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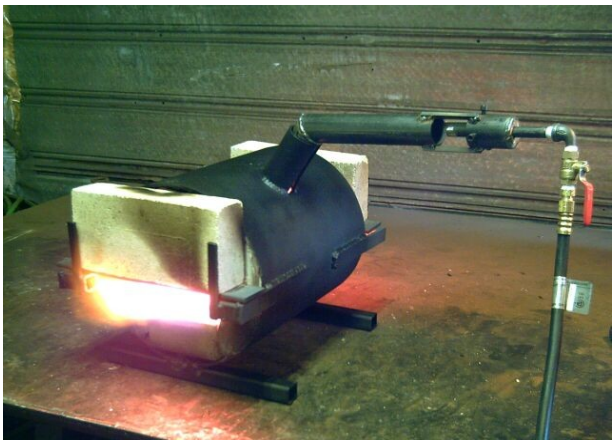
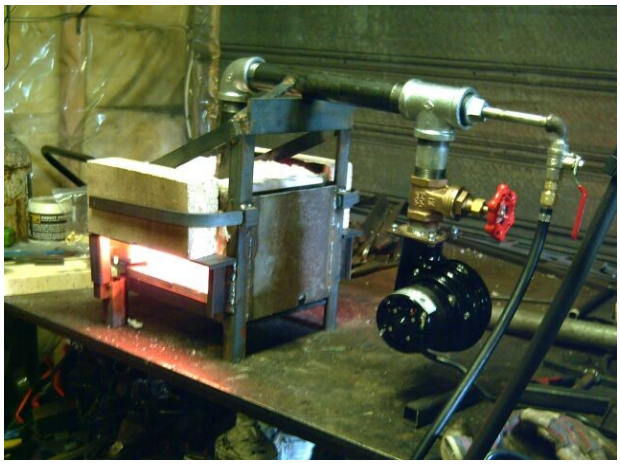
Atmospheric Pipe Forge

with Bonus

Square Box Forge with Blower





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Introduction

Disclaimer:
This publication is strictly for educational purposes. This is how I built two different gas forges. I am not recommending that you build a gas forge! I accept no liability for use of any information in this publication. You use any and all information completely at your own risk!!!! Propane is hazardous. It is flammable and in the right conditions explosive. This is an unrated propane appliance and as such if you build one or use one, it is likely that your insurance will be null and void.
Have I scared you yet?

Blacksmithing has taken off in recent years as very enjoyable hobby. There are many tools that are required for this craft that are not common. In many cases we can build very suitable working tools with a minimum of equipment and expertise.

The forge whether coal or gas is a fundamental tool of the blacksmith. It is our primary tool for heating the metal to make it soft and malleable. Coal forges are very easy to build but the fuel has associated problems with it. It is very smoky and in places very hard to get. Fire maintenance is a big headache for the novice blacksmith. There is always the risk of burning your steel.

Coal is the most versatile heat source for the blacksmith. The shape of the forge allows almost any shape to be heated and then worked. A coal forge is also the cheapest forge to build.

As of writing this book I have been using propane to fire exclusively my forge for 8 years full time work. The previous 12 years I used both coal and propane but mostly coal. I do still teach courses which have a part of the instruction on a coal forge. The vast majority of my students immediately see the benefits of using propane.

Propane has a number of limitations that you must consider before building a forge. Propane has a lower temperature than burning coal. This means large bars over 1.5 x 1.5 inches square can take a very long time to heat up. Everything that has to heat up has to fit inside the box. Large or complex shapes become very difficult to work in a gas forge. You become very creative at fitting your bar into the forge.

The benefits of the propane forge are that it is easy on and easy off. Faster start up

means more work gets done. Clean burning although it produces no smoke it does use up oxygen very quickly and produces carbon monoxide (deadly), and carbon dioxide (detrimental in large quantities). **Always have good ventilation!**
Other benefits are that the fuel is readily available, and once you set the temperature you really don't have to mess with it. It is much cleaner and takes up less space and is easier on your lungs.

The real solution as you will find many smiths have both coal forges and propane forges. They use either one as the work requires. This is the smart solution.

This book describes two types of gas forges. The first is an atmospheric forge that is made out of a large diameter pipe. The second is a square box forge that has an electric blower on it. Both forges will reach welding temperature. It is easier to reach welding temperature in the blower forge. Either forge could be converted to blower or atmospheric.

The steps I outline require basic cutting, drilling and welding skills. Attention to detail is often important so read and re-read the manual. These tools are very similar to the ones I use in my shop every day. With care they will last a long time. They do not last forever. You will have to do some maintenance such as re-insulating from time to time.

