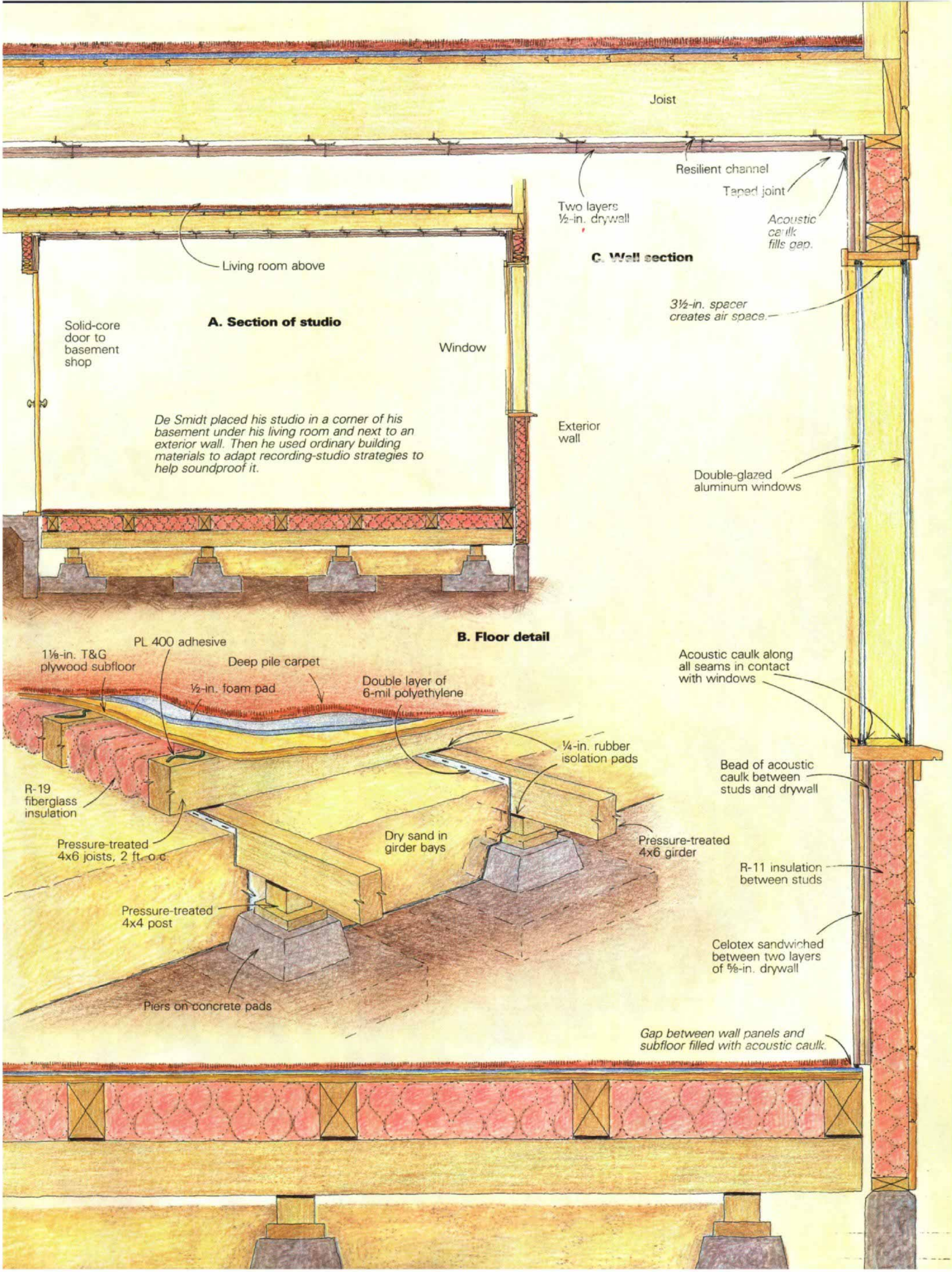
I used 4x6 floor joists 2 ft. o. c., and filled the spaces between them with fiberglass-batt insulation. Before I screwed down the 1⅛-in. plywood floor, I ran a bead of PL 400 construction adhesive across the tops of each joist. Gluing down a subfloor has become standard practice in construction, but it is of special benefit in a sound-controlled room. Besides eliminating squeaks, the adhesive remains somewhat resilient, lessening the transfer of sound waves to the joists. As a final touch, I covered the floor with ½-in. foam carpet pads and deep pile rugs. Between the isolated floor structure and the mass of the sand, I've pretty much stopped the transmission of source-oriented low-frequency sound out the bottom of the studio.

