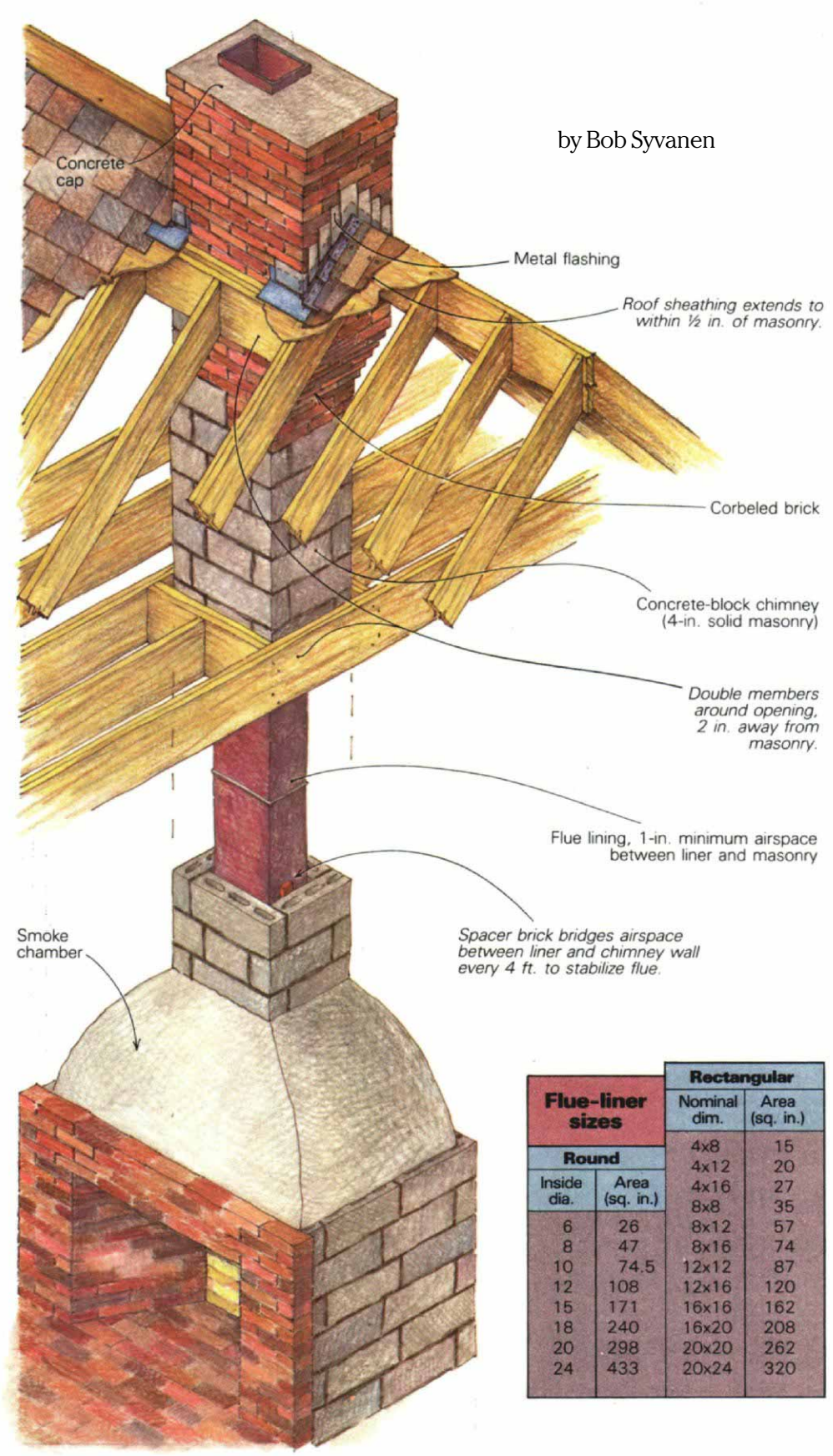
The Fireplace Chimney

Flashing and capping are the tricky parts of the job

by Bob Syvanen



Flue-liner sizes		Rectangular	
Round		Nominal dim.	Area (sq. in.)
Inside dia.	Area (sq. in.)	4x8	15
6	26	4x12	20
8	47	4x16	27
10	74.5	8x8	35
12	108	8x12	57
15	171	8x16	74
18	240	12x12	87
20	298	12x16	120
24	433	16x16	162
		16x20	208
		20x20	262
		20x24	320