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Pipe Forge

Pipe Forge Part List

1 pc) 10 ¾ inch diameter pipe 12 inches long
2 pc) 3/16 by 1 inch angle iron 12 inches long
1 pc) 1 ¼ inch schedule 40 pipe 2 inches long
1 pc) 1 ¼ inch schedule 40 pipe 13 inches long This piece is cut on diagonal to give two pieces.
At 7 7/8 inches on top and 7 inches on bottom (see photo below)
3 pc) ¼ inch square bar 3 inches long.
1 pc) ¾ inch schedule 40 pipe 2 inches long
1 pc) 1 ½ inch schedule 40 pipe 3 ¼ inches long
1 propane hose from Princess Auto (part number: 8005543)
1 (800) 665-8685
1 propane regulator from Rexotherm (part number: 567HBTZHS-2)
(416)-253-9778
1 pc) ¼ inch female thread ball valve. Rate WOG (water oil gas)
1 pc) ¼ inch street elbow
2pc) acetylene reverse thread flare to ¼ npt fitting. Available at Praxair 1 800 225-8247 (part number: wes33). Other welding supply shops may carry it as well. One fitting threads into the regulator the other into the bottom of the ball valve.
4pc) 2 ¼ inch x 4.5 inch x 9 inch hard fire brick
1pc) 500 ml Refractory Mortar from Pottery Supply House
1 (905) 849-5540
1pc) T tape or pipe seal compound for gas joints
1 pc) ¼ inch schedule 40, 6 inch long pipe nipple

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1 pc) ½ inch round solid bar 6 inches long cut to 1/8 inch thick disk
1 pc) Fibrofax (Kaowool) 2 feet by 2feet by 1 inch thick rated 2300 degrees F from Pottery Supply House 1 (905) 849-5540

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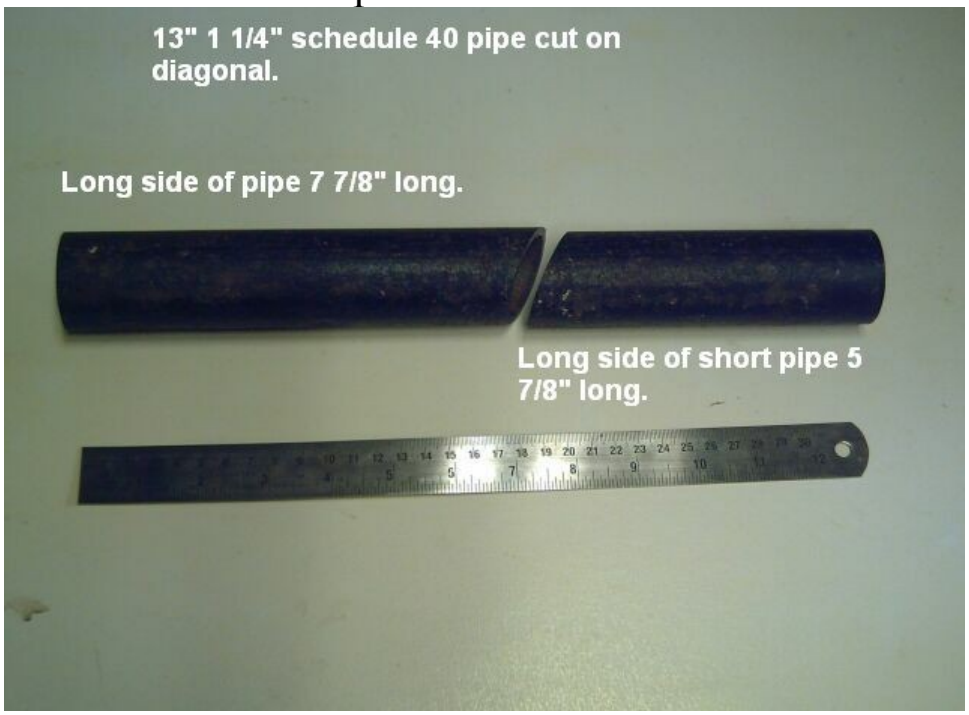
You use any and all information contained in this manual completely at your own risk, and you assume complete liability for any use of this material. David Robertson does not make any claims as to the accuracy of the information contained and presents it for educational purposes only.

Lets Take Look at what all the parts look like.