Walls—Once I had my floor finished I sat in the studio space and listened for sounds from outdoors. The existing wall was minimal, with 1x clapboards on the outside and full 2x4 studs exposed on the inside. Still, not much sound was coming through them, and what did was mostly shrill street noise like that made by a small-bore motorcycle. This is high-frequency airborne sound, and the best defenses against it are isolation and tightly sealed walls. On the other hand, I wanted to minimize the sound leaving the room, so I needed some mass to cut down on the low-frequency escape.

I decided that an adequate treatment of this wall was to fill each stud bay with fiberglass-batt insulation, and to apply a sandwich of ⅝-in. drywall, ½-in. Celotex and another layer of ⅝-in. drywall (drawing C). Drywall has a lot of mass, as anyone who has dragged around ⅝-in. thick panels knows. Celotex, on the other hand is a soft, fibrous wall panel that helps to filter out some of the vibration passing from the studio to the framing.

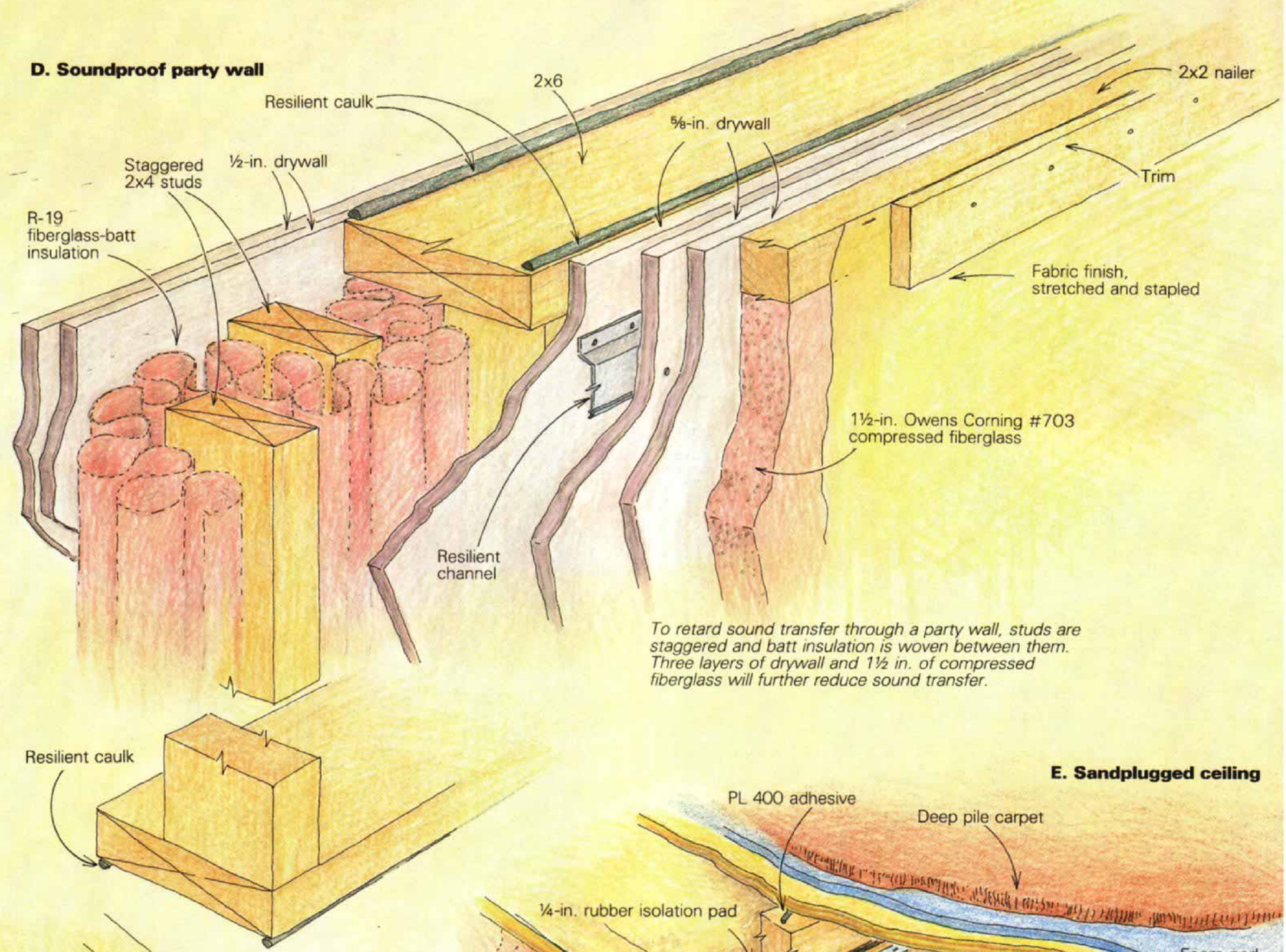
I installed the drywall with the long dimensions parallel to the floor, and I ran beads of acoustic caulk along the studs to lessen sound transfer. Once I had the first layer in place, I taped each seam. Then I added the Celotex, sealed its seams with duct tape, and added another layer of ⅝-in. drywall. The seams of all these panels are staggered, and I stopped the drywall and Celotex short of the floor and the ceiling. As shown in drawing C, these gaps are filled with acoustic caulk—I like to use a brand

