Mudsills Where the Framing Meets the Foundation



Even if the foundation is not square or level, getting the mudsills right will get you back on track

BY JIM ANDERSON

Framing a traditional house begins at the mudsill; it's the first piece of lumber that is attached to the foundation. If you build on a foundation that's out of square or level (and they're common), correcting the problem at the mudsill stage will make for a lot less trouble later. The first step in installing mudsills is determining if the foundation is square.

Checking for a square foundation

While my helper sweeps off the foundation and checks to make sure the anchor bolts are plumb, I look over the plans for the foundation's largest rectangle. It will provide an ongoing reference for establishing bump-outs (areas outside the large rectangle) and recesses (areas within the large rectangle) that

SQUARE MUDSILLS DEPEND ON A SQUARE LAYOUT



Before you can install the mudsills, you have to make sure that the foundation is square. And occasionally, foundations are a little out of square. To get the framing off to a good start, you have to snap a series of square layout lines for the mudsills. Locating and snapping lines on the foundation's largest rectangle provides a square reference for the remaining areas lying inside or outside the large rectangle. If a large rectangle can't be found, a large right triangle (see "Finding square with triangles" below) will work.

1. Find out if the foundation is square

A Locate the foundation's largest rectangle and snap a reference line on one of the long walls 3½ in. from the outer edge of the foundation wall. (We're using 2x4 mudsills in this example; for 2x6s, snap the line 5½ in. from the outer edge.)

B On the wall opposite the reference line, snap a parallel line 3½ in. from the foundation's outer edge. Make sure this line is parallel to the reference line by measuring between them at each end. If they're not and the difference is less than ½ in., simply move the end of the parallel line that measured short until the measurements are equal.

C To find the rectangle's corners, mark points *a*, *b*, *c*, and *d* 3½ in. from the edge of the foundation. Make sure that line *ab* is equal in length to *cd*.

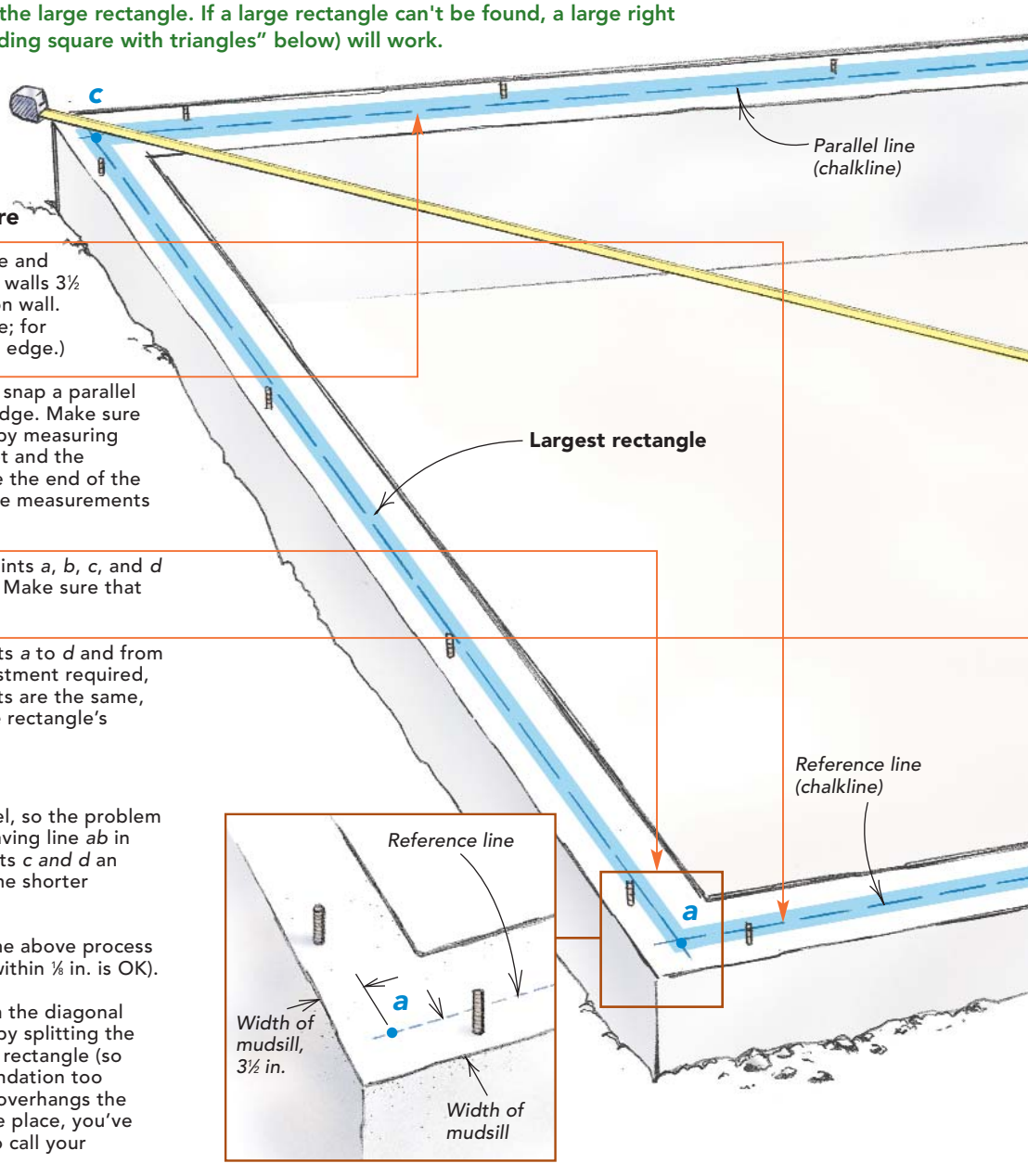
D To check for square, measure from points *a* to *d* and from points *b* to *c*. There's usually some adjustment required, but if you're lucky and the measurements are the same, the foundation is square. Snap the large rectangle's remaining two chalklines.

2. If the foundation isn't square

A We know that lines *ab* and *cd* are parallel, so the problem is in the other two walls (*ac* and *bd*). Leaving line *ab* in place, square the layout by moving points *c and d* an equal distance toward the corner with the shorter diagonal measurement.

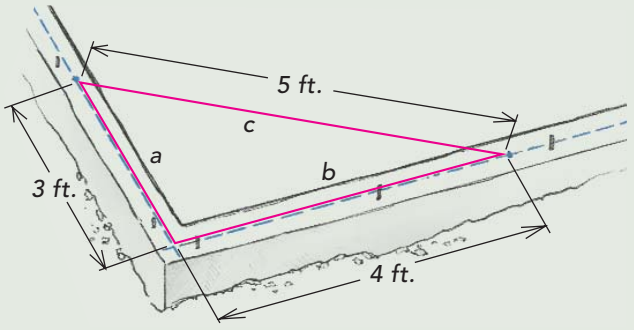
B Check the diagonals again and repeat the above process until the two measurements are equal (within ⅛ in. is OK).

C If there's more than an inch difference in the diagonal measurements, adjust the entire layout by splitting the difference among all four corners of the rectangle (so that the mudsill won't overhang the foundation too much). If, after this is done, the mudsill overhangs the foundation by more than ⅝ in. in any one place, you've got a bigger problem and might want to call your foundation contractor.



FINDING SQUARE WITH TRIANGLES

According to the Pythagorean theorem ($a^2 + b^2 = c^2$), any triangle with sides that measure 3-4-5 (or any multiple of these) will always have a right angle opposite the hypotenuse (side that measures 5). If a = 3, b = 4, and c = 5, and $3^2 + 4^2 = 5^2$, then 9 + 16 = 25.



Drawings: Dan Thornton

3. Laying out the recesses and bump-outs after squaring the large rectangle

Recess

Mark the lengths of each side by measuring from the main rectangle. Snap connecting chalklines.

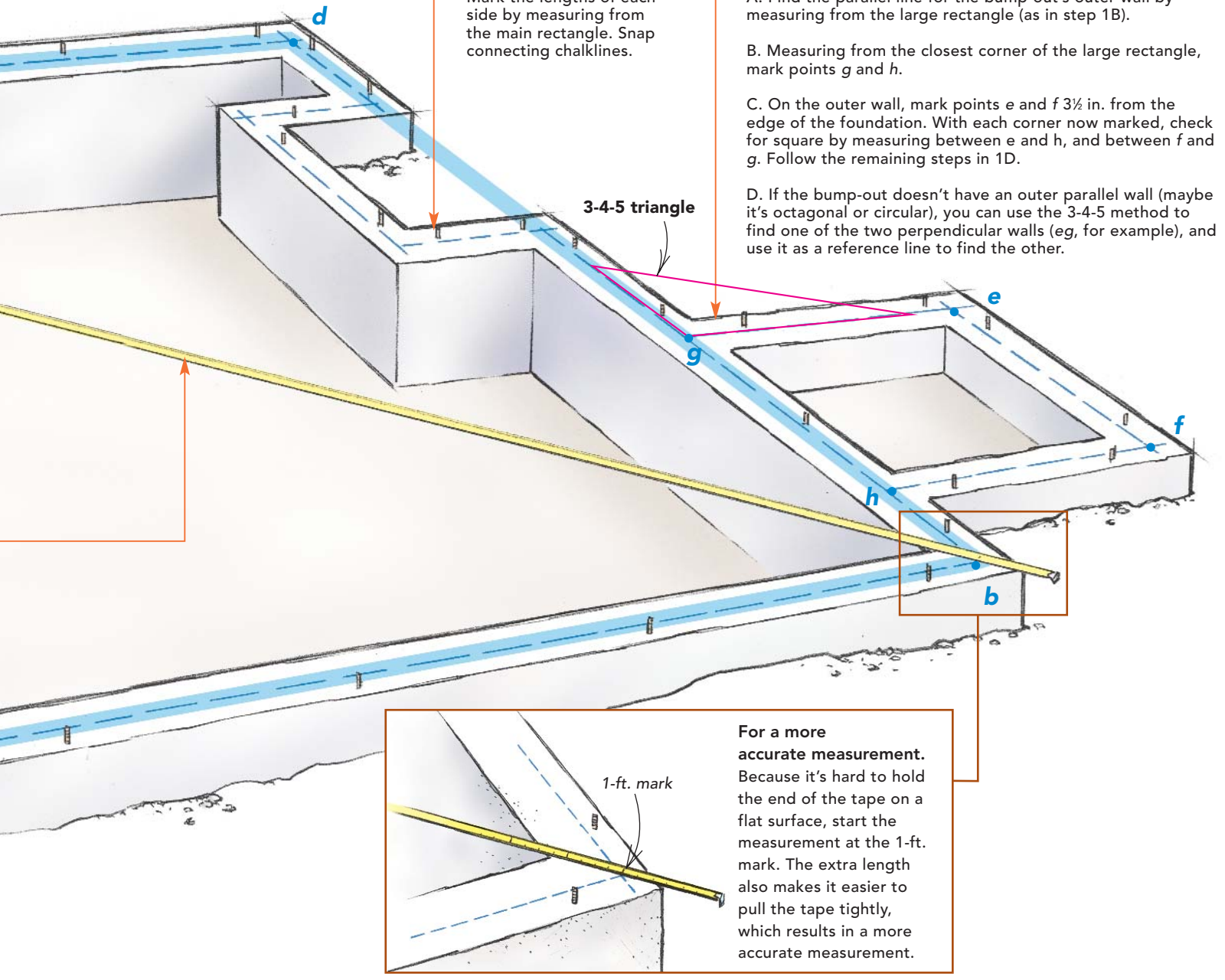
Bump-out

A. Find the parallel line for the bump-out's outer wall by measuring from the large rectangle (as in step 1B).

B. Measuring from the closest corner of the large rectangle, mark points *g* and *h*.

C. On the outer wall, mark points *e* and *f* 3½ in. from the edge of the foundation. With each corner now marked, check for square by measuring between e and h, and between *f* and *g*. Follow the remaining steps in 1D.

D. If the bump-out doesn't have an outer parallel wall (maybe it's octagonal or circular), you can use the 3-4-5 method to find one of the two perpendicular walls (*eg*, for example), and use it as a reference line to find the other.



For a more accurate measurement. Because it's hard to hold the end of the tape on a flat surface, start the measurement at the 1-ft. mark. The extra length also makes it easier to pull the tape tightly, which results in a more accurate measurement.

are square to the house and to each other. The drawing above shows how to square the large rectangle or to create a large 3-4-5 triangle if a rectangle can't be found.

After squaring and marking its corners, two of us snap chalklines for the large rectangle and any bump-outs or recesses, while a third person spreads pressure-treated 2x4s (or 2x6s if requested) around the foundation to serve as mudsills. Working as a team with a systematic approach is really important on these projects. We begin at the front corner and run the material along the chalkline from end to end, and then do the same in the rear. We fill in the sidewalls last.

As we work our way around the foundation, we mark the bolt locations by standing the plates on edge and outlining the bolts on the sill plate (photo left, p. 66).

