1. Ribbon Forge Burner

Instructions by John Emmerling

About five years ago, a glass artist purchased the building next to mine and set up his glass blowing studio. Since glass blowers use copious amounts of gas and efficiency is paramount, I was immediately curious to see how his furnace and glory hole were heated. He showed me his ribbon burners and gave a hand in making my own. Using a ribbon burner has improved the performance of my forge immensely as the heat and gas efficiency are truly amazing.

For those of us who prefer the control of a blown forge, a ribbon burner is probably one of the most efficient and quiet. The beauty of this burner is that it can be made in any configuration depending upon the size and shape of the heat desired. There are no hot spots as in a venturi burner forge and combustion is complete at the burner and not dependent on the swirling motion of a blown pipe forge. The forge itself can be made in any configuration...pipe, tube, fire brick or just about anything one wants to heat steel in. The ribbon burner can easily be built from materials found in most shops or obtained locally. The castable refractory used in the burner can be purchased in a 50 pound bag, which is enough to make many burners.

Step 1
Cut a length of tube to the desired length of the heat. In this case I used 3x3x3/16” by 10 inches long. (A burner length of ten to twelve inches works well in an eighteen to twenty inch forge.) Measure in ½” from the outside edge of the length and width of the tube and torch cut out that piece. In the center of the reverse side, take a 2” pipe nipple and mark and cut out that round. Next, cut two pieces of 3/16” flat stock for the end caps. The last part is the baffle. I used a 3” diameter punching and ground the edges flat to fit the inside diameter of the tube. Any piece large enough to cover the hole will due. Drill several holes in the baffle to allow some air to pass thru. (Fig 1)
Step 2
Weld in the baffle on the pipe side of the tube first. It should be welded in 5/8-3/4” up from the opening to allow some of the air/gas mixture to go thru the drilled holes and the remainder to circulate to the edges of the burner. (Fig 2)
Next, weld on the pipe nipple and end caps. The end caps can be flush or inset. Either way, grind the welds flush (for mounting later). Make good welds as no air should escape. (Fig 3)
Step 3
Find a piece of ¾” plywood that is several inches larger than the burner and trace the O.D. of the burner on it. Measure and mark the O.D. of the cutout as well. On this burner the cutout measures 2”x9”. I used ½” spacing between the rows of air holes and 1” between the holes. Alternate holes and rows. (Fig 4)
Step 4

Buy a box of Crayola crayons and remove the paper. (A utility knife works well.) On a drill press, drill holes in the marked plywood to accommodate the crayons. Usually a 5/16” or 25/64” hole will work. The crayons should fit snug in the holes and the hole depth should be about 3/8” deep. If your drill press has a stop, set it and keep the holes consistent. The dam for the castable is made from 1”x3” (3/4 x 2½”). Cut and screw together to the size of the exterior of the burner. Attach the dam to the plywood with screws. (Fig 5)
Step 5
On the burner, tack weld on both sides a stopper (which will be removed later) ¾" up from the opening. (Fig 6)
The stopper allows the burner to only penetrate the castable ¾” in depth. When cured, the castable will be locked in place in the burner body.

Step 6
The castable refractory I use is Mizzou or HPV-ESX castable, both of which are purchased at Harbison-Walker in Portland, OR. (www.hwr.com). They come in 50 lb. bags and cost approximately $35.00. Other high temperature refractories can be used. Your local refractory distributor or ceramics shop should be able to cross reference brands.

Mix well with water to the consistency of peanut butter. Too much water (concrete consistency) will make a weak burner and cause cracking. Mist the inside of the wooden dam with WD-40 as a release agent. Using your fingers or a spoon, drop in
the mixture taking care not to break or loosen the crayons. Fill the dam nearly to the top and allow for some displacement. Straighten the crayons as necessary. (Fig 7)

Center, and insert the burner into the dam to the stopper depth. Lightly shake the plywood to settle the castable around the inside edges of the burner. The casting is now complete. (Fig 8)
Step 7
Allow several days setup time in cold weather. I take my burners next door to the glass blower and sit them by his furnace. Overnight is adequate in that case. Remove the screws to the wooden dam and plywood and with a screw driver/chisel, gently pry the sides away. Grind off the two stoppers. Then, lay the burner on its side on the edge of a table (with the castable supported by the table) and tap the plywood to break the crayons. Remember, the castable is still green and care must be taken in handling the burner. I like to drill out the crayons using an undersized bit in the drill press. Burning them out in a coal forge is an option, but it is smelly and messy. (Fig 9)
Step 8
The burner mount depends upon your forge configuration. For a pipe forge, construct a surround of ¼” x 2” flat stock and drill and weld nuts for bolts. Cut a hole in the pipe and weld the surround to it.(Fig 10)
The castable should extend into the Kaowool of the forge about an inch. It is imperative that the metal part of the burner NOT be inside the cavity of the forge. This burner can be mounted in any position on the forge.