Drawings: Christopher Clapp



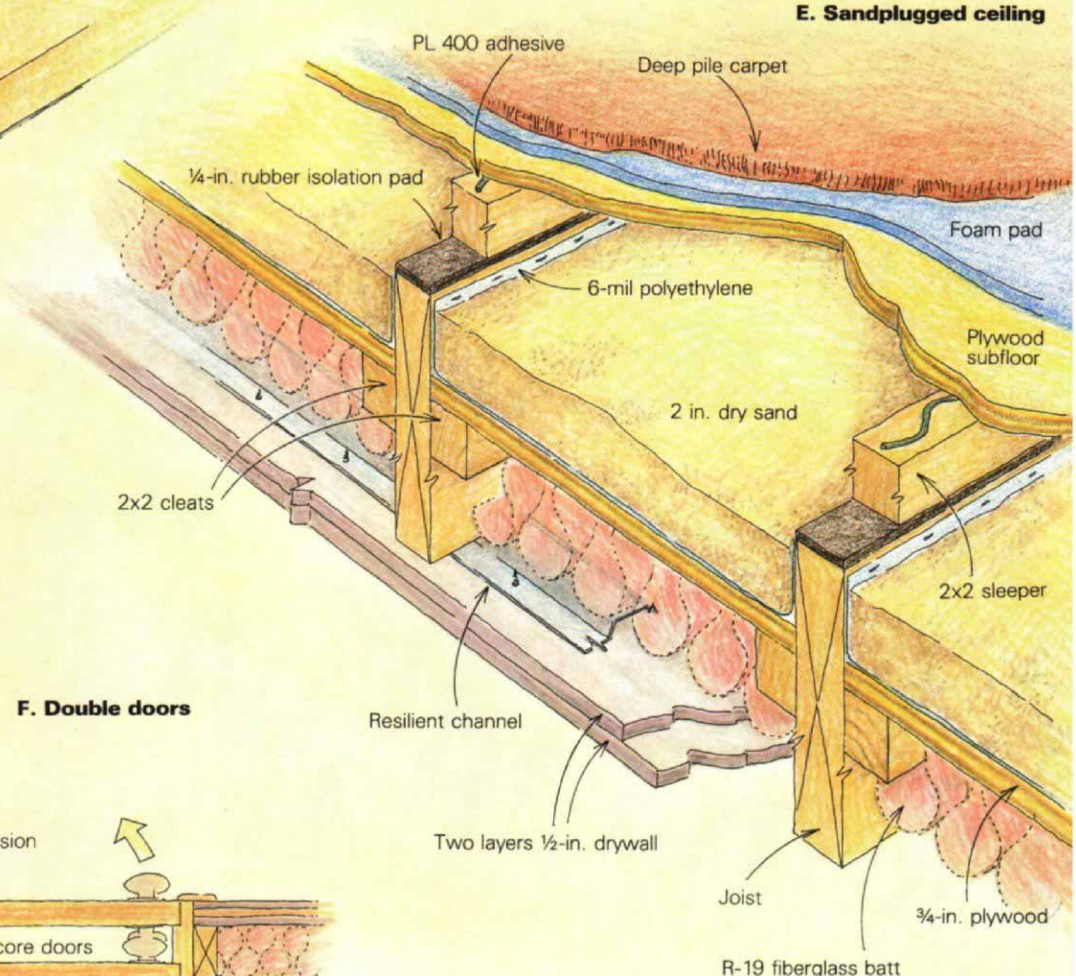
De Smidt placed his studio in a corner of his basement under his living room and next to an exterior wall. Then he used ordinary building materials to adapt recording-studio strategies to help soundproof it.

