Rumfordizing Brick by Brick

How to convert an energy-wasting fireplace to an efficient heater

by Kent Burdett

Most modern fireplaces don't do a very good job. Many smoke so badly that they can't be used, and almost none are efficient heaters. In fact, many of them draw more heat out of the house than they return, sucking in warm room air and sending it up the chimney. But it's possible to convert one of these mere ornaments into a functioning and efficient fireplace. An American Tory named Benjamin Thompson, later called Count Rumford, demonstrated the relevant principles two centuries ago.

Rumford proved that the key to an efficient fireplace is a properly proportioned firebox, with important dimensions based on the width of the opening. (The parts and proportions of a Rumford fireplace are shown on the facing page.) Both the firebox's depth (distance from opening to fireback) and the width of the fireback should each equal one-third the opening's width. This makes for a shallow firebox with covings angled at a sharp 45° to reflect the fire's radiant heat into the room. The fireback, which must be vertical to a height equal to one-third the opening's width, begins to slope forward from that point to a small throat above the lintel. The sloping back reflects more heat, and the small throat results in a more forceful movement of air up the chimney. It also leaves room for the smokeshelf, a necessary feature where descending cool air and ascending hot air circulate to set up a strong draft.

Rumford's workmen renovated so many smoking fuelwasters in England that a new word entered the language. His wealthy customers didn't just have their fireplaces improved, they had them "rumfordized." Once you know the principles, you can rumfordize your own fireplace. Fireboxes are not structurally connected to the masonry of the chimney, so you can tear out an unsatisfactory one and replace it easily.

Materials—For this job you'll need clean sand and water, masonry cement for the rubble fill behind the new firebox, firebricks and fireclay to join them. Experience provides the best way to judge just how much of each you will need for a specific project. For a fireplace 24 in. wide and 30 in. tall, I used 84 firebricks (2¼ in. by 4½ in. by 9 in. each), along with ¼ yard of sand and 2 sacks of cement. You can buy clean sand by the fraction of a yard at most lumberyards.

There are two kinds of fireclay, premixed and dry. The premixed costs twenty times as much as the dry variety, and can't be scraped or chipped from the faces of firebricks after it dries. Dry fireclay (available at ceramic supply houses) is sold in 50-lb. sacks, but one sack costs less than a single gallon of premixed.

As for the firebricks, try to buy what you need from the same lot. They will be fired to the same hardness, and there will be fewer small variations in their dimensions. You can find them at masonry supply houses and many lumberyards.

You probably already own or have access to most of the tools you'll need: a lightweight hammer, a tape measure, a try square, a level, a soft

Benjamin Thompson, Count Rumford

by Simon Watts

An efficient fireplace was hardly Benjamin Thompson's only contribution to civilized living. He was an extraordinary American whose adventurous life and considerable scientific achievements remain largely unknown. He was an ingenious inventor, always trying to improve clothing, coffee pots, eating habits, lamps and whatever else crossed his path. Perhaps he was overshadowed by his great contemporary, Benjamin Franklin, but I suspect his obscurity has more to do with his having been on the wrong side of the American Revolution.

Born in 1753, Thompson showed his scientific bent early. While still in his teens he experimented with gunpowder and electricity, and was already keeping a detailed journal of his observations, which became a lifelong habit. On at least one occasion his scientific curiosity nearly cost him his life. Attempting to repeat Franklin's famous experiment, he constructed a 4-ft. kite and flew it in a thunderstorm. Going the more prudent Franklin one better, he soaked the kite string in water to make it a better conductor. The results were suitably dramatic: Watching from the house, his family was amazed to see the youthful experimenter outlined in fire. He later remarked in his diary, "It had no other effect on me than a general weakness in my joints and limbs and a kind of listless feeling. However, it was sufficient to discourage me from any further attempts."

In 1772 Thompson was invited to teach school in Concord, N.H. Within a few months he married a wealthy young widow, and for the first time was financially independent. He settled down to manage his wife's estates and pursue his scientific studies, but those were restless times. Rebellion was in the air, and the colonists were taking sides. Thompson remained loyal to the king, barely escaped being tarred and feathered, and fled to England, where he was put in charge of recruiting, equipping and transporting British forces in North America.