Notes
The first several firings should be short in duration and not at a high temperature to allow the castable to cure. Once cured, welding heats using propane or natural gas are easily attainable. I have found that a large blower (mine is a Centaur forge with a Baldor motor) operating at capacity in combination with a gate valve to reduce the volume gives the most control. Since gas pressure is not as great an issue when using propane (as in a venturi burner), an orifice of 1/16” is adequate. With natural gas, ¼” seems to work well
for me having 2 lbs. of line pressure. As a rule of thumb, natural gas should be introduced into the air line at a distance of at least nine times the diameter of the supply pipe. So, a 2” pipe times 9 equals 18 inches minimum from the burner. Since propane mixes more readily with air, the distance can be shorter.

As the burner is long in relation to the forge, I weld heat shields on the pipe to limit direct heat to the ends of the burner. (Fig 10)

Longevity of the castable depends upon usage and abuse. My forge run time averages twenty-five hours plus per week, and that often includes on and off operation several times daily. Expansion and contraction of the burner ultimately takes its toll. The castable in my original nine inch long burner has been replaced once in the past five years. Recasting the burner is simple and quick if you keep the wooden pieces.

Finally, safety comes first. Put on your safety glasses and turn on the air prior to lighting the forge.

Although I do not always have time or the energy to check my email, I will be happy to try to answer questions regarding this burner.

1. John,
   I’m asking you directly because you’re the only one I know of who has experience. I have a ton of questions I will keep the list short as I can.
   1. Does the jet to surface area have a ratio or a minimum chamber size or is it just a pressure equalizer?
   2. Do you know if the burner can be as long as you want, or are multiple burners required to add length?
   3. Do these burners work well in an ‘open’ type forge?
   4. Is there an optimum burner size to forge size ratio?
   I would love to see your forge in action do you have any videos you would post? I know I don’t ask much.
Bob

http://www.pineridgeburner.com/ for commercially built ribbon burners

Next post by Dave Hammer

1. This is a very long post, but hopefully it will be useful for those of you considering using ribbon burners...

   I’d like to summarize my experience with the Pine Ridge Ribbon burner.

   First of all, all the issues I first had with the burner were because of my un-familiarity with them, how blowers work and the suggestions that Pine Ridge provides for users of their burner. I bought the burner last year after reading that they were much quieter than other burners.
I finally got around to building a forge with the burner a few weeks ago. I already had a blower I had bought from Blacksmith Depot that was being sold as suitable for propane forges (their $100, 112 CFM blower). I thought this blower would be adequate.

I have the smallest burner that Pine Ridge sells. It is 4 x 4 inches. Pine Ridge states this burner will work with one to five inches of water column pressure. I built a forge with a 10 inch cylinder, 16 inches long. I used two inches of thermal blanket and put in a refractory floor.

My first experience with the forge was not very satisfying. The mild steel I was heating barely got beyond an orange heat, not the yellow I am used to forging at. This was using the blower at full out speed and adjusting the volume of propane for the best flame. The best flame is achieved in the same manner as adjusting an acetylene torch. You fiddle with the mixture till you get a stable flame. I use a high pressure propane regulator cranked up…. and control propane by volume with a needle valve. The air can be controlled with a dimmer (type) switch, or an air gate.

Without writing a book about how I learned the following, I will summarize what I know now...

1. The blower I first used would not, with the ribbon burner in the forge I built, produce the heat I wanted.
2. The blower I was using would provide 2.5 inches of water column pressure (I learned how to make a simple Manometer and measure active pressure).
3. Once I replaced the blower with one that would provide more active pressure, I was easily able to get the heat I want.
4. The Pine Ridge burner works amazingly well.

Pine Ridge recommends that the burn chamber NOT be less than .75 cubic feet for the burner I bought (I had misplaced the instructions I received with the burner). The forge I built has a burn chamber less than a half cubic foot. Although I was achieving the heat I want (with the right blower), I will bend to their recommendation and build another forge. I’m hoping to get even better results with it.

I believe these burners will work in all types of forges (sides and/or ends open), but the best heat will be provided with mostly closed forges. If you are using aspirated burners now and take advantage of that "blast" area, you won't have that anymore. If the forge has a lot of open area, I expect most of the heat will leave the confines of the forge.

A couple lessons about blowers I learned (primarily from Jeff Reinhardt). CFM ratings for blowers do not tell you what you need to know for blowers that are going to be used where there are air pressure requirements (e.g. on blown forges, at least not in every case). The blower has to be able to provide not only volume, but pressure. Blowers that provide the most pressure usually have “paddles” pushing air, rather than a squirrel cage. With most squirrel cage blowers (and some paddle blowers, depending upon
design), if the air passage way is severely restricted, the squirrel cage will spin without continuing to try to force much air out (if any). When pressure is required for an application (like this), if the air passage is restricted, the blower needs to continue forcing air out, thus producing air pressure. One of the ways to measure that pressure (force), is with a water column, using a Manometer. Five inches of water column means that the air pressure pushes a column of water five inches. A simple manometer can be made with a clear plastic hose. All you need to do... is provide a port in the pressurized area to connect the hose to, then make a “U” with the plastic hose. Pour water in the hose so you have a “U” of water in the hose, without water getting near the burner. Put a mark on the hose (with a sharpie or tape) where the water is initially (blower not on). Turn on the blower and see how far the air pressure pushes the water. Measure that distance in inches and double it (the water is pushed down on one side of the loop and up on the other side, so if the water level changes one inch, the water has moved two inches). The diameter of the hose doesn’t matter (pressure is per square inch of surface). To make the port, I just drilled a hole in the air line (just below the burner), put in 1/8" NPT threads, then screwed in a one inch nipple. Slipped the hose on it to do the measurements. When I was finished measuring, I just pulled the hose off and put a cap on the nipple. The pictures below were taken before I put the pressure measurement port in. I drilled the hole in the galvanized elbow just below the burner. The blower in the pictures is the one that produces 2.5 inches of water column pressure.

I found another blower I had that would produce 7.5 inches of water column pressure. With that blower, the forge works great. It worked satisfactorily at 5 inches, better at more.

Without a doubt, ribbon burners produce more heat with higher air pressures (and more propane). This is clearly stated by Pine Ridge on their web site. My forge was working with the blower producing two inches of water column pressure, but not at it’s best capability.

As I said before, the mixture of air and propane has to be adjustable and is set in the same way you set an Oxy/Acetylene torch flame. The sound and behavior of the flame makes it easy to set the combination. Start with a small flame, then increase the intensity. If you are not getting a good flame, increase the air. If that doesn’t produce the flame you want, bring the air back down a bit and increase the volume of propane. Then step up both to get the flame you want. The sound of the burner (light roar), as well as the elimination of the dragon breath tell you what the optimum combinations are. The burner can be set to work at many combinations of air pressure and volume of propane. The more air pressure (and propane), the more heat the burner will produce.

These are GREAT burners.

Now to get back to the initial reason I bought one... NOISE.

The burner is definitely quieter... The fan may not be. I have two fans that will produce
enough pressure. Neither of them are as quiet as I would like. I’m sure there are fans out there that are quiet and will work. I’m still looking for one that doesn’t cost a fortune.

I LOVE the information provided about how to build these burners yourself, but I feel compelled to offer one bit of advice of caution. If you do build one, be sure you are a competent enough welder to make leak free welds (under pressure). It is NOT easy, even if you are fairly competent at welding. If you can’t, we will probably be reading about you in the newspaper. Propane does not disperse into the air gracefully, it pools on the floor.

John uses natural gas, from what I remember he said, that the difference between LP and NG was that you need a longer mixing tube for NG, 9 times the width of the tube for NG and could be a little shorter for LP(is that right John?)

(Dave Hammer further says:
My burner never got hot on the outside. It was significantly cooler than the outside of the forge body. Pine Ridge states that the burner needs to be mounted in a hole with "space" between the burner and the forge frame. This removes problems caused by conducted heat from the forge frame and potential expansion of the burner (or forge). They further state that this space needs to be packed with thermal material (like kaowool) so there is no blowback by the sides of the burner.

This is another thread on NWBA forum:  http://blacksmith.org/forums/threads...er-forge-build

Posted by Larry L. FYI. I measured the holes in my pine ridge burner .300 on the nose

Check out these burners, click Gibersom ceramic burner don’t miss the Burners page 2 at the bottom, they have a venturi mixer http://www.joppaglass.com/burner/d_burners.html .

Amen...12 x12 pipe. 3" kaowool, hard brick on the botton, a 2.5" sq x 8" ribbon burner ( 2 rows of holes spaced an inch apart) will weld all day with little use of gas. less is best.

je (john emmerling)

1. I’d like to offer my 2 copper on what I have learned about owning a Ribbon burner Forge. I have a Behemoth of a Forge bought from Ron Wailes, I do believe that it was his experimental model that some of you probably remember? hehe, I have it now. Anyway, I changed it from what it was a bit. It was pretty un-manageable heat-wise with it's original setup.
I have found that the ribbon burner itself is quite versatile and I can tone my forge down to work 1/8" stock or crank it up to forge weld 4" stock by adjusting the air/fuel mixture without having to change out jets or anything.

The provided pictures will hopefully help with my explanations as my use of the english language is usually horrible, please forgive me.

In one of the pictures you can see a copper tube and another tube with a brass cap that's been drilled to .052. The copper tube was what the forge came with and ran the forge at under 1 lb of pressure ... no back pressure at all ... yes, the low pressure seemed nice but it ate through fuel like crazy and you can't really regulate fuel pressure very well set up like that .. sooo, I changed that part. I put a cap on it drilled out to .46 and now I run the forge comfortable at around 12 psi propane. The Air was the next problem. I had a problem regulating the air intake using the cover flap that comes on the blower (OCP's 112 CFM model) ... so as you can see in another picture, I installed a stopper / choke directly on the 2" piping going to the burner ... Now I can adjust my air and fuel easily. Fuel efficiency is awesome now that I put that Orifice on it.

The Forge is roughly 19" long with a 6" opening all the way through using a ribbon burner at 2" wide x 8" long.

On a side note for orifice size:
I've since seen Mike Neely's forge and played on it and he set his up (Tapped the feeder tube with a 1/4-28 tap) to use a .025 wire feed tip for welders, that way if he wants to adjust, he can adjust the amount of fuel entering the orifice size on the fly by taking the .025 tip off and changing it for any of the other tips sizes available for wire feeds.

I hope that made sense?
What is a gas/air mixer, and do I need one?

The Pine Ridge Burner is a premix type burner. This means that the air from the blower must be combined with the fuel prior to entering the burner. The point at which the air and fuel combine is referred to as the mixer. There are many different mixer designs, from inexpensive and homemade, to expensive and high tech. They all do basically the same thing, some just do it better than others. We sell a simple mixer that works well with our burners. For some applications the more high tech mixers are well worth the money, and in some cases even necessary. See our "links to suppliers" for more information.

![How a mixer works](image)

One style of gas/air mixer
Should I install a safety system?

The burner should be installed according to all federal, state and local plumbing and electrical codes. In some locations an "attended appliance" (an operator in attendance at all times) requires only an easily accessible emergency shut-off valve on the gas supply line. Many appliances built using our burners rely on this system. Check with your local building inspector and Fire Marshal to see what's required for your installation.

If your appliance will be left running unattended, we recommend installing a normally closed solenoid valve on the gas supply line. Run electrical power through an air sensing switch to the solenoid valve and blower motor (see schematic below). Use a normally open momentary switch to jumper over the air switch at start up. Once the system is running, air pressure from the blower closes the air switch which opens the solenoid valve and maintains blower power. In case of power interruption or blower failure, the air switch opens and the solenoid shuts off the fuel. The entire system stays off until it is manually restarted with the jumper switch. This "proof of air" system also insures that, at light up, no fuel can be supplied to the burner without combustion air from the blower. This system does not protect against flame-out. Flame-out protection requires installing UV detection hardware. If flame-out detection is required for your installation, or you feel it is necessary, please contact one of the companies listed in our "links to suppliers" for further information.

![Typical "proof of air" safety system](image-url)
Is this burner system a "do-it-yourself" project?

It is for most people. It does require basic knowledge of plumbing and electricity. Our burners come with written instructions, working drawings of burner installation, and schematics of typical gas/air plumbing systems. There is also a CD-ROM available for more in depth instructions. You will need to be able to read and understand this material. If you do not possess these skills, you should seek help from someone that does.

The basic "LP" system is very straight forward. The "GH" system requires a bit more plumbing and a few more parts. (See photos and schematics below). If you choose not to do it yourself, there are several manufacturers listed in our "links to suppliers" that build high quality equipment using our burners.

All the information we supply is true and correct to the best of our knowledge. It works well for us because we understand it. Since we have no control over the consumers interpretation, understanding, or implementation of this information, the consumer uses it at their own risk. Our burners leave the factory in perfect working order. Since we have no control over the shipping, installation, or use, we will assume no liability for the safety or performance of any appliance built using these burners.

"LP" Plumbing Schematic
LP190 Burner (with basic safety) in small glory hole