D. Soundproof party wall

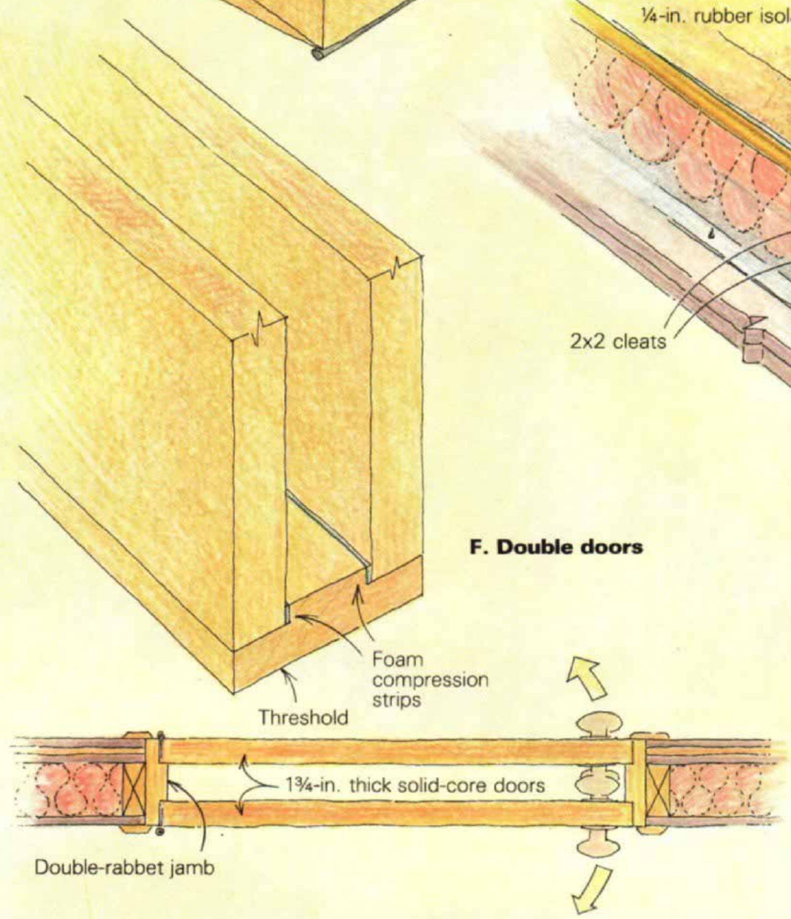


To retard sound transfer through a party wall, studs are staggered and batt insulation is woven between them. Three layers of drywall and 1½ in. of compressed fiberglass will further reduce sound transfer.

E. Sandplugged ceiling



F. Double doors



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of caulk that has latex and silicone in it for long-term resilience.