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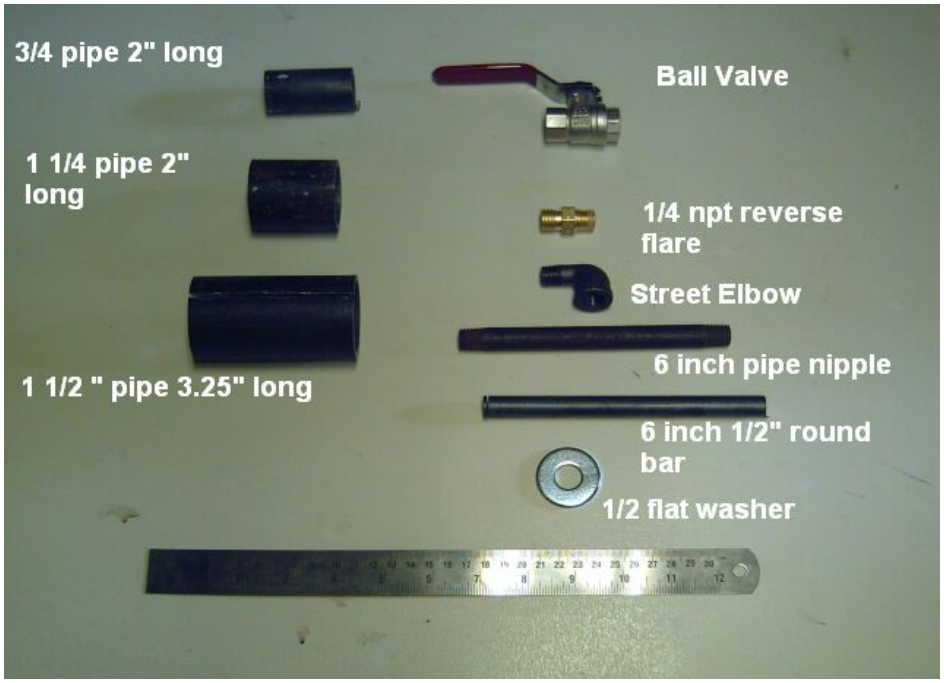

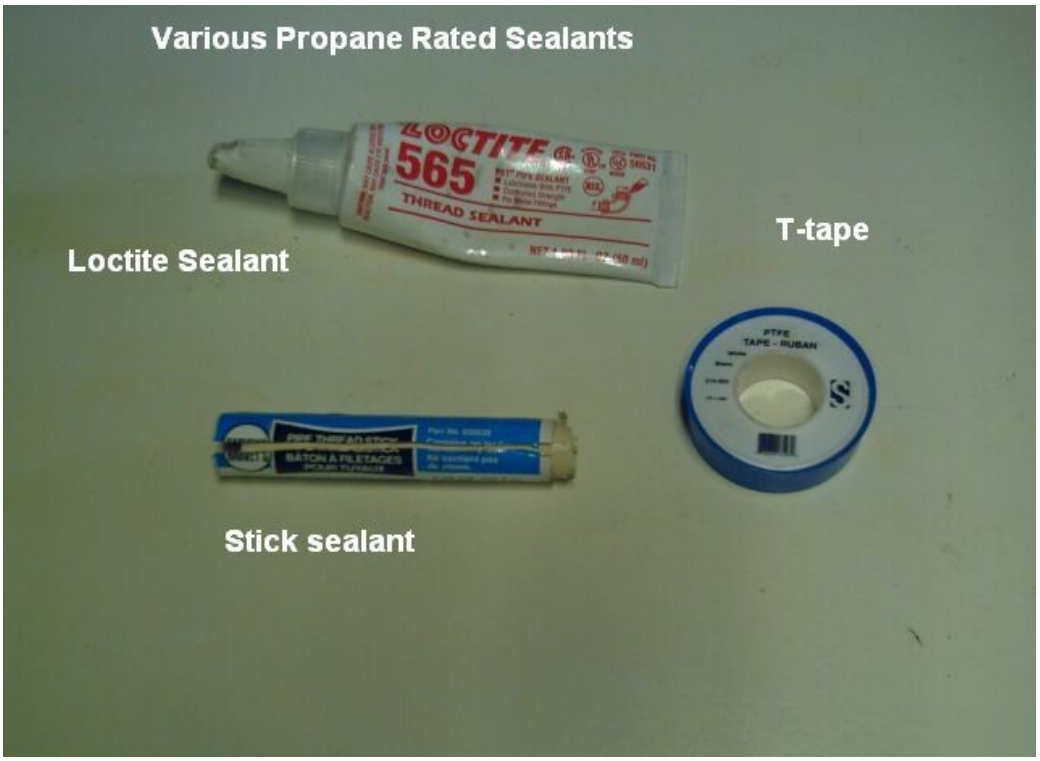

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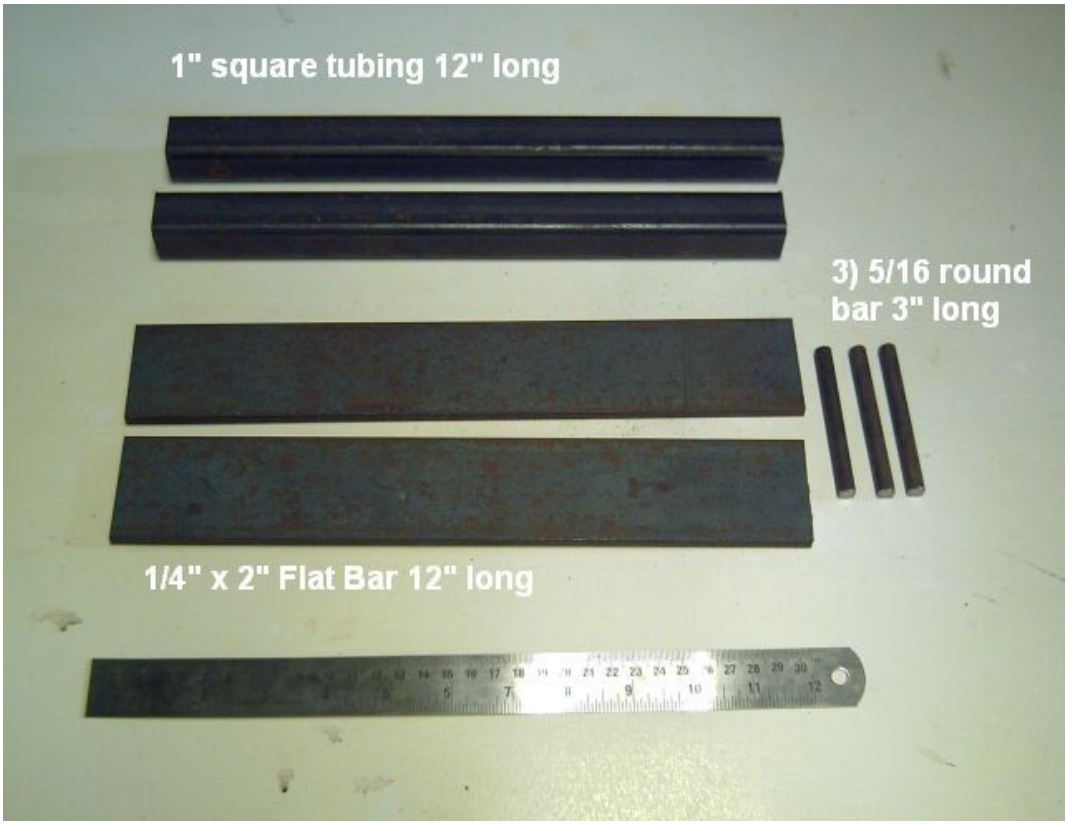

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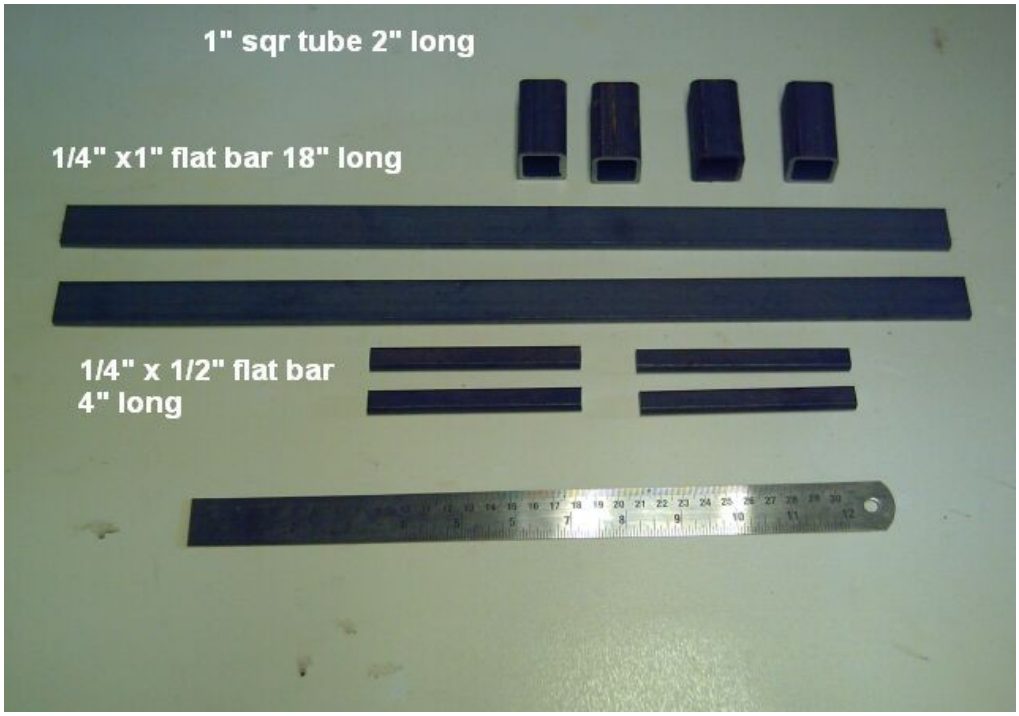

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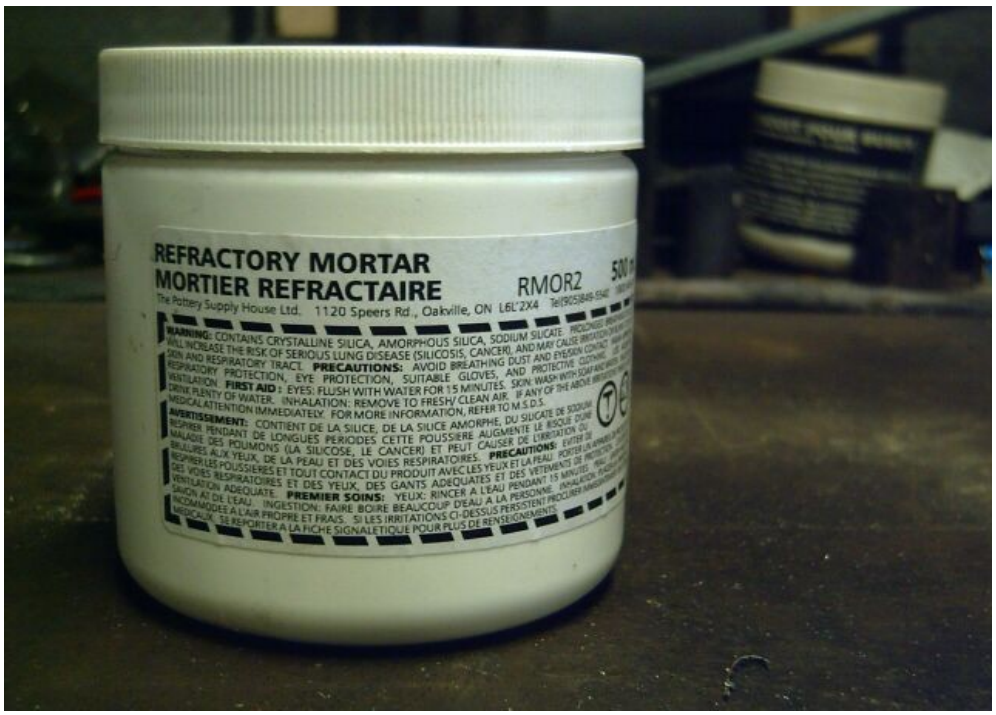

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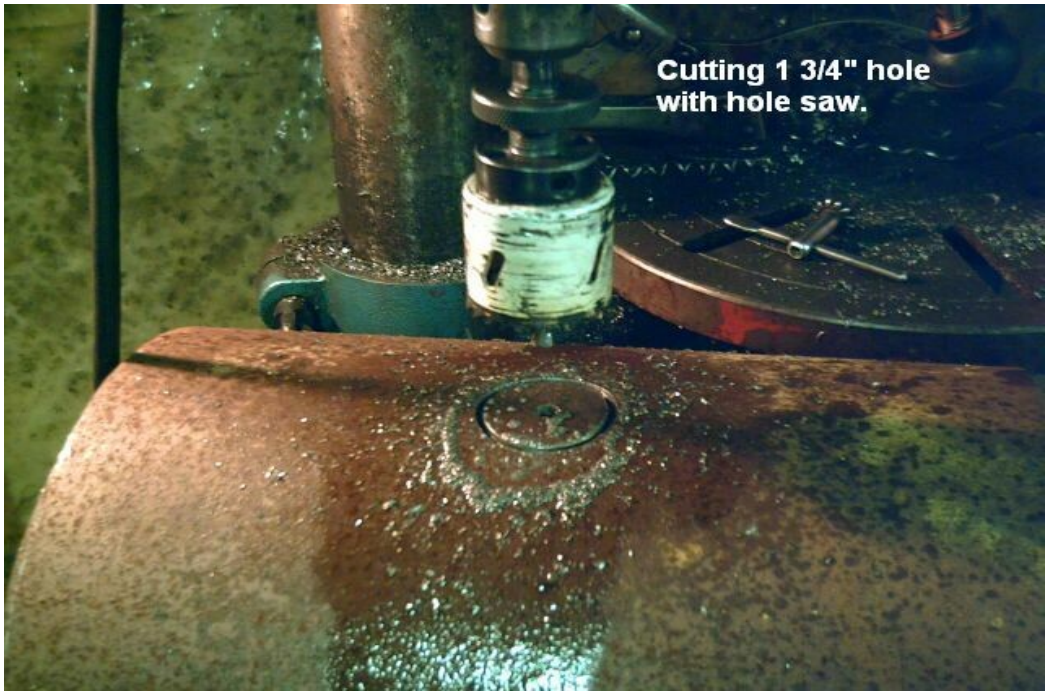
Creating the Chamber for the Pipe Forge

The 10 ¾ inch diameter pipe is cut 12 inches long. This is our chamber.

If you have trouble finding a pipe this size an alternative is a 20 lb barbeque tank. To use this propane tank, you must first remove the valve fill it with water, empty it. Then cut the ends off. Make sure all the propane is out of it before you do any cutting! Otherwise you could have an explosion!

Our first task is to cut a 1.75 to 2 inch hole in the middle of one side of the pipe. I prefer to use a hole saw in the drill press to do this. You could also torch cut the hole.



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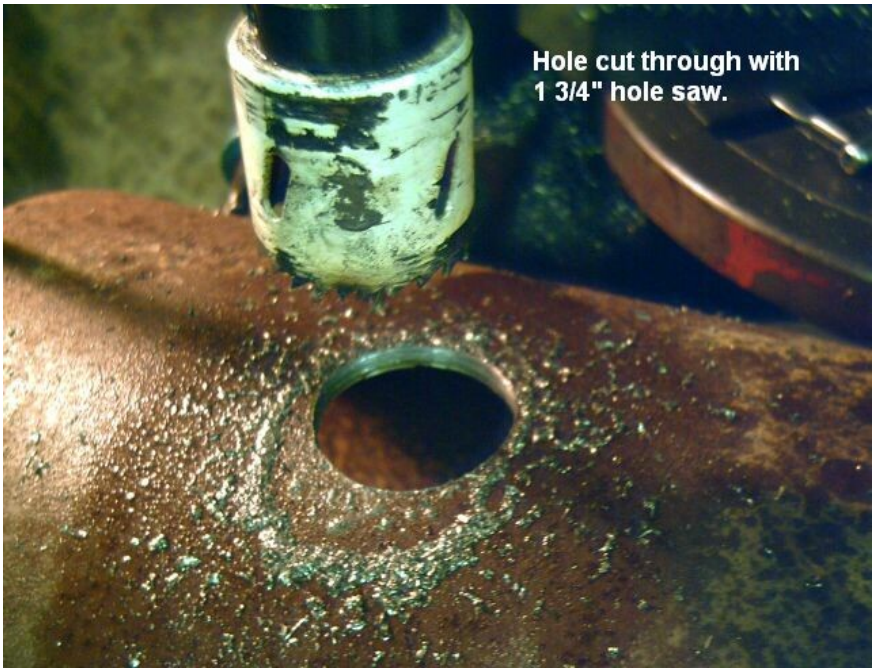
The hole cut through with the hole saw. This makes a clean cut that is easy to weld and has no slag to clean up after.



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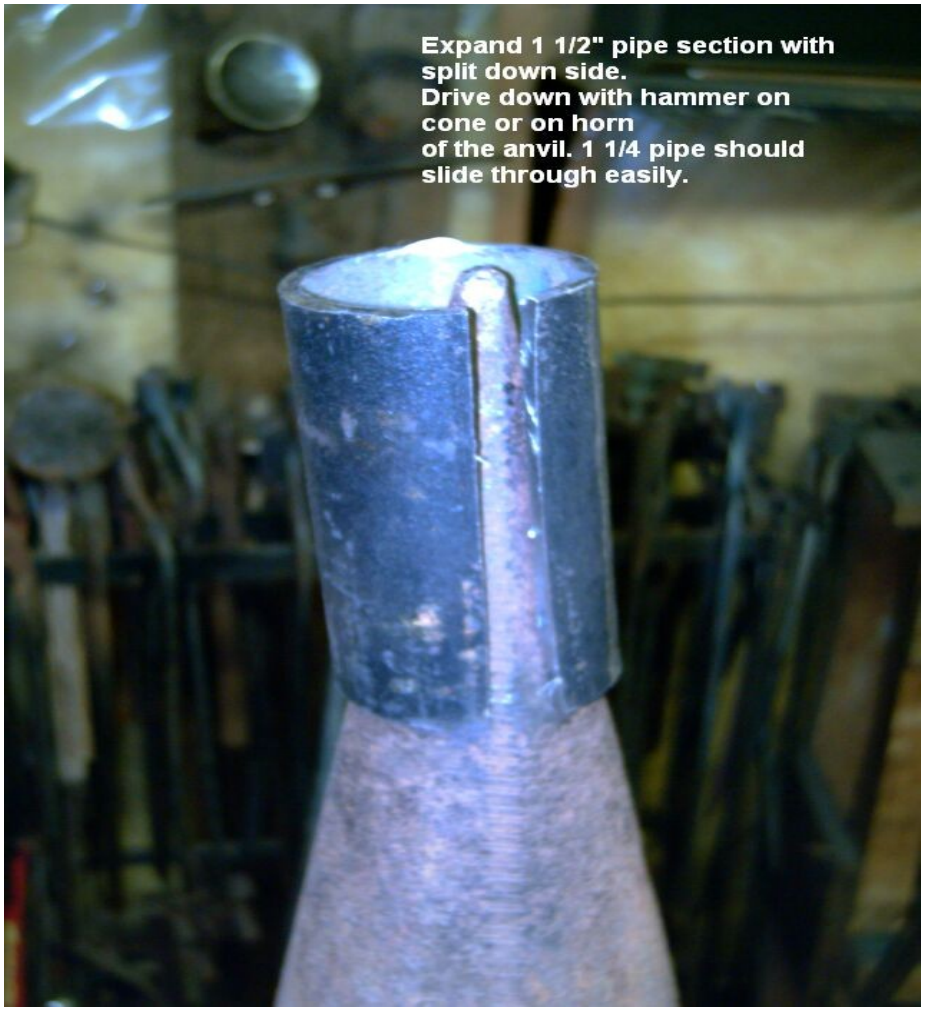
After the hole is cut in the side wall you need to flare the piece of 1 1/2” schedule 40 pipe 3 inches long. This piece has a cut along the length of one side. You can make the cut with a hack saw or a cutting blade on an angle grinder. This slot allows the pipe to expand when it is driven onto a cone shaped wedge such as the horn of the anvil. I use a cone mandrel but use what yo have on hand. If you have a torch you could warm it up a bit to make



it easier. The important thing is to make it large enough that the 1 ¼ pipe easily slides all the way through. It should not be sloppy but a smooth easy fit. This sleeve becomes the socket for the burner and is welded to the side wall of the forge.

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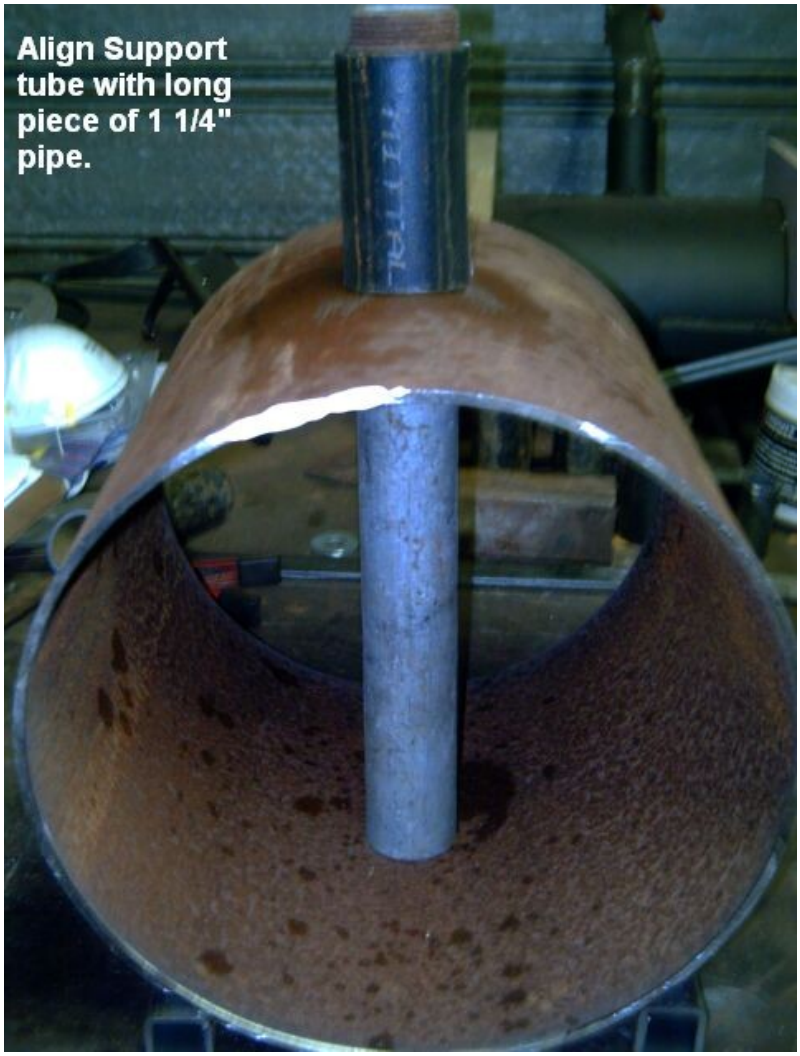
Alignment of the burner socket is critical. I use a scrap piece of 1 ¼ pipe and set the alignment so that everything is vertical. Tack weld the socket to the forge body on the top of the forge first. I prefer to put the split to one side. Make sure that the guide pipe moves freely. Tack weld in a couple of more spots. Check again to make sure it moves freely. Once tacked into position run weld all the way around the socket tube after removing the guide pipe. Reinsert the guide pipe and grind or file clean any burs that stop it from going all the way down.



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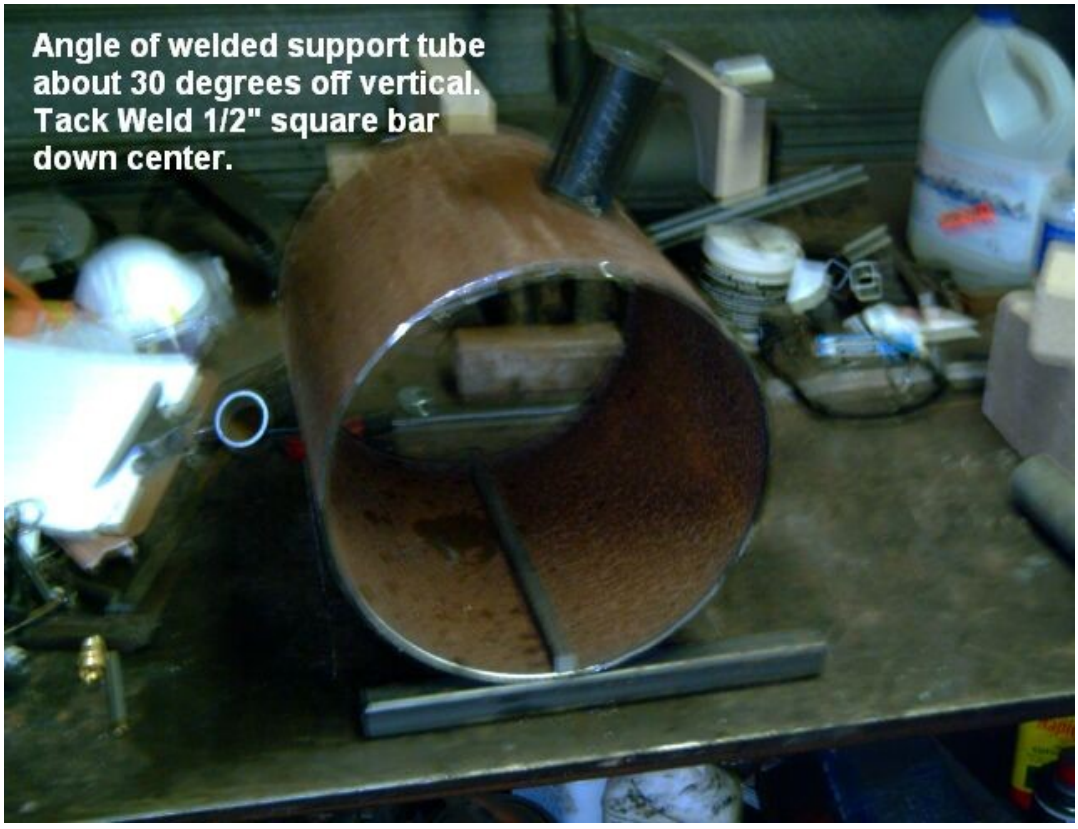
The forge is tipped to one side (the side that the slot in the burner socket should be down), by about 30 degrees off the vertical. This doesn't have to be exact but close. The feet (the 1 inch square tubing) are welded off center to support the weight of the burner and hose. Leave about 4.5 inches sticking out on the short side from center. These tubes are welded right at the edge of the large diameter pipe. Tack weld first for position then do a full weld on both sides of the square tube feet.

The ½ inch bar 12 inches long is placed in the bottom. Use a fire brