Plumb Bobs, String and Chalkboxes

Working with string and the tools that hang from it

by Trey Loy

String is pretty basic stuff, but there is no end to the little tricks that make using it easier. If you're cutting gable gypboard or laying out walls, try a small, sharp scratch awl instead of a nail for holding one end of the snapline.

Building, it will surprise no one, is based on geometry and trigonometry. Points are established by measuring, these are connected to form lines, the lines are grouped to form planes, and these planes join to form a solid. Great—in theory. But this whole process relies on establishing straight lines with the right relationship to each other, and keeping them that way as you fill in the outline.

Levels and straightedges are good for short lines. But for long spans, a length of string, whether it is stretched between two nails, suspended by a weight on a plumb line, or coated with chalk and snapped against something, is indispensable. String can be used for many things: to plumb and level your work, to define points in midair, to tell you what's straight and what isn't, to establish grades, to align walls and floors, to make a circle or project its center up or down in space, and to mark your work for cutting or assembly. And if things aren't going well, you can always use the first 100 feet or so to go fishing.

String—String, or twine, is thicker than thread and thinner than cord. Twine is made from natural hard-leaf fibers such as sisal and manila, or from cotton or synthetic fibers like nylon, Dacron and polypropylene. The fibers are drawn into slivers, counted, and spun into threads that are twisted or braided.

Coarse cotton line is ideal for chalkboxes and will do for a plumb bob. Cotton fibers stretch very little, but they rot and mildew around water and cement products, and are easily abraded. Nylon, on the other hand, doesn't absorb water readily and is alkali resistant. Nylon string is also elastic, which is an advantage in stringing a line because you can get it very taut.

Nylon twine is either twisted or braided, and comes in twenty-some sizes ranging from a thin #3 to a thick #120. In carpentry and masonry, you'll be fine with one of two sizes: #15, which measures a skinny 1/16 in. in diameter, and has a breaking strength of 120 lb.; and #18, which measures a fat 1/16 in. and will withstand a 170-lb. force. The twisted version of either of these sizes of nylon line is pretty inexpensive, costing around $3 for a 350-ft. roll, and is adequate for laying out foundations and lining walls. It will stretch up to 8% of its length, and return to normal when released.

Braided nylon twine is a favorite with masons, because it's more durable and easier to work with than twisted line. It costs about twice as much, but it stretches less. One kind of braided string is even heat set for minimum stretch.

Nylon string comes in three colors: white, yellow and green. Green is hard to spot in a background of grass or shrubs, but it is the best color if you've got fishing on your mind. White is very popular, but I like yellow for its high visibility. All three colors are sold in lengths of 250 ft., 350 ft., 500 ft. and 1,000 ft.

One last kind of braided nylon worth mentioning is bonded nylon line. It is woven with an extra thread that is usually a different color and fiber. This bonded thread contributes strength and durability, and gives the twine a flecked appearance that makes it more visible than a solid color. It is treated to make it less slippery, and costs slightly more than braided line.

There are two other synthetics used in construction. For big commercial sites and highway layout, braided Dacron line is often used. It runs about $16 per 500 ft. Dacron has twice the breaking strength of nylon, but isn't elastic. Polypropylene is also very strong, but it's slippery and stiff, and doesn't hold knots well. Like Dacron, poly won't stretch. But it will float.

Securing a line—Knowing how to tie a variety of knots is important to me as a carpenter, yet I notice that many of the people I work with aren't sure how to proceed, and use knots that only hinder their effort. A good knot is not only simple to tie, but also easy to untie. One of the first places you'll need one is when you form a loop at the end of the string. A common knot for this is the *bowline,* which is shown at the top of the facing page (A). The resulting loop can be slipped over a nail or an awl. You can also slip the standing part of the line (the string back down the line from the knot) through the bowline to create a simple slip knot.

String lines aren't much good unless they are taut, and using an elastic line like nylon makes that possible. The knot that holds the tension can't slip, but you should be able to release it without much fumbling and you shouldn't have to cut the string to tie it. A *twist knot* is the knot generally used by carpenters. It's formed by looping the string around your outstretched fingers once, and then twisting the loop three or four times (B). Place this loop over the nail, and stretch the string tightly with one hand, while pulling the excess through the twists with the other. Keep up this routine—heave and pull in the slack—until the line is singing. Sometimes it helps for your partner to pull from the middle of the span. Secure the knot by pulling the free end of the string back toward the nail. This will cause the twists to bunch up next to the nail, overlap themselves and create lots of friction. A lot of carpenters tie a couple of *half hitches* around the nail for security, but these are hard to loosen later. Instead, pass the standing part of the line around the nail once, making sure that it is sitting under the twists—this will provide all the friction needed to keep the string taut.