I built the other walls in my studio with this same three-layer detail, and they have served my purposes well because I don't play at high volumes in the studio and my neighborhood is relatively quiet. If I needed a heavier sound barrier, I would do a version of the party wall (drawing D, facing page). It consists of two rows of 2x4 studs that are either aligned on opposite sides of a 2x6 plate or placed on separate 2x4 plates 1 in. apart. The void between the studs is filled with fiberglass insulation, and the sheathing is built up of multiple layers of drywall. After applying the first layer of drywall, I positioned resilient channel 16 in. o. c. parallel to the ceiling. Resilient channels are strips of galvanized sheet metal that are similar to Z-flashing. One leg is screwed to the joist or stud, while the other serves as a mounting strip to which you can screw drywall. The ½-in. flange separating the two legs isolates the drywall from the framing, dramatically reducing structure-borne sound.

I built the party wall shown here for a studio that needed to absorb a lot of low-frequency sound. For extra sound absorption I glued 1½-in. thick Owens Corning #703 compressed fiberglass panels to the studio side of the wall, and covered them with fabric stapled to wood nailers around the perimeter of the wall. This wall will cause a transmission loss of over 50 decibels. That means that a shouting match on one side of the wall would sound like a quiet conversation on the other side, 10 in. away. An average conversation would be rendered inaudible.

If you put outlets or light switches in a party wall, don't put them directly opposite each other because they will create a direct channel for high-frequency sound. Also, fill any gaps around the wires where they enter the outlet boxes with acoustic caulk. Caulk any gaps between the boxes and the drywall, and use foam gaskets between the wall and the cover plates.

Ceilings—One man's floor is another man's ceiling, especially where sound transmission is concerned. Probably the most typical and difficult noise problem is the transmission of sound through common floors and ceilings. Again, it is important to pinpoint the source of the sound and try to diminish it. For instance, if your upstairs neighbor has hardwood floors and wears high-heeled shoes, your sanity may be endangered by a constant tapping sound coming through the ceiling. It would be easier to stop this impact sound with a pad and a carpet upstairs than by adding layer after layer of soundboard to your ceiling.

In my house, I have a living-room floor made of 1x4 T&G fir over 2x8 joists that are exposed on the underside. Even though the floorboards are loose and squeaky from years of foot traffic, I couldn't afford to tear them up and start over again. Consequently, I left the floor intact but I worked on it from both sides.

I fixed the squeaks from the top side. I drilled small holes through the 1x4s where they bear on the joists. Then I injected some PL 400 construction adhesive into each hole, and secured each board to each joist with a Phillips-head particleboard screw. This fix completely eliminated the squeaks. To lessen the impact sound from my two-year-old daughter dragging her Quackalong Duck Truck over my studio, I bought an area rug with a thick foam pad. Working from below, I filled each joist bay with R-19 fiberglass batts. Then I ran resilient channels at 12 in. o. c. perpendicular to the joists.

In my studio, I hung two layers of ½-in. drywall from the channels. After I had the first layer in place, I applied a second layer using construction adhesive and screws to secure the drywall to the first layer and to the resilient channels. Like the wall-to-floor intersection, the ceiling rock doesn't touch the wall rock (drawing C, p. 61). This gap is filled with acoustic caulk, and then taped in the traditional manner to seal against high-frequency noise.

If you can afford to tear up the floor from above, sand plugging and rubber isolation mounts will help you gain a floor that will drop sound transmission by 50 decibels (drawing E). Two inches of dry sand will add about 25 lb. per sq. ft. to the floor load, so make sure the joists are beefy enough to handle it. If not, consider doubling them. For those who are remodeling attics and want a substantial sound barrier, this can be an effective absorption technique when you don't want to redo the ceilings below.

Doors and windows—Recording studios don't have many doors and windows, and it's because they're difficult to seal properly. Also, the larger the window area, the greater the transmission loss will be. A typical studio will have a pair of 1¾-in. thick solid-core doors with double-rabbeted jambs and foam compression strips all around (drawing F). The doors share a common jamb, swing in opposite directions and have offset knobs or bullet latches. If one of the doors is an exterior door, it will probably have a dropped seal that closes off the space between the threshold and the bottom of the door.