Throughout most of history, masonry chimneys were just hollow, vertical conduits of brick or stone. These single-wall chimneys have many problems: they conduct heat to the building's structure; they aren't insulated from the cold outside air, and so allow severe creosote buildup as the cooling gases condense; and they suffer from expansion and contraction, which lead to leakage of water (at the juncture of chimney and roof) and smoke (through cracks in the masonry).

In present-day chimneys, ceramic flue tile carries the smoke. It can withstand very high temperatures without breaking down, and also presents a much smoother and more uniform passageway, which means easier cleaning and thus less chance of chimney fires. Brick or concrete block, laid up around the tile but not in contact with it, serve as a protective and insulative layer.

Ceramic flue tiles can be either circular or rectangular in section, and are available in a number of sizes (see the chart below left). Brick, block and mortar are the only other materials you need to build a chimney (to find out how to build a fireplace, see pp. 54-58 of *FHB* #20). John Hilley, a mason I've worked with for the last eight or nine years, uses type S mortar throughout the entire chimney, but some codes require refractory cement to be used for all flue-tile joints.

Requirements and guidelines—Before you start building a chimney, you've got to consider sizing, location and building-code requirements. I'll be talking about masonry chimneys that are built above fireplaces, but most of the construction guidelines also apply to masonry chimneys that are meant to serve a woodstove, a furnace or a boiler.

The Uniform Building Code ($40.75 from I.C.B.O., 5360 S. Workman Mill Rd., Whittier, Calif. 90601) contains basic requirements for chimney construction, and most states and municipalities have similar rules tailored to meet particular regional needs. I have a 1964 U.B.C. that reads the same as the 1984 Massachusetts State Building Code. It calls for a fireclay flue lining with carefully bedded, close-fitting joints that are left smooth on the inside. There should be at least a 1-in. airspace between the liners and the minimum

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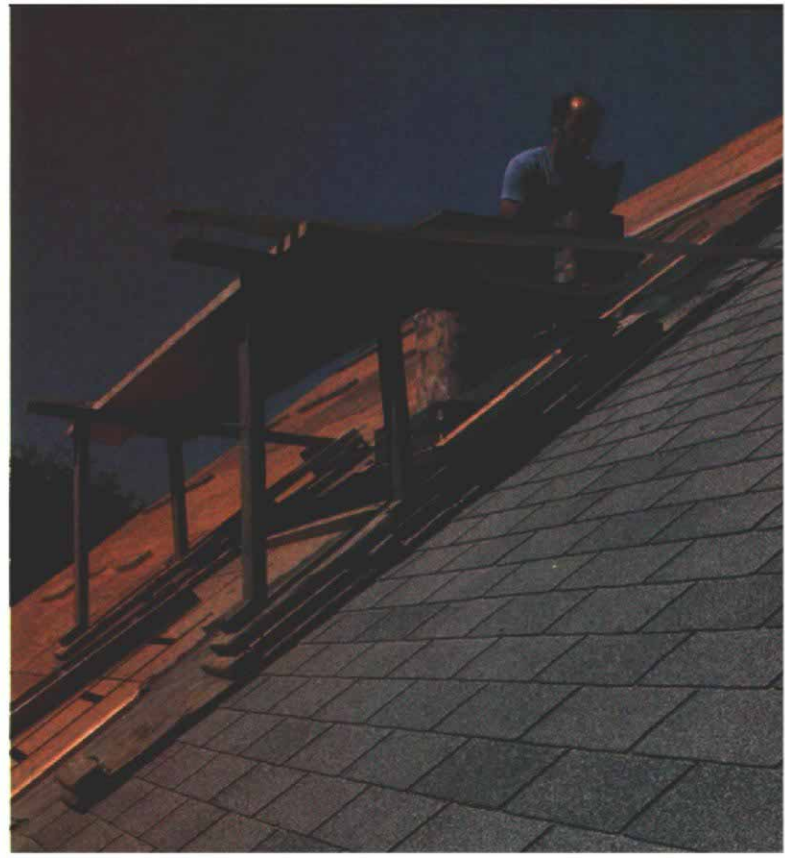
Illustrations: Christopher Clapp