There's another simple knot that will keep a string tight. I call it a *tension hitch* (C), and I use it when I'm stringing lines between posts or stakes. Just take two wraps around the stake, making sure that the part of the line under tension is laid over the two turns. This combines the elasticity of nylon with the friction between layers of string to hold the hitch.

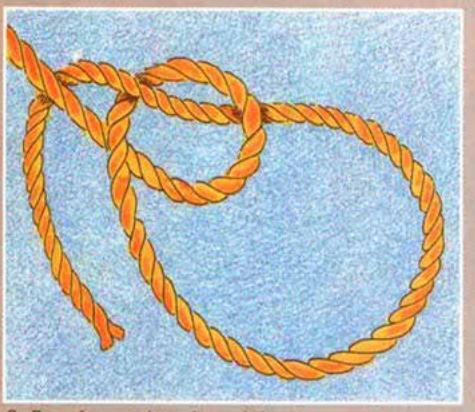
If you are stringing multiple lines, as you would laying out a foundation, don't cut the string, but take the spool to the next batter board, paying the line out as you go. Use a *clove hitch* (E) to secure it to the next nail, since it will cinch down no matter which end of the line you pull. You tie it by forming two consecutive underhand loops in the line, and laying the second loop on top of the first. The combined loops should then be slipped over the nail, and the ends pulled taut in opposite directions.

Although there isn't any reason to cut the string after making any of these knots, you will sometimes have to join two pieces of string. This is most easily done with a *surgeon's knot* (D). This is merely a square knot with an extra turn taken in the first overhand knot.

Once all of the knots have been untied, a lot of string still gets thrown away, because it's such an effort to wind it up in an orderly way. You

A. Bowline—*The best knot for forming an end loop that won't slip.*

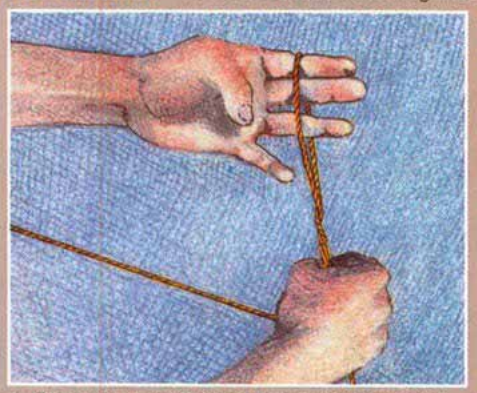
1. Make a loop near end of line.



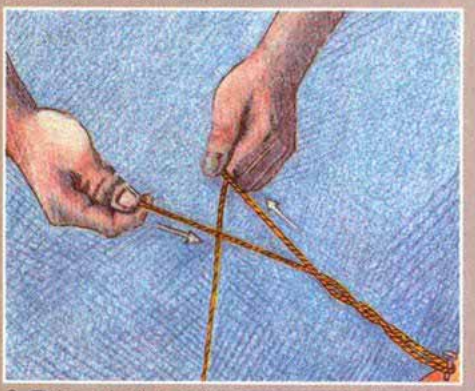
2. Pass free end up through loop.

3. Pass the free end around the standing string and back down through the loop.

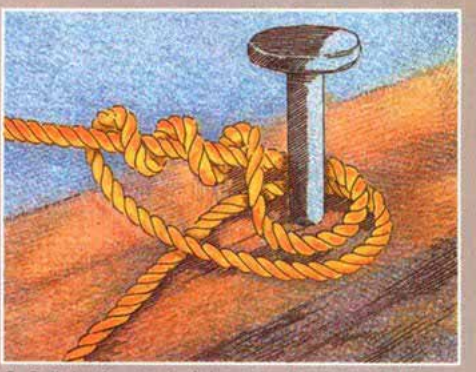
B. Twist knot—*The knotless knot for making lines taut and securing them around a nail.*



1. Form a loop, twist it around your outstretched fingers three or four times, and lay it over the nail.

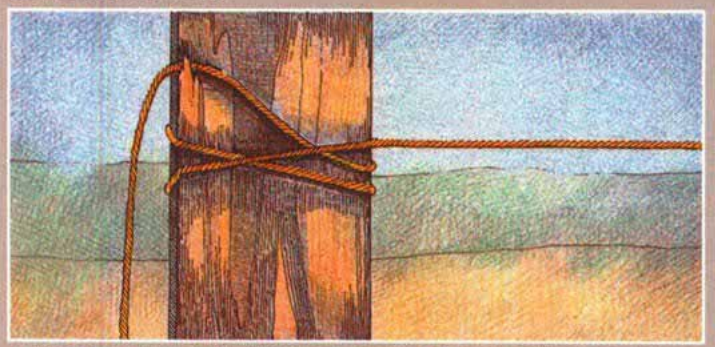


2. Tighten the line and retrieve the slack through the knot.



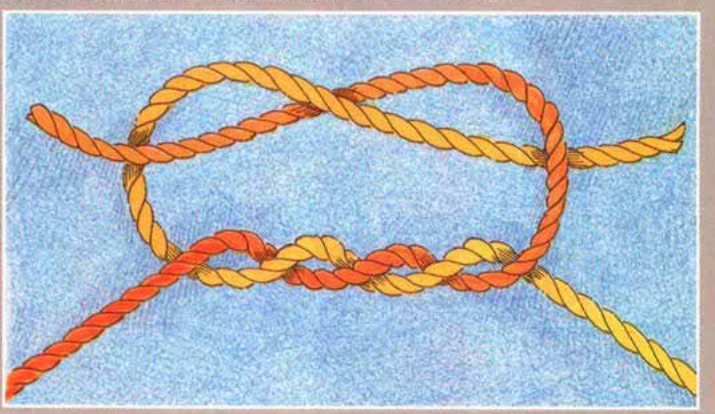
3. Pull the free end of the string back toward the nail and finish off the knot by pulling the free end back under the twists.

C. Tension hitch—*An easy knot to hold an elastic string like nylon taut between posts or stakes.*



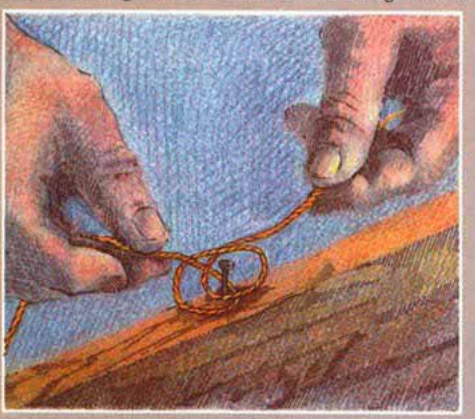
1. Make two wraps around the stake. Recover the slack so the line is taut. Make sure that the end of the line that is under tension crosses over the top of the two wraps.

D. Surgeon's knot—*Used for joining two pieces of string in line. Simply a square knot with an extra turn in the first overhand knot.*

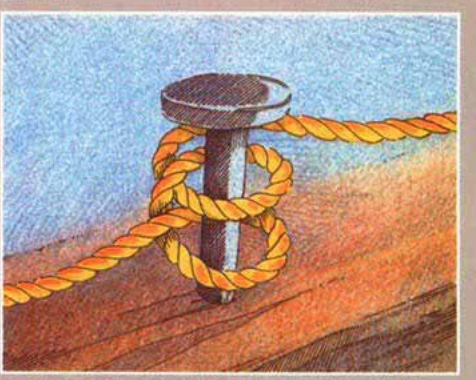


E. Clove or builder's hitch—*Used to fasten the middle of a string so that tension can be brought from either end.*

1. Form two consecutive underhand loops in the standing part of the line.



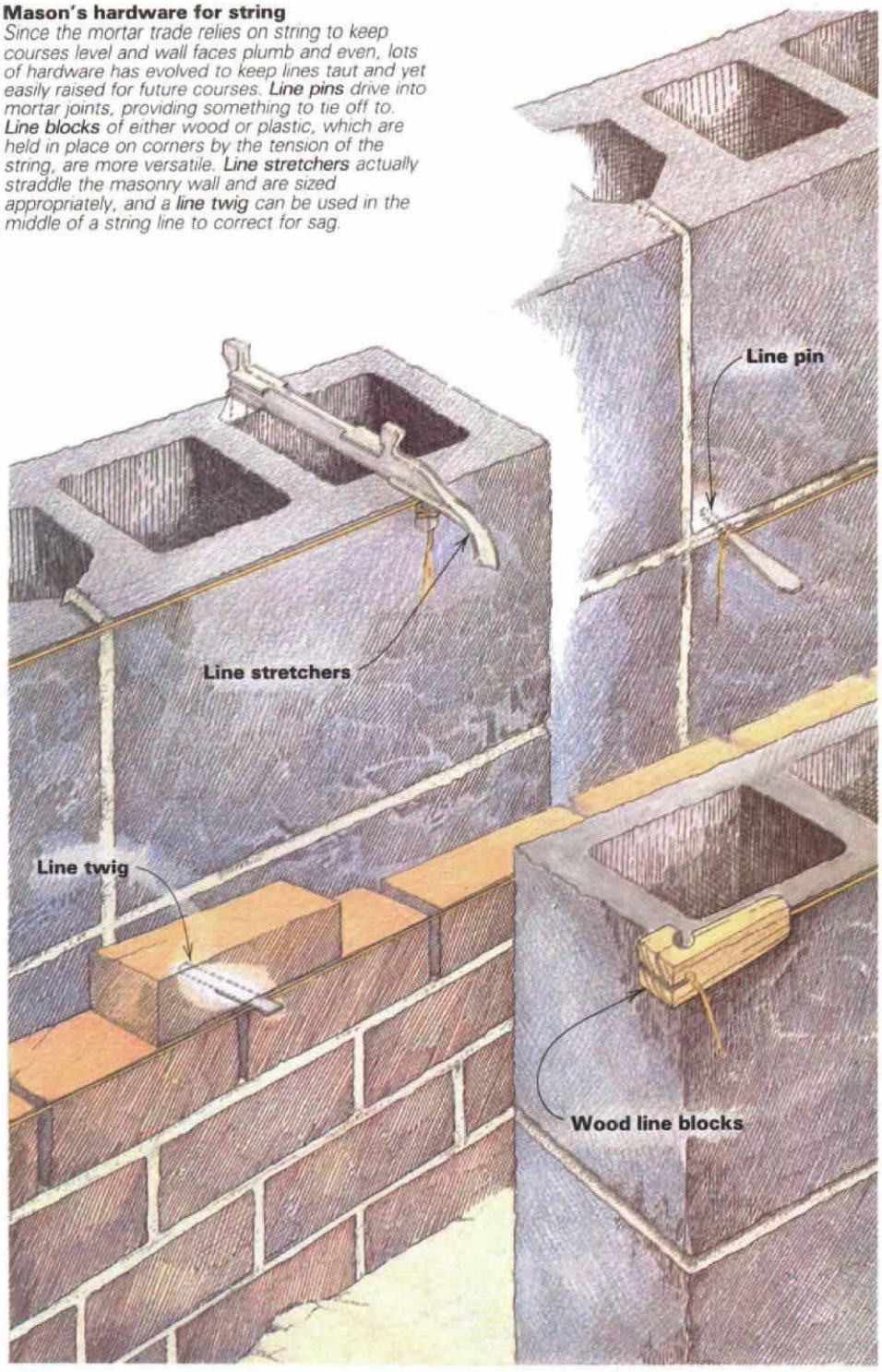
2. Lay the second loop on top of the first.

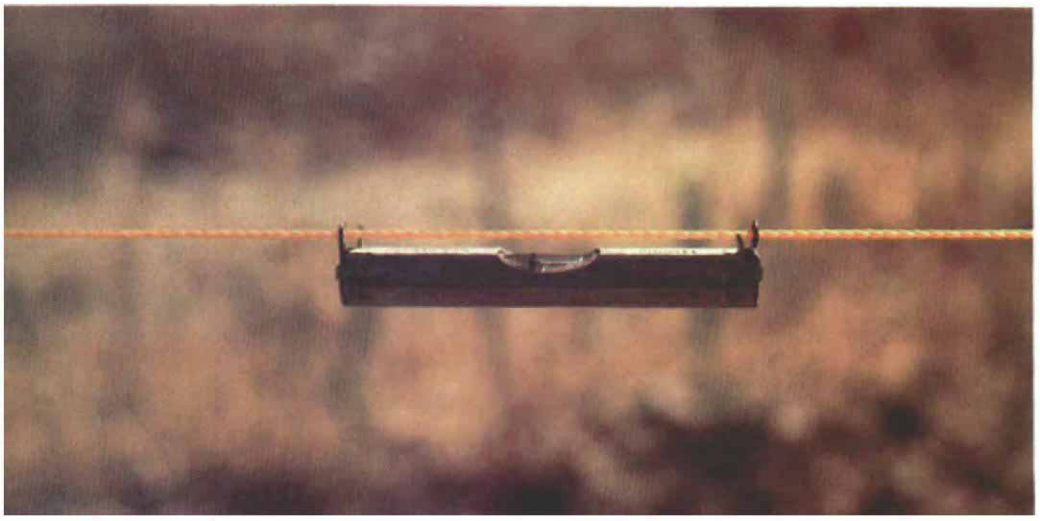


3. When slipped over the nail and tightened, the first loop should cross over the standing part of the line and the other one pass under.

Illustrations: Elizabeth Eaton

Mason's hardware for string
Since the mortar trade relies on string to keep courses level and wall faces plumb and even, lots of hardware has evolved to keep lines taut and yet easily raised for future courses. **Line pins** *drive into mortar joints, providing something to tie off to.* **Line blocks** *of either wood or plastic, which are held in place on corners by the tension of the string, are more versatile.* **Line stretchers** *actually straddle the masonry wall and are sized appropriately, and a* **line twig** *can be used in the middle of a string line to correct for sag.*





A line level doesn't give a highly accurate reading because of the sag it creates even in the tautest string lines, but it's a useful tool for rough layouts and grading. This aluminum-clad version runs about $3.

can buy plastic winders that look like the letter H or make one out of a 1x4, but I was taught to use a 1x2 or a piece of pipe about 10 in. long. With it, you can imitate machine-winding, although your figure-eights aren't going to lay in quite so nicely. After building up a small core of string on the stick, hold it loosely in the middle and twirl the top of the stick in the direction of the string line so that it wraps around once, and then twist the top away so that the bottom gets a wrap. If you rotate the stick in your fingers at the same time you are twirling it in the air, you'll be able to distribute the wraps ail along the stick so that you don't get one big ball in the center. When you're finished, secure the loose end by tying it to a nail and sticking it in the string.

Hardware—Masons rely on string to keep their courses straight and level, and they use a variety of fasteners to keep it taut and in place (drawing, left). But unlike most of the string lines that carpenters run, a mason's line has to move up every few courses. One method of securing the line is to use *line pins*. These are steel wedges (tempered ones are best) about 4 in. long that are driven directly into the mortar joint of a built-up corner, and used for tying off the string.

With block and brick, most masons use *line blocks*. These are small blocks of wood or plastic rabbeted on one side to form a heel that fits around a corner block or batter board. They are used in pairs, and the tension of the string between them keeps the blocks in place. A void in the inside corner of the block allows you to secure the string without affecting the block's grip, and a lateral groove on the inside face holds the tensioned string in place. Wood blocks grip the wall best and cost about 50¢ apiece. Plastic ones last longer but cost four times as much.

Line stretchers can also be used for block. These are made of steel or aluminum bar and have knobs on both top and bottom spaced so the stretcher will fit tightly across walls of two widths. The knob that fits over the front face of the wall is notched to hold the string. Line stretchers run about $7 a pair and come in several sizes. Adjustable models cost a bit more.

Even an elastic line like nylon will sag in the middle from its own weight on long walls despite heroic attempts to tighten it. This is where *line twigs* come in. These are flat metal line-supports that clip around the string like hairpins. Once attached to the string, the blade of the twig can then be set on top of a brick or block that has been laid to the working height in the middle of a wall. A loose block or brick can be stacked on top of the twig to hold it in place. Long walls may require more than one twig; they cost about 20¢ apiece.

A lot of masons use corner poles that can be set at the beginning of the job and left until the last course is laid (see *FHB* #15, p. 46). They combine the advantages of line blocks and story

poles. The strings are moved up the pole in course increments as the work progresses. Corner poles are available with attachments for both inside and outside corners, and in free-standing models or with telescoping braces. The cost of these aluminum or steel guides is prohibitive unless you do a lot of masonry.

Most of the time, I rely on a builder's level or tubular water level to set my level lines (I make sure that my batter boards are exactly level before I ever get the string out), but for very rough layouts a *line level* (photo facing page) will suffice. It is a lightweight aluminum tube about 3 in. long that is fitted with a level vial. Little hooks project from the tube so that it can be hung from the string. Line levels run about $3. Remember that the line sags somewhat of its own weight, and slightly more with the level, so the reading will only be approximate.

Strings for laying out—I use string the most when I'm laying out foundations. In this process, the strings form a full-scale drawing of the foundation plan. Begin by building batter boards just back from what will be the corners of the building. They should all be level with each other. Then run string lines between the batter boards, and adjust them until the dimensions of the building are correct, and the strings are square to each other (see *FHB* #11, pp. 26-28 for a more detailed explanation of this process). You should set up additional batter boards to line up piers, post brackets or any other hardware that needs accurate placement.

By plumbing down from the perimeter strings, you can establish footing lines with loose chalk. Before removing the strings from the batter boards for the backhoe, clearly mark their final position with a single nail or saw kerf. After the trenching is completed, the lines can easily be replaced for forming.

String is also helpful when you're grading fill for a concrete slab. I run lines 4 ft. or 5 ft. apart just above the ground at finished concrete height, measuring down the thickness of the slab to check the level of the aggregate. A handy gauge for grading this way is to use an eyelet on your workboot that is the correct height to the string from the top of the gravel.

Gauging straightness—Strings that are used to line walls or to check an existing structure require some kind of offset where the string is attached at each end. This will allow the line to run parallel to what's being aligned without actually touching it, so that deviations in the material won't get in the way of the string. It's best to use a standard increment for this offset. Framers usually use a 1x or 2x scrap at each end, and then gauge along the string with a third block of the same thickness.

When lumber comes out of the sawmill it is square and straight, but it's a long way from there to the job site. If you suspect a high joist (you did crown them, didn't you?), use a string before you put the plywood down. This will show you how much to plane off if you have to. The same goes for setting big ridge and purlin beams. What gets sold as "minimum crown" in a huge beam can cause you a lot of problems once the rafters are up, and it doesn't take long to run a string to find out how bad the hump is, so that you can either ignore it or correct it.

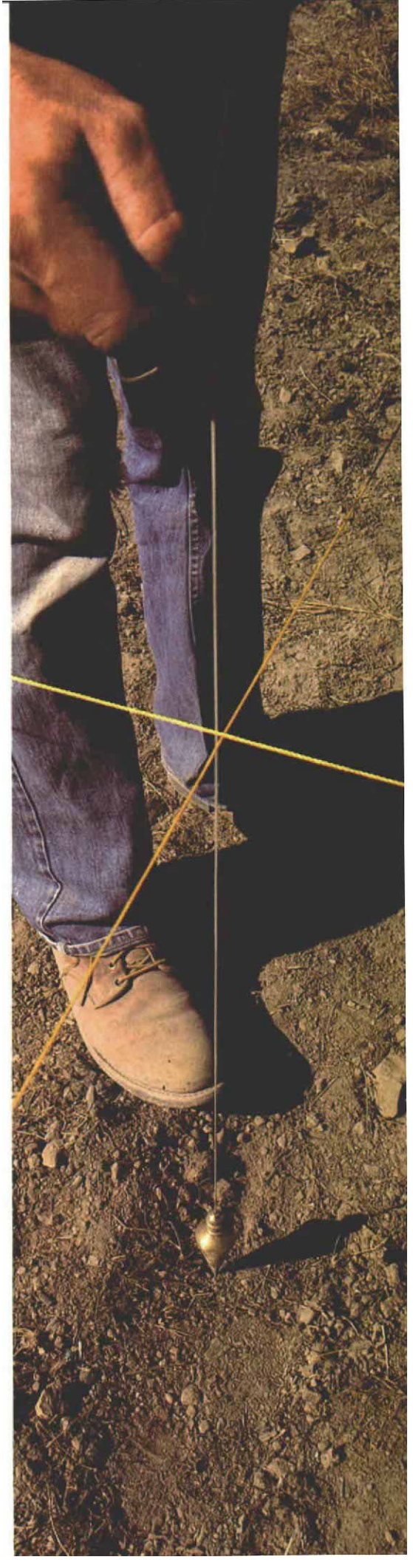
Figuring with string—String is also a good medium for puzzling out how things fit together. Those odd rafters—the ones that aren't in the book or that you can't work out on the square—can be defined with string line. An adjustable T-bevel and a level can then be used to gauge the angles off the string line. If you are doing this, make sure that your string really does represent the top edge of the rafter. It's easy to get in a hurry and stretch the string from the ridge down to the outside edge of the double top plate of a wall.

To get the height of the lower end of the string right, I usually tack a block to the top of the double top plate. It should be the same height as the distance from the seat cut to the top of the rafter. The top end of the string should be stretched over the ridgeboard unless the rafters require a seat cut at the top for a ridge beam or high wall. In that case, cut an appropriately sized block and tack it in place.

Plumb lines—Using a plumb bob is based on the fact that if you suspend a string and weight it at the bottom, it will be vertical and perpendicular to any level plane it passes through. Building projects as impressive as the Pyramids relied solely on plumb bobs to get true vertical. Flooding an irrigation ditch with water gave these builders a gauge of what was level. With these resources they achieved impressive accuracy. Modern builders have more sophisticated tools—transits and spirit levels—for establishing plumb, but there are lots of times when none of these is the right tool, and a plumb bob is.

Plumb bobs can do two basic things: provide a reference for true vertical, and project points up or down. Foundations are a good example of the latter. In this case the string layout hovers above the ground at least a few feet. Superimposing that layout on the ground—first for the backhoe and later for squaring the forms—requires plumbing down from the strings. Provided you didn't do too much celebrating the night before and a gale isn't building, a plumb bob is a very accurate way to do this.

Transferring the corner points to the ground is done by holding the plumb-bob string tight to the 90° intersection of batter-board strings without actually touching them. You should set your legs apart in a secure, comfortable stance, brace your arms against your body and lean directly over the plumb bob. In this case you will have to make sure that you are clear of the batter-board strings, but you'll be using this same position whenever you project a point from above. Hold the bob a fraction of an inch off the ground and concentrate on the intersection of strings above. Once you're satisfied with the position of the string, let it slip from your hand so that the point



Using a plumb bob to project the corner of a building down to grade or the top of the forms from intersecting batter-board strings requires a surprising degree of steadiness, but it's by far the most accurate and practical method.

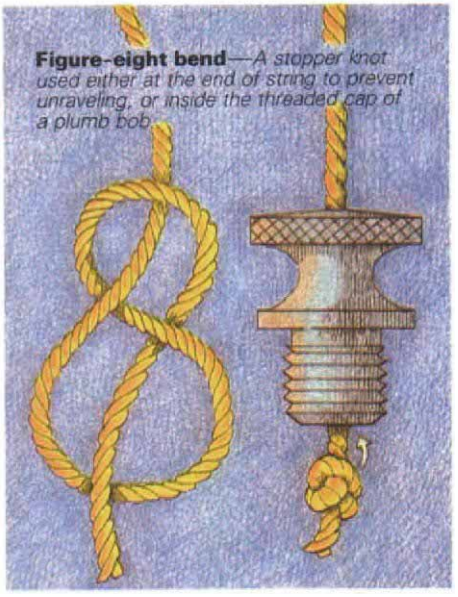
hits the ground. If greater accuracy is needed, spot a nail in the dirt where the point hit and plumb it again, making sure that the point centers on the nail head.

To find a point along the line you've established, you will need to use a tape measure in combination with a plumb bob. This requires two people. Your helper should "burn a foot" of the tape (hold it on the 1-ft. mark), or use a leather thong to get a good grip while holding the tape accurately over the intersecting strings. A solid stance allows your helper to sight down on the tape and to brace against the tension that you'll be exerting on it. On the smart end of things, lay the plumb-bob string directly over the tape on the correct dimension. Make sure that you are paralleling the batter-board string, which is level and square to the rest of the layout, and then keep the tape taut while you pay attention to the bob itself.

Another common use of a plumb line is projecting an established point up in the air, such as lining up the face of a beam with the layout on the floor. It saves time to use two people here—one on the plumb-bob point at the floor and the other up on the beam.

A plumb bob also makes good sense when you need to establish a true vertical line but the distance is too great to be checked with a level. High walls, posts and very tall door and window jambs are good examples. When you use a plumb line this way, it's necessary to offset the string from the work to allow the plumb bob to hang free. When this offset measurement is constant along the entire height of the string, then the object is plumb.

Because a plumb line is absolutely vertical, it's also indispensable for laying out chimney flues



Maybe the most common use of a plumb bob is to project a point up or down in space. Here, the author checks a layout point (represented by the duplex nail driven into the top of the stake) by using the plumb bob together with a tape measure. This requires a braced stance and steady nerves if the tape is going to be stretched tight enough for an accurate measurement from the original benchmark.

and stovepipes, and for figuring out where a light fixture goes in a sloped ceiling.

Almost any type of string will work to suspend a plumb bob, but braided nylon has no natural twist, so it doesn't spin in one direction and then in the other like a confused top. The line should be attached through the hole in the bob's threaded cap and tied off with a figure eight or stopper knot (drawing, facing page). When it's not in use, the string can be wrapped around the plumb bob, reeled into an old chalkbox, or stored on a small winder (see *FHB* #11, p. 14 for a spool that offsets the string when the bob is in use).

Steel plumb bobs are the cheapest. Henry L. Hanson, Inc. (220 Brooks St., Worcester, Mass. 01606) makes a bullet-shaped, hexagonal bob that I see a lot, but there are many other manufacturers. Popular weights are 5 oz. and 8 oz., and they run well under $10. These are fine for short drops, but for anything a story high or more, you should use a heavier version. Solid brass plumb bobs in a teardrop shape are the most popular. General Hardware Mfg. (80 White St., New York, N. Y. 10013) makes them with replaceable steel tips in 6-oz., 8-oz., 10-oz., 12-oz., 16-oz., 24-oz. and 32-oz. weights. They range in price from $8 to $28. Stanley (Stanley Tools, 600 Myrtle St., New Britain, Conn. 06050) makes a painted cast-metal version in 6-oz., 8-oz. and 12-oz. weights for a bit less money.

The heavier the bob, the better chance that you'll be able to get a good reading when there's a breeze. But large plumb bobs are pretty cumbersome to carry around in your nail bags. The ideal setup is a small bob for most work, and a 16-oz. or 24-oz. bob for long drops where the wind is a bigger factor.

There are two other types of plumb bobs that you will occasionally see. The first is the old-fashioned squat type. These are made of iron, but because of their shape it is very difficult to see a mark beneath them. The other kind is the small-diameter, bullet-shaped steel plumb bobs that have been bored and filled with mercury to get a low center of gravity and lots of weight for their size. L. S. Starrett Co. (Athol, Mass. 01331) makes a 12-oz. plumb bob that is only 6 in. long and ⅞ in. in diameter.

Chalklines—Being able to connect two points at considerable distance from each other with a straight line that is highly visible by simply plucking a string is a gift from the gods that a builder couldn't live without. There's no end to the applications. Carpenters of the 19th and early 20th centuries had to chalk their lines by running the string over a hemisphere of solid chalk. A chalkbox is a lot easier.

There are a number of brands on the market priced under $10. The most popular are Stanley's, Evans' (The Evans Rule Co., 768 Frelinghuysen Ave., Newark, N. J. 07114) and Irwin's (The Irwin.Co., 92 Grant St., Wilmington, Ohio 45177). Stanley and Evans chalkboxes have aluminum die-cast cases (Stanley also makes a less expensive polypropylene model) that you can fill through a threaded cap. All of these boxes are available in 50-ft. and 100-ft. models (you're better off paying the extra dollar for the extra length). Evans' best model, which runs under $7, has a crank that can be stored completely flush with the case, and will release the string from this position. A slide mechanism allows you to lock down on the string. The Irwin Strait-Line box is an aluminum alloy, but is filled from a nylon sliding window on the side. It costs about half as much as the other two.

There are also geared chalkline reels in ABS plastic (Keson Industries, Inc., 5 South 475 Frontenac Rd., Naperville, Ill. 60540) and aluminum (B & S Patent Developing Corp., Box 1392, Riverside, Calif. 92502) that will recover the string at up to four times the pace of a direct-drive box. This can be a real advantage when you're laying out large spaces. They run about $5 to $7. On the E-Z Fastline, you can disengage the gears, which lets the string free-spool out of the box, by keeping the top of the crank depressed. This is a nice feature, since with some boxes you have to cope with the handle spinning around in your hand as the string is released. Unfortunately, the geared boxes are quite large and take up a lot of room in your nailbags. I also haven't been impressed with their quality—the cranks on the ones I've seen are quite flimsy, and the plastic cover for the filler hole looks like it wouldn't survive an assault by 16d nails in the bottom of a nailbag.

Most chalkboxes are outfitted with cotton line to which a small metal hook/loop combination is attached. Cotton is used because it doesn't stretch, it leaves a crisp line, and the rough natural fiber retains the chalk well. It does, however, abrade easily. Although cotton replacement line is available for less than a dollar, I experimented with braided nylon for its toughness but I didn't have much luck. The line wouldn't hold much chalk, and what chalk did adhere was thrown every which way with the snap. Also, because nylon is elastic, it vibrated after the pluck, leaving a thick line.

Powdered chalk comes in four colors: red, blue, yellow and white. It is packaged in plastic containers holding 1 oz., 4 oz. or 8 oz. of chalk, and a 1-gal. size weighing 5 lb. I keep an 8-oz. bottle in the toolbox, refilling it from the less expensive gallon jug. It pays to have a couple of different chalkboxes so that you can use contrasting colors when you want to overstrike a mistake or distinguish between two things in a complicated layout.

There aren't too many tricks to using a chalkbox. If it was recently filled, pluck the line in the air a time or two to shake off the excess chalk. But even if the string is really loaded at first, two to four snaps and you won't be able to produce a visible line. You could then rewind the string, but it's faster if you just have another few snaps to do to pull out more string instead.

You will often see carpenters automatically rap their chalkboxes on the floor or against their thighs before attaching the free end of the line. This merely redistributes the remaining chalk in a partially filled box so that the string will come out with a full coating.

The universal hook that comes on the end of all chalkboxes will work on the edge of almost anything but a concrete slab (the edging trowel usually has a larger radius than the hook can accommodate). In this case, you're best off getting a helper. On plywood or lumber, drive an 8d nail and lower the hook onto it or use a scratch awl. For shorter snaps, you can hold one end down with your foot. In a pinch, you can snap a line that is less than 18 in. or so by using your thumbs to hold the ends, and using your little finger to make the snap. This can be useful when you've got to cut a series of jogs in plywood siding, for instance. If you practice this a few times you'll find it faster than taking your combination square apart to connect the lines.

No matter how long the line, it must be quite taut to get a good snap. The pluck must be perpendicular to the surface to be marked, or you'll get a curved line. Lift the line just enough for the ends to clear and let it go. Take time to get it right the first time, because a second snap usually makes a mess. On long runs the line must be lifted so high that you run a real danger of not being able to pull straight up on the string. Solve this by holding the string down in the center and snapping each side individually. □

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You'll get a clean snap every time if you stretch the string as tightly as you can, raise it straight up off the work with your thumb and forefinger, and then release it quickly in mid-air. For accurate snaps of 12 ft. or more, get a helper to hold the string down in the center and pluck the line separately on both sides.