The observation windows that I've seen in studios usually consist of two pieces of glass. On the source side (the inside), a piece of ½-in. thick float glass is secured in neoprene channels and mounted with the top kicked in at a 7° angle off vertical. This angle deflects sound toward the floor, where it doesn't interfere with recording. Opposite the source side there is a 6-in. to 8-in. airspace, then a piece of ¼-in. glass in neoprene channels. The two pieces of glass are of different thicknesses to prevent a common resonance between them. Smart builders put silica-gel beads between the layers of glass to absorb moisture. I adapted this isolated double-glazing method for my studio by installing a pair of dual-glazed aluminum sliders separated by wood spacers with acoustic caulk at every seam, as shown in drawing C on p. 61.

So far I have a single solid-core door attached to the double-jamb setup. To seal leaks around the edges, I used the stick-on foam tape available at my local hardware store. This arrangement has worked so well that I haven't needed to install the second door. Also, to cut down on impact noise from upstairs, I got my son a large piece of cardboard so he can practice his break dancing on the sidewalk. □

A sound glossary

***Sound*—Sound originates from a point source and spreads outward in a spherical pattern. It is a wavelike motion that travels at about 1,100 ft. per second. The ear receives sound through the displacement of a wall-like membrane known as the oval window. This generates a sound wave in the cochlea. The basilar membrane is displaced, and the sensing cells respond to the displacement. Minimizing the membrane displacement in the ear decreases the perceived sound level. What builders are trying to do when they reduce sound levels is to minimize the displacement of the walls in a building, which are analogous to the membranes in your ear.**

***Frequency*—Sound waves are generated at various rates, and they are measured in cycles per second (cps). The international unit of sound frequency is the hertz, and it equals one cps. The human ear can detect sound vibrations from as few as 20 cps to about 16,000 cps. A baritone voice is at about 80 cps, while a soprano's voice can go to 4,000 cps.**

***Decibel (dB)*—The decibel is a unit that measures the intensity of a sound. A quiet conversation is about 25 dB, the average TV is about 60 dB, a loud automobile horn at 25 ft. is around 100 dB, and pain sets in at about 130 dB. Any of the levels can be annoying if they are transmitted into a residential space through inefficient walls, floors or ceilings.**

***Noise*—Noise is any unwanted sound that intrudes upon our concentration. Sound specialists generally agree that high-frequency noise is perceived to be noisier than an equally loud noise of a lower frequency.**

***Impact noise (structure-borne sound)*—Impact sound is sound that sets a structure vibrating. Water flowing through pipes, whirling washing machines and refrigerators with their compressors on impart steady vibrations to a structure. Impulse sources such as footsteps, bouncing balls and dropped dishes also fall into this category. A structure vibrating from Impact noise carries the sound to all its connected parts. Interestingly, heavy construction members in the building can sometimes exacerbate structure-borne sound. It's best defeated with resilient connections between structural members, and by isolating the source from the structure.**

***Airborne sound*—Airborne sound is sent into the air from sound generators such as musical instruments, stereos, conversations and passing airplanes. Reduce low-frequency airborne sound, like the bass notes from a piano, by absorbing it with mass.**

For more information on acoustic design, see *Detailing for Acoustics* by Peter Lord and Duncan Templeton (Nichols Publishing Co., P.O. Box 96, New York, N. Y. 10024, 1983; $37.50); *Environmental Noise Control* by Edward B. Magrab (Krieger Publishing, P.O. Box 9542, Melbourne, Fla. 32902, 1975; $48.50 plus $4.00 handling); and Acoustical Manual (National Association of Home Builders, 15th and M Sts., Washington, D. C. 20005; $4.00 to members, $5.00 to non-members; $2.50 handling). *—G. D.*

ERRATA

Wide flange out

Concerning "Soundproofing a Music Studio" (*FHB* #35), there is an error in drawing E on p. 62. The resilient channel is illustrated in an inverted position. The wider flange is for drywall attachment and should be shown as it is on p. 61. Otherwise I enjoyed the article very much and would appreciate more information on this subject in future issues.

—Stephen Kester, Manager, McAvoy Insulation Co., Kingston, Pa.