After the war he went to Bavaria, where he was given the job of reorganizing the Elector's woe-begone army. With characteristic thoroughness, Thompson spent several years making a detailed study of the army, and finally came up with a plan so comprehensive that it stunned his critics speechless. Thompson's report focused on the army's two major expenses—food and clothing. Questioning the existing cloth, he set about experimenting with different materials, such as fur, feathers, cotton, wool and jute, to find out which were the cheapest and most effective for soldiers' uniforms. He devised ingenious experiments to compare thermal conductivity, and was the first to suggest that it was not the material, but the air trapped in the fibers, that provided insulation. He then designed a new cloth and looked around for a firm to weave it. None of the existing companies was willing to cooperate, and they all thwarted his every attempt to set up a new factory.

This setback prompted Thompson to make his most spectacular experiment in social reform. At that time Munich was plagued by professional beggars so numerous and well organized that they practically ran the city, even intimidating the police. Thompson saw an opportunity both to staff his factory and to rid the city of its beggars. On New Year's Day, 1790, he made his move, and before nightfall every beggar had been arrested and locked up in what was euphemistically called "The Poor People's Institute," but which was actually a workhouse. Thompson ran the Institute with a firm hand, and within a few months the former beggars had been trained to produce cloth of an acceptable standard.

By 1791 Thompson had become a general in the Bavarian Army, as well as Minister of War and Minister of Police. In 1792 he was made a Count of the Holy Roman Empire, and adopted the name of Rumford—the original name for Concord, N.H.

If you're interested in reading more about this singular man, try Sanborn G. Brown's *Count Rumford: Physicist Extraordinary* ($18,25 from the Greenwood Press, P.O. Box 5007, Westport, Conn. 06881).

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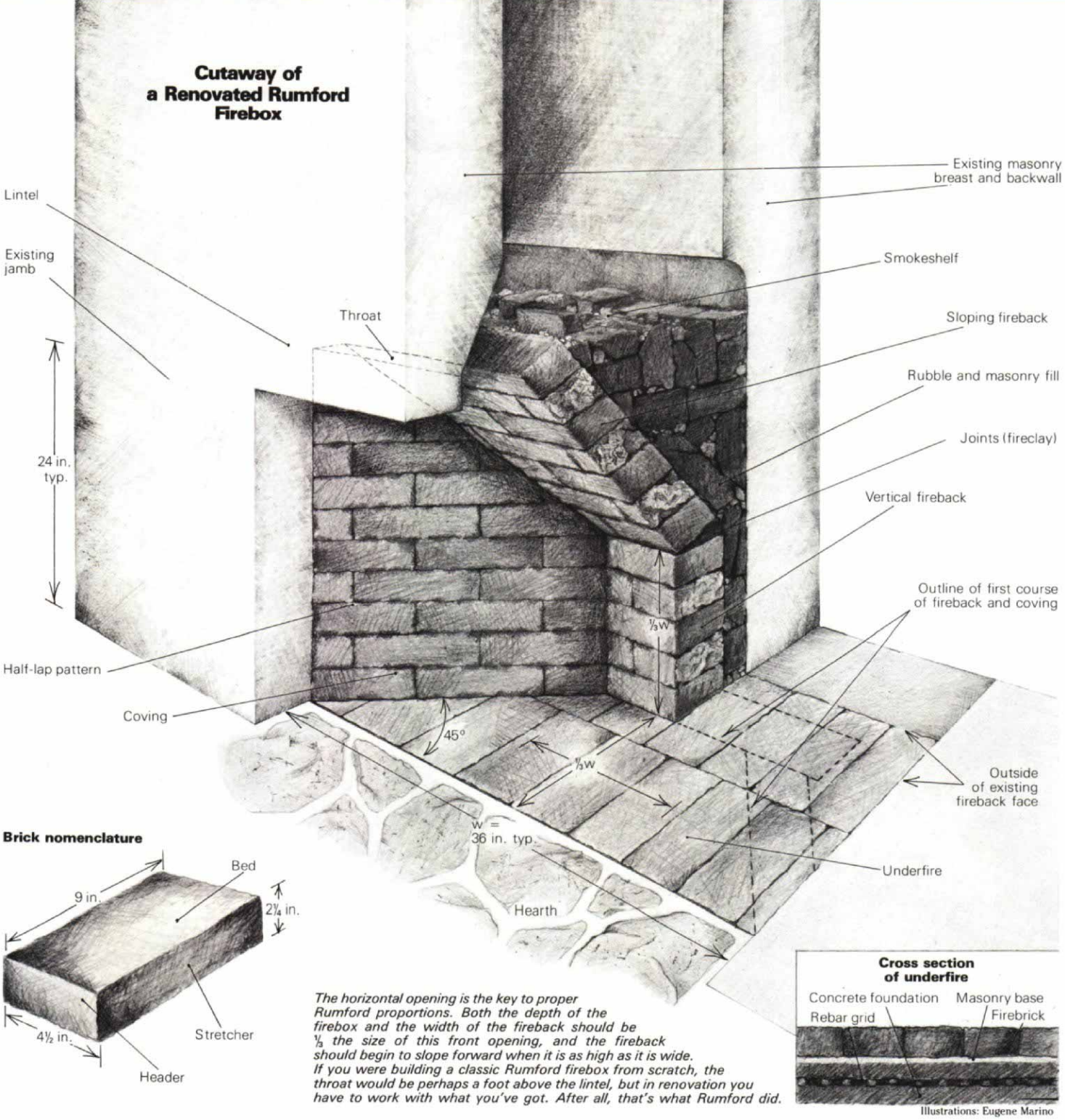


Illustrations: Eugene Marino

brush, a string, a shovel, a hoe and a wheelbarrow for mixing cement. You will also need a 4-in. brick set (a chisel for breaking bricks), a 12-in. mason's trowel and a cold chisel or all-purpose masonry chisel. All these tools can be bought at most hardware stores.

Underfire—Often, all you have to do to remove an original firebox is to reach up, grab the top back brick, and pull (photo next page, top left). If the bricks don't tumble right down, use a hammer and an all-purpose chisel. This is a dirty job that stirs up a lot of dust, so be sure either to cover the furniture or to move it out of the room, and seal the doors to the rest of the house with tape. Save both the old firebricks and the rubble behind them. You may be able to use them later. If there is already a damper mechanism at the throat, leave it. Cement from the chimney bricks or tile will hold it in place.

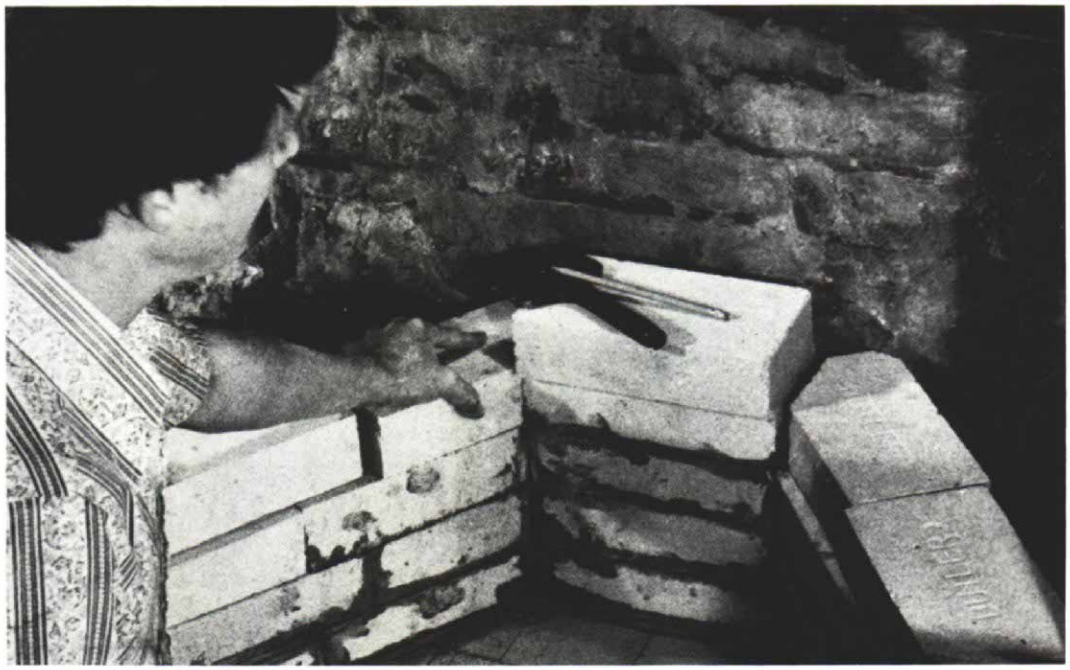
After pulling down the old fireback, covings and rubble fill, remove the bricks of the existing underfire. Using a chisel and hammer, firmly tap the masonry foundation beneath. If it seems solid, you can go ahead and lay the new underfire. If the foundation is cracked, loose or crumbling, however, you will have to replace it. Chisel it out to a depth of about 4 in., then lay a grid of ½-in. rebar 4 in. on center before pouring a new foundation of concrete. You will want the finished underfire to be level with the outer hearth, so take careful depth measurements and leave enough room above the foundation pour for a base and the underfire brick. If a sound foundation is too high for the bricks you are using, you will have to chisel it out. When the foundation is ready, pour a base ¼ in. to ½ in. deep for the new underfire. Mix two parts of clean, dry sand with one part of masonry cement, then add enough water to create a pourable mixture. Spread it over the foundation.

Lay the firebricks for the underfire with no fireclay between them. The hearth takes a lot of abuse, and cracked brick can be broken away from the base cement and replaced easily if it has been installed this way.

Lay the first row of bricks beginning with the ones on the extreme right and left of the open-

Photos: Gary Hensarling

Fireboxes aren't structurally connected to the masonry of the chimney. You can often tear one out, as at left, by reaching up and tugging. Above, the underfire should be installed dry, without fireclay between the bricks. Be sure each brick is set level. (The bottle is covering an old gas line that will become a fresh-air intake.)



When the fireback is only one brick long, the most efficient way to butt coving and fireback is to cut the coving brick to fit along the fireback's header, left. When the fireback is longer, cut the coving brick to fit against fireback stretchers. Above, firebox is filled in behind with rubble and masonry. A fairly wet concrete mix will flow to the bottom.

ing. Once these are in place, you can rest your level across them to be sure they and subsequent bricks are perfectly horizontal. Next, use a plumb bob to find the opening midpoint, and center a carefully leveled brick on it. Place and level bricks alternately on either side of the central one until you reach the two at the edges of the opening. The fit will probably be less than perfect, and these outside bricks will have to be trimmed. They will eventually be covered by the masonry of the new firebox, so all the bricks that show will be the same size. This looks good, and it also makes them easier to replace, if that ever becomes necessary.

Once the first row is set in place, complete the rest of the underfire. You don't need to cover the entire masonry base you've poured, just enough of it to provide a solid surface on which to build the fireback and covings. The rest will be covered with rubble and masonry as you build up the firebox and fill in behind.

When the underfire is laid, draw in the lines of the fireback and covings. This is when the critical psychological problem arises. If you're not used to Rumford dimensions, the outline of your new firebox will look too shallow. You'll wonder if wood will fit, and whether such a fireplace could possibly draw well. Don't worry. A Rumford can be up to two-thirds more efficient than a squat, deep, modern fireplace. But be prepared for kibitzers telling you it won't work. This is such a predictable nuisance that I prefer to do this part of the job without an audience.

Fireback and covings—The night before you plan to lay the firebricks along the lines you've drawn, mix 2½ to 3 gal. of dry fireclay with enough warm water so that when a brick is dipped in, 1/16 in. to 1/8 in. of the mixture will adhere to it. The next day, your technique will be to dip each brick's bed and headers into the fireclay and lay up the covings and fireback with joints 1/16 to 1/32 in. wide.

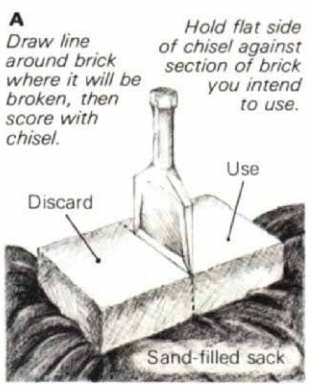
Begin by laying up the first course of the firebrick. You will build up the firebox using a half-lap pattern. The fireplace in the photos above has a front opening just 27 in. wide, so I used a single 9-in. firebrick to form the vertical fireback. Firebacks are usually more than one brick long. For a half-lap pattern, start by placing a brick on each side of the midpoint of the line you've drawn on the underfire. Then lay bricks along the line to a point at least half a brick length beyond its end. The next course will start with a brick centered above the midpoint line, laid up so that each brick overlaps half of each of the two bricks beneath it. It's a good idea to

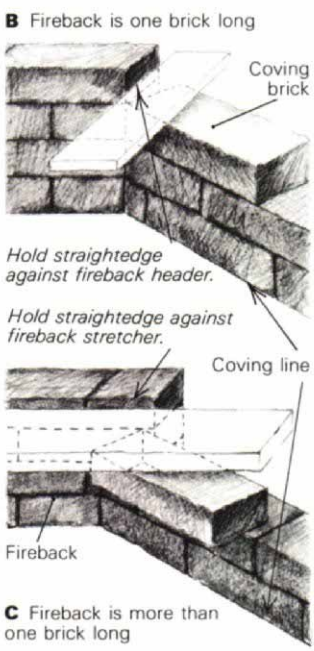
Marking and Breaking Brick

For a simple straight cut, mark the brick as shown in figure A, and lay it on a cloth sack or cement bag filled with clean, screened sand.

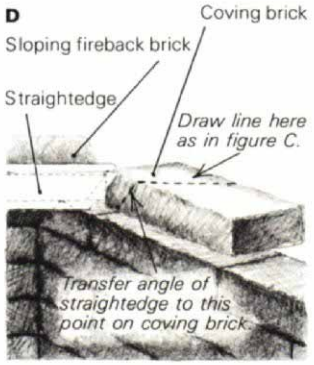
Hold the chisel as shown, and give it a tap just heavy enough to score the brick along one of the lines you've drawn — don't attempt to break it with one blow. Score the other three sides, being careful to hold the chisel firmly against the brick, so it doesn't pop up after you strike it. The brick will break along the proper plane.

For the angled cuts required when the lower courses of firebrick and coving meet, the breaking technique is the same, but scribing the lines to score along is somewhat more complicated (see figures B and C).

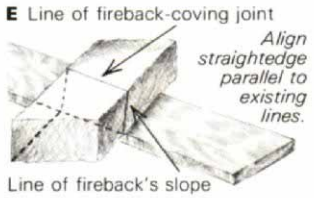




Once the fireback begins sloping, scribing lines becomes a two-step process with the straightedge because the angle must be cut through two planes (see figure D).

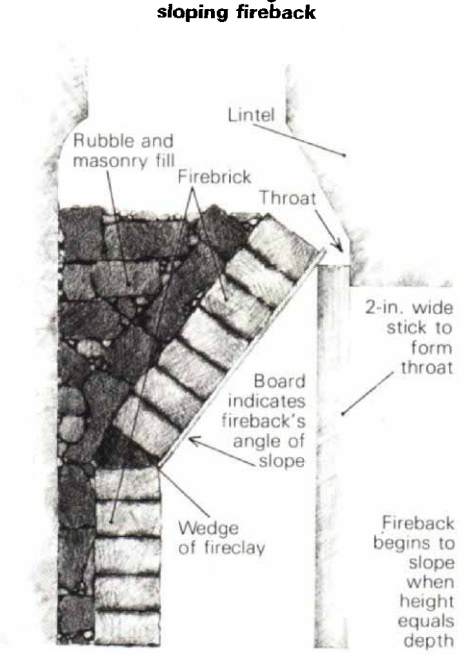


To draw lines on the third and fourth sides, set your straightedge beneath the brick, align it parallel



to the existing lines as shown in figure E, mark the edges, and connect the dots. Break the brick the same way as for other angles, striking the brick perpendicularly. — K. B.

Establishing the sloping fireback



The throat of an efficient fireplace should be only 2 in. deep. Its depth and location determine the slope of the fireback. Use a stick to form the throat, and lean a board against it from the top of the vertical fireback. Then lean a firebrick against the board and fill in with a wedge of fireclay.

pre-mark the center of each brick, so that they can be set quickly in place. At either end, use a half brick, so that the courses come out the same length. Alternate these methods as you build the fireback up course by course.

With a single-brick fireback, the simplest place to join coving to fireback is along the fireback bricks' headers (photo facing page, center left). On longer firebacks, fit the deepest coving brick against the stretchers of the extended fireback bricks. Both of these techniques require cutting coving bricks at angles. Building up the firebox will require a number of such angled cuts, and even, as the fireback begins to slope forward, double-angle cuts. The drawings above show how to deal with this, probably the most technically difficult part of building a firebox.

After this brick is cut to the proper angle, set it aside, and begin laying bricks from the front. Set more bricks along the coving line until you're close enough to the fireback to bridge the gap with the brick you've set aside. Transfer the measurement of that distance to the short stretcher of the brick, cut it to length, and lay it in place.

The second course of the coving should begin with a half brick at the front to achieve the half-lap pattern, but the rest of the procedure is the same. Right and left covings should be mirror images of each other.

As you build up the fireback and covings, fill in behind with rubble and concrete (photo facing page, center right). You may be able to use much of the rubble you pulled out when you tore down the original firebox. You can also use broken brick you know you won't need to build up the new firebox. I usually use a concrete mixture of three parts sand to one part cement, though I often use a two-to-one mixture if it's already around and handy. Add enough water to achieve a fairly wet consistency, so the concrete will flow to the bottom of the rubble.

Throat —When the fireback is as high as the firebox is deep, it's time to start sloping it forward. It is at this point that you have to decide how wide a throat your fireplace should have, because this will determine the angle of the slope. Almost all modern fireplaces have much too large an opening at the throat. Vrest Orton, in his book *The Forgotten Art of Building a Good Fireplace* ($3.95 from Yankee, Inc., Depot Square, Peterborough, N.H. 03458), says that the opening should be just 4 in. deep. I believe that even this is too much for anything smaller than a fireplace of a baronial hall. For most installations, 2 in. is more suitable.

Exactly where behind the breast will the throat fall? This is where the difference between building a fireplace from scratch and renovating one in the space allowed becomes most evident. In a classic Rumford, the throat will be perhaps a foot above the lintel. However, you probably won't have room to work much higher than a few inches above the lintel, so you'll have to form the throat there.

Begin by finding a stick of wood with a 2-in. dimension, and stand it vertically in the front of the firebox to mark the width of the throat. Remember that a milled 2x4 isn't the right size in any plane, but you can rip it to a true 2 in. along its nominal 4-in. face. Next, cut a flat board, perhaps a piece of plywood, just long enough to extend at an angle from the front of the fireback's highest course to the vertical stick at the point you want to form the throat.

This board describes the fireback's slope. Take a firebrick and, keeping in mind the half-lap pattern you want to continue, reach behind the board and set the brick's front stretcher against the board's back. Fill beneath the brick with a wedge of fireclay, let it set up for 10 to 15 minutes, then take down the board and remove the vertical stick. Lay up the rest of the course, using your level as a straightedge to make sure that the rest of the bricks slope at the same angle, and allowing each wedge to set up. Once the slope is formed, subsequent joints on the fireback need no time to cure. Build the covings up course by course with the fireback. The fireback widens as it slopes forward, so you will have to extend each course a half brick or so beyond each end of the previous one.

As the fireback widens the covings get shorter, but the fireback's slope means that the final coving brick on each course must be cut at angles through two planes rather than just one.

If there was no original damper, you'll have to insert a new one before you build the firebox too high. Damper mechanisms can be bought at many lumberyards and brickyards. Get one to fit the width (not the 2-in. depth) of your fireplace's throat. You can wedge it up out of your way as you work to finish the covings and fireback. The rubble and masonry fill behind the fireback will create a flat smokeshelf on which the damper will eventually rest. You needn't fasten the mechanism down; just fill with concrete any gaps between metal and masonry.

You may light a fire in the firebox at any time during construction with no ill effects. Remember, though, that you wouldn't race your car until it's warmed up. Build a small fire at first, and only gradually stoke it up to a roar. □

Kent Burden is an Oklahoman who has been installing and renovating fireplaces for 15 years.