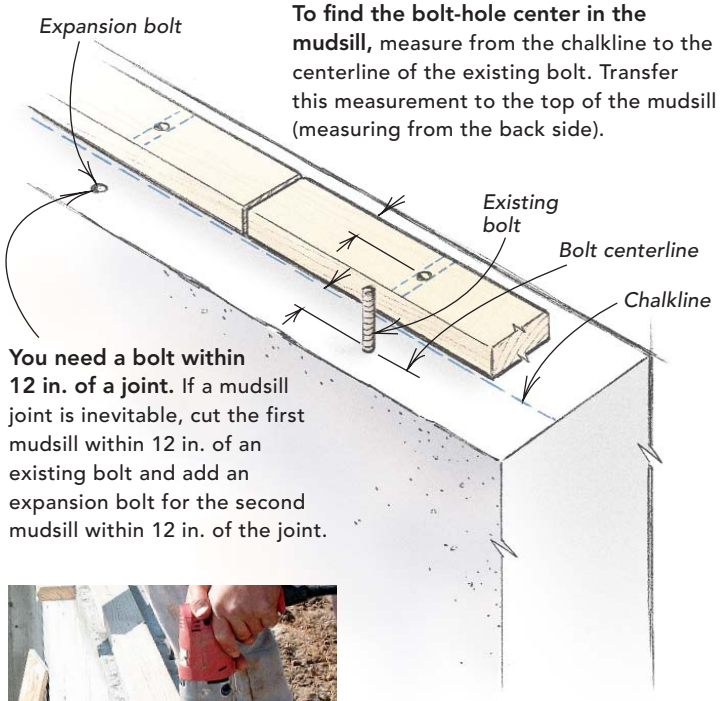
When we have to join two mudsills, we cut the first plate within 12 in. of a bolt and add an expansion bolt for the adjacent plate. Local code requires an anchor bolt within 12 in. of the end of mudsills or of any joints.

Marking the bolt centers on the mudsills for drilling is next (photo right, p. 66). It's as simple as laying the mudsill alongside the chalkline on top of the foundation, measuring from the chalkline to the center of the bolt, and transferring the measurement to the top of the mudsills (top drawing, p. 66). At this point, we add insulation (or sill seal if requested) between the foundation and the

EASY FOUNDATION-BOLT LAYOUT



Stand the sill plate on edge *and trace the outline of the bolt onto the plate.*



To find the bolt-hole center in the mudsill, measure from the chalkline to the centerline of the existing bolt. Transfer this measurement to the top of the mudsill (measuring from the back side).

You need a bolt within 12 in. of a joint. If a mudsill joint is inevitable, cut the first mudsill within 12 in. of an existing bolt and add an expansion bolt for the second mudsill within 12 in. of the joint.

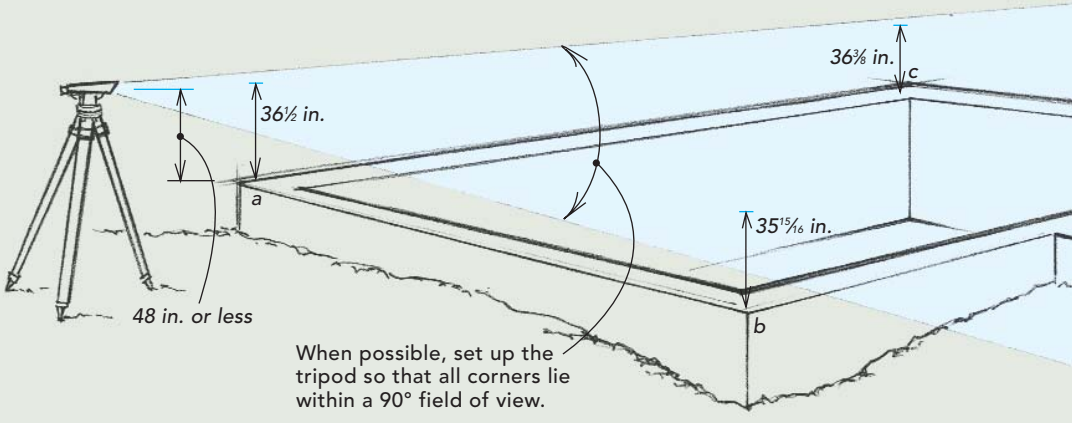


Drill holes in the mudsill as straight as possible. *An angled hole will pull the plate off the chalkline. Use a ⅝-in. bit for a ½-in. anchor bolt; place a piece of scrap lumber beneath the plate to protect the bit, or cantilever the mudsill beyond the foundation.*

A builder's level finds the high spots

Commonly though wrongly called a transit, a builder's level rotates only horizontally; a transit rotates both horizontally and vertically. Looking through a builder's level is like looking through a rifle scope, cross hairs and all. Properly set up, the horizontal cross hair represents a level plane, and the magnification is great enough to read a tape measure held 100 ft. or more away. A builder's level is leveled with either three or four thumbscrews and integral bubble vials. Comparing measurements taken in different spots tells you their relative elevations. Be warned,





mudsill. (For more on sill seal, see "Tools & Materials," p. 116.)

Shims level the mudsill; bolts hold it down

After drilling the bolt holes, two of us place the mudsills over the anchor bolts, and another follows behind, adding nuts and washers, tightening them only enough to check for obvious high or low spots. Then we add the necessary expansion bolts at the mudsill joints and nail a second 2x4 on the mudsill. This adds an extra 1½-in. ceiling height in the basement.

Next, we use a builder's level (sidebar below) to measure the height of the corners and to look for any high spots. After comparing the measurements, we shim the corners to within 1/16 in. of the highest point on the foundation. Then we run a string from corner to corner and level the mudsills between.

When shims are necessary, the local building code requires steel shims at joist, beam, and point loads, so I mark these locations on the mudsill. After inserting the shims between the foundation and mudsill, we tighten the nuts on the anchor bolts and check the height one last time, shooting for plus or minus 1/16 in. □

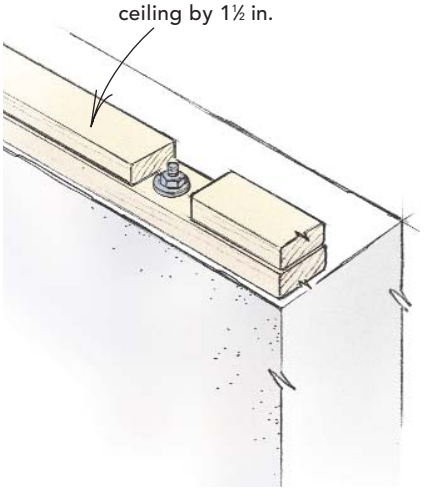
Jim Anderson is a framing contractor living in Littleton, Colo. Photos by Ron Ruscio.

SHIM THE MUDSILLS TO THE STRINGLINE

Shim with steel. *Once you've established a level stringline, use steel to shim between the mudsill and foundation beneath all joist, beam, and point loads.*

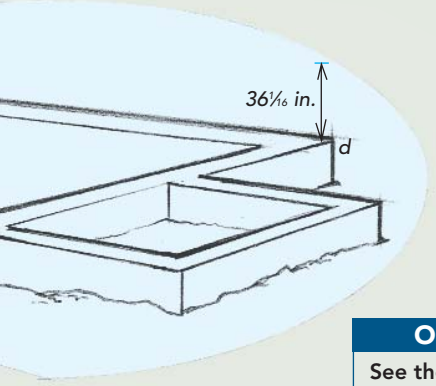
For a rough count, *stack the shims up to the stringline in each location. Steel shims are available in 50-lb. boxes from Metalwest (800-336-3365).*





though: This comparison can be counterintuitive. The highest spot, being closest to the level's plane, will have the shortest measurement.

For years, I have used a builder's level to install mudsills, and although I have tried laser levels, I haven't been happy with the results. The Sokkia E32 level (800-476-5542; www.sokkia.com) that I now own cost around $400 in 1999, and it has given me great service.



SET-UP TIPS FOR BEST RESULTS

1. Position the level so that you clearly see each of the foundation's corners within a relatively narrow field of view (90° or less). This helps to eliminate errors associated with swinging the level in wide arcs.

Place the level as low to the foundation as possible. Extending the tape or measuring rod high in the air introduces error.

2. With a helper holding a tape, shoot the outside corners *abcd* and write their elevations on each corner. The shortest measurement is the high corner (*b*).

3. Subtract the shortest measurement from each of the other corners, and write the difference (the amount to be shimmed) at each corner.



Remove high spots with an air chisel. *If a high spot is really bad and it's a short length of wall, an air chisel makes quick work of a labor-intensive job.*

4. Shim the corners until they measure within 1/16 in. of the high corner.

5. Run stringlines from one corner to the next. For the areas between the corners, see "Shim the mudsills to the stringline" (above).

—*J. A.*

ONLINE CONNECTION

See the author use a builder's level at our Web site, www.finehomebuilding.com.