Just below the roofline, the chimney wall shown above changes from 4-in. thick concrete block to brick. Block is much faster to lay up than brick, but it's usually used where appearance isn't important. The brick wall has been corbeled out against a temporary plywood form, enlarging the chimney above the roof and also centering it on the ridge. From this stage on, a good working platform on the roof is essential, right.

4-in. thick, solid-masonry chimney wall that surrounds them. Combustion gases can heat the liner to above 1,200°F, and the space between liner and chimney wall allows the liner to expand freely. Only at the top of the chimney cap is the gap between liner and wall bridged completely, and here expansion can be a problem. We'll talk about this later.

Chimney height is pretty much dictated by code. According to my Massachusetts Building Code, "All chimneys shall extend at least 3 ft. above the highest point where they pass through the roof of a building, and at least 2 ft. higher than any portion of a building within 10 ft." This rule applies at elevations below 2,000 ft. If your house is higher above sea level than this, see your local building inspector. The rule of thumb is to increase both height and flue size about 5% for each additional 1,000 ft. of elevation.

Exterior chimneys must be tied into the joists of every floor that's more than 6 ft. above grade. This is usually done with metal strapping cast into the mortar between masonry courses. No matter where your chimney is located, it should be built to be freestanding. The chimney can help support part of the wood structure, but the structure shouldn't help support the chimney. And there should be at least 4 in. of masonry between any combustible material and the flue liner.

The U.B.C. also has standards for flue sizing. For a chimney over a fireplace, the interior section of a rectangular flue tile should be no less than 1/10 the area of the fireplace opening. If you're using round flue tile, 1/12 the area of the fireplace opening will do because round flues perform slightly better.

Rectangular flue tile is dimensioned on a 4-in. module—8 in. by 8 in., 8 in. by 12 in., 8 in. by 16 in., 12 in. by 12 in., and so on. Standard tile length is 2 ft., though you can get different lengths from some masonry suppliers. When a mason talks about a 10-tile chimney, he usually means that it's at least 20 ft. high.

Using the flue-sizing formula isn't a guarantee that your chimney will draw properly. The chimney height and location, the local wind conditions, the firebox type, and how tight the house is are all factors that influence performance. John Hilley has found that on Cape Cod (at sea level), a 10-tile chimney atop a shallow firebox will work fine with flue sizing as low as 7% of the fireplace opening. Generally, short chimneys won't draw as well as taller ones. If you've got any doubts about what size flue tile to use, it's a good idea to ask an experienced mason or consult with your local building inspector,

Chimney construction—The fireplace chimney starts with the first flue tile on top of the smoke chamber of the fireplace (see the drawing on the facing page). As described in *FHB* #20 (pp. 54-58) the smoke chamber is formed by rolling the bricks of each course above the damper to form a strong, even, arched vault with an opening that matches the cross section of the chimney's flue tile. Since the smoke chamber will carry the weight of the chimney above it, it's got to be soundly constructed. If the rolled bricks of the chamber form an even, gradual arch, there should be no problems.

To begin the chimney, seat the first flue tile on top of the smoke-chamber opening in a good bed of mortar. Building paper or an empty cement bag on the smoke shelf will catch mortar droppings. You can remove the paper by reaching through the damper when you've finished the chimney.

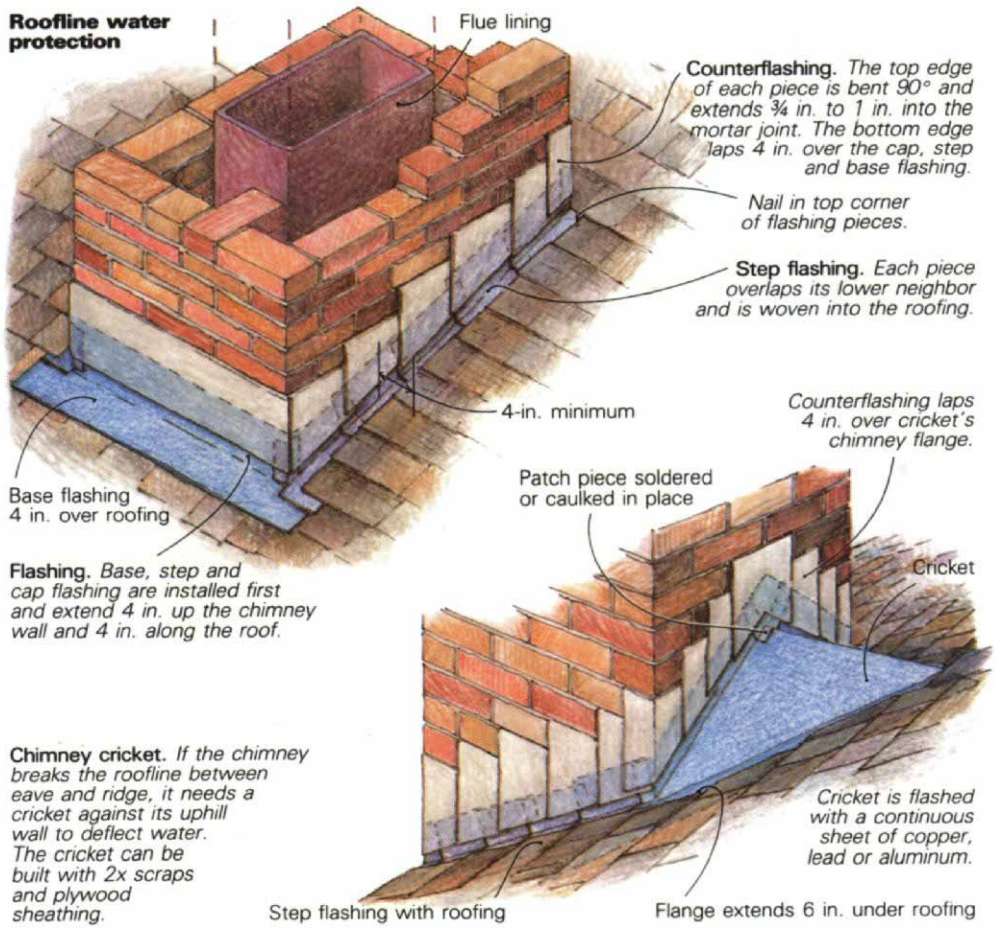
Lay the chimney wall up around the flue tile, maintaining a 1-in. minimum airspace between tile and chimney wall. It's best to lay one flue tile at a time, building the chimney wall up to a level just below the top of each liner before mortaring the next one in place. Use a level to keep the liners and the chimney walls plumb. The mortar joint between tiles should bulge on the outside, but use your trowel to smooth it flush on the inside.

At every other liner, Hilley bridges the 1-in. airspace with two bricks or brick fragments that butt against the flue tile. These should extend from opposite sides of the chimney to opposite ends of the liner. This stabilizes the flue stack without limiting its ability to expand and contract with temperature changes.

If the chimney wall will be hidden behind a stud wall or in an attic, you can use 4-in. thick concrete block, which can be laid up much faster than brick. You can then switch to brick just below the roofline. Below the roof, chimney size is usually kept to a minimum to save space. If a larger chimney is desired above the roof, the chimney walls can be corbeled in the attic space (photo above left). The corbel angle shouldn't be more than 30° from the vertical (an overhang of 1 in. per course). A temporary plywood form set in place at the desired angle works well as a corbeling guide.

Coming through the roof—Roof sheathing should extend to within ½ in. of the chimney, with structural members around it doubled and no closer than 2 in.

The next step in this part of chimney construction is to set up a good working platform on the roof (photo above right). Staging for



chimney work must be steady, strong and roomy. You can rent steel staging or build your own from 2x material. Either way, check the soundness of your staging well before you load it up with bricks and mortar. And before you bring any mud up on the roof, lay down a dropcloth to keep the roof clean.

To get to the staging, I put a ladder on the roof with its upper end supported by a ridge hook. It's a good idea to put some padding between the eave and the ladder rails so that the edge of the roof isn't damaged as you trudge up and down. You'll need a second ladder to get from ground to roof, unless the roof is steeply pitched. In that case, you can simply extend one ladder (if it's long enough) from ridge to ground.

Flashing—You're bound to find generously caulked flashing if you look closely at the chimneys in your neighborhood. I've lost track of the patch jobs I have done trying to stop chimney-flashing leaks. What sometimes happens is that rain gets blown in behind this flashing during a storm. Infrequent leakage doesn't mean the flashing job was poorly done, and caulking is a good stopgap in cases like this. But if your flashing leaks regularly in rainy weather, it probably wasn't installed correctly in the first place.

The Brick Institute of America (1750 Old Meadow Rd., McLean, Va. 22102) recommends flashing and counterflashing at the roofline. This creates two layers of protection, with the counterflashing covering the base and step flashing on all sides of the chimney.

The Brick Institute recommends the use of copper flashing, but today you'll see more widespread use of aluminum, since it's much less expensive. Through-pan flashing (explained at right) is usually done with lead.

If your chimney straddles the ridge, first install the base flashing against the two chimney walls that run parallel with the ridge. Then step-flash the sides. Each flashing piece should extend at least 4 in. onto the roof, and is held with one nail through its upper corner.

Install counterflashing over the step and base flashing. The bottom edges of the counterflashing overlap the base and step flashing by 4 in. (drawing above left). The top edges of the counterflashing are turned into the masonry about ¾ in. They can be cast into the mortar joints as the chimney is built, or tucked into a slot cut with a masonry blade after the chimney is finished.

If the chimney is located against the side of the house or in the middle of a sloping roof, then you need to build a cricket against the uppermost chimney wall (drawing, above right). Otherwise, water will get trapped here, and you'll eventually have a leak. I use scrap 2xs and plywood to construct the slope, then cover the cricket with building paper and flash it with a large piece of aluminum or copper. The cricket flashing should extend 6 in. under the shingles and be bent up 4 in. onto the masonry, where it's covered by counter-

Through-pan flashing

Driving rainstorms can cause a lot of water to penetrate a chimney through cap and brick. Even when perfectly installed, conventional flashing can do little to stop this kind of penetration. The best way to drain out water that gets between the outer brick wall and the flue lining is to install through-pan flashing. Through-pan flashing is just what it sounds like—a continuous metal pan sloped from the flue lining to the roof. Weep holes between bricks just above the pan provide drainage.

There's some controversy about the effect that through-pan flashing has on the strength, and stability of the chimney, since it breaks the mortar connection between bricks in adjacent courses. According to the Brick Institute, "if there is insufficient height of masonry above the pan flashing, wind loads may cause a structural failure of the chimney." This might be a valid warning, but I've never seen this kind of structural problem here on Cape Cod, which has its share of windy weather. And there's no arguing that through-pan flashing creates a more complete water barrier at the roofline than the conventional flashing scheme. Unless you live in earthquake or hurricane country, I can't see any reason not to use this system.

You can use copper or lead for through-pan flashing. John Hilley prefers lead because It's less expensive than copper, more malleable and generally easier to work. A utility knife will cut the stuff Lead isn't supposed to last quite as long as copper, but I've seen 50 year-old lead pans that are still in good condition,

***Building the curb*—Before you can install the pan, you've got to build a curb where the chimney walls come through the roof. This is done with a combination of angled bricks or blocks and mortar, set in a form made from 2x lumber (top photo, facing page). The side walls of the curb should match the slope of the roof, and be around 1½ in. above the roofline. The lower and upper walls of the curb should be 4 in. to 6 in. above the roofline, parallel with it, and level. Like chimney walls, curb walls should be at least 4 in. deep.**

Top the curb with a smooth layer of mortar, and the next day, rub the surface with a brick and round the corners to soften any sharp edges that could pierce the lead. Then install base, step, and cap flashing against the curb. With through-pan flashing, the pan takes the place of the counterflashing that is usually attached to the chimney walls.

***The lead pan*—If the joint between flue tiles falls just below or just above the roofline, then one piece of lead works well since you can roll it out on the base, find the outline of the flue, and cut holes for the next flue section to fit through. Alternatively, two or more sheets of lead can be used to make the pan. Just overlap the joints 6 in.**

To determine the size of the pan, add 20 in. to the length of the chimney's lower wall and 24 in. to 32 in. to its side-wall measurement. Measure the side wall by following the angled curb with your tape measure. The chimney shown here is 64 in.

wide by 32 in. deep, and ft required a sheet of lead 84 in. by 69 in. (7 ft. by 5 ft.). Lead sheets usually come in even foot widths and different lengths. For this job, Hilley trimmed a 6-ft. by 8-ft. sheet to size. These dimensions work for a chimney straddling the ridge. When the front and back walls of a chimney are on the same side of the ridge, the lead on the back or upper side of the chimney should be long enough to extend under two shingle courses plus one inch (more on a steep roof).

With the curb finished and flashed, and the lead cut to size, the next step is to install the pan. Roll the lead out over the curb and position it symmetrically (photo center left), then press down gently to find the outline of the flue tile.

Hilley cuts the hole for the tile about *2* in. smaller than the outside dimensions of the flue. Then he makes relief cuts in each corner and folds up the lead so that the flue can slide through it.

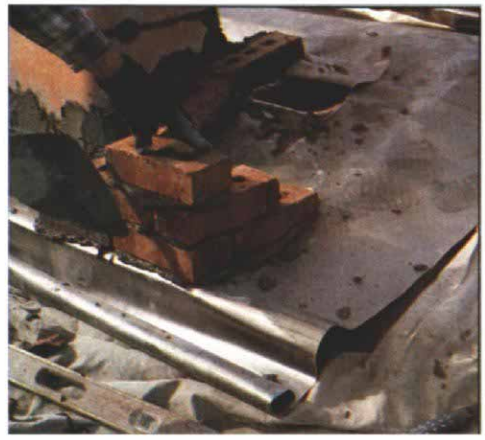
You have to be careful when handling the lead sheet; it's surprisingly easy to tear and puncture. The easiest way to carry a sheet is to roll it up. Never form lead with a hammer. Use your hand, a block of wood or a rubber-handled hammer handle. If you do pierce or tear the pan while installing it, pull the hole up above the surrounding pan so that water will drain away from it. You can also mend a hole by parging it over. As you position the pan, keep in mind that the object is to direct water away from the flue.

Once the flue tile that extends above the pan is in place, pull the lead up the sides of the flue to achieve the necessary outward slope. You can stiffen the top edge of the pan around the flue by folding it over. This helps to prevent sagging. After the lead is formed up tightly around the flues, parge the lead-to-flue joint with mortar.

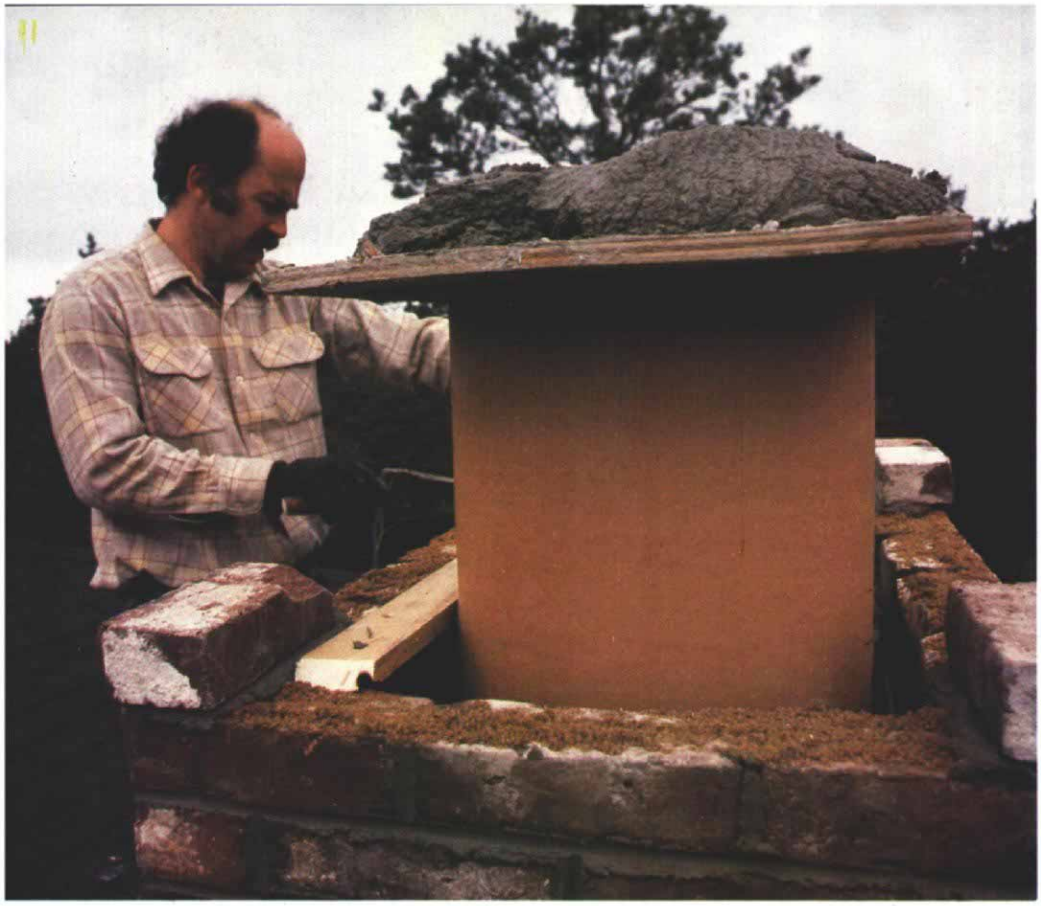
Laying up the brick—Lay the first brick course over the pan in a thin bed of mortar (photo center right). Be careful to follow the curb under the lead. Make a few weep holes at the lowest points of the pan. You can do this by temporarily inserting a twig or rope in the mortar between bricks, or by leaving a vertical joint between bricks open. You'll have to cut the bricks that fit just above the sloping sides of the pan. Use either a mason's hammer, a chisel or a masonry blade. Once the courses on both sides of the ridge join, finish the chimney just as you would if there were no through-pan flashing.

Finish the through pan by creasing its exposed corners, trimming the pan edges and bending them down against the roofing. Before you start this part of the job, carefully lift the lead and sweep out any loose rubble. Creasing the corners so that they look nice is hard to do. The easiest way to start the crease is by slipping a short length of wood or angle iron under the pan at the corner. Hold the wood or metal edge so that it bisects the 90° corner, and gently start to form the lead over it with your hand. Then, if necessary, use a scrap 2x4 or a similar tool to form the lead into a more defined crease, as shown at right. Sharpening the crease should force the pan down against the roofing. A second crease, close to the first one, will force the pan down even farther. —*B.S.*

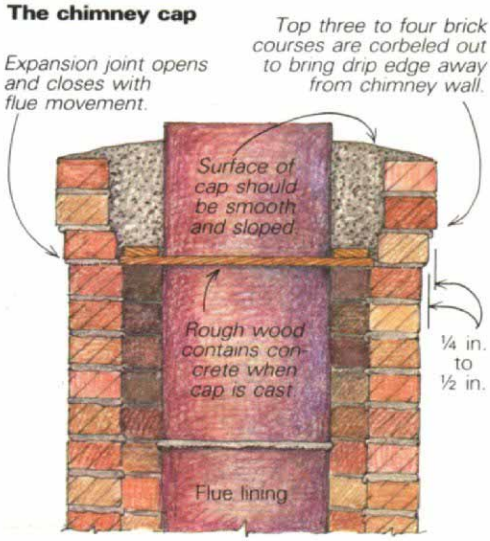
The curb for the through-pan, above, Is a combination of bricks and formed concrete, built directly on the chimney walls where they intersect the roofline. Curb walls should be at least 4 in. thick. The side walls of the curb are sloped to match the roof pitch, and 1½ in. above the roofline. End walls are level, parallel with the ridge and 4 in. to 6 in. above the roofline. At left, a lead sheet is cut to fit over the flue tiles and carefully rolled and bent over the curb. This forms the through-pan that will drain water away from the center of the chimney and onto the roof. Below, the pan is parged to the flue, and the first course of the chimney cap is mortared to it, bearing squarely on the curb.



The last step is to crease the corners of the pan, trim its edges and bend them down against the roof. Wood blocks and gentle hand pressure are used in this final forming.



The chimney cap



flashing. Once the cricket is finished and flashed, flash and counterflash the three remaining sides as mentioned earlier.

The cap—The chimney cap covers the airspace between flue tile and chimney wall, stabilizing the flue and directing water away from the rest of the masonry (drawing, below left). It's good to corbel out the chimney's top brick courses or to install a cap that overhangs the chimney walls. This will direct runoff onto the roof rather than onto the brickwork.

You can buy precast caps in a few sizes or cast your own in place. Installing or forming a cap is more complicated than it sounds because of the way the ceramic flue behaves. Cross-sectional expansion of heated flue tile is accommodated within the 1-in. airspace between tile and chimney wall. The concrete chimney cap bridges this gap, and if it's mortared directly to the tile, you're bound to have cracking and breaking problems. Even if the upper tiles stay cool and don't expand widthwise, the tiles near the fire will expand along their length, forcing the entire flue upward.

One way to accommodate vertical movement of the flue is to create an expansion joint between brick courses just below the cap. The topmost flue tile, cast to the cap, forces it upward as the flue stack expands. The cap's weight closes the expansion joint as the stack cools. Hilley creates his expansion joint by sprinkling a thin layer of sand on the brick course before laying down the mortar (photo top left). The sand prevents the mortar from adhering to the brick directly beneath it, but doesn't affect the bond to the bricks above.

The chimney top's first corbeled course creates an inside ledge that will support a form for the concrete cap (photo center left). You can use corrugated sheet metal or scrap wood for the form. If you use wood, as Hilley does, make sure it sits loosely on the brick ledge, and soak the wood in water before pouring the cap. This way, the wood won't swell and force bricks out of their bond.

The last flue tile should project above the level of the last brick course at least 2 in. so the concrete cap can slope down toward the edges of the chimney (photo bottom left).

Forming the concrete cap is the last step. Hilley casts the cap directly to the topmost flue tile, relying on the control joint several courses below to accommodate flue-stack expansion. An alternate method is to cast an expansion joint around the topmost flue tile. To do this, pack some ⅜-in. dia. backing rope around the top flue tile where the cap will fit, and then caulk the space with a flexible, non-oil-base sealant after the cap is cast. □

Capping the chimney. **Top, John Hilley creates an expansion joint with a loosely spread layer of sand beneath the mortar. Located several courses below the chimney top, this joint will widen and shrink with the normal expansion and contraction of the flue tile. The wood will be part of the concrete cap's bottom form. At center, the cap is cast between the flue and the top three brick courses. At left, the completed cap slopes away from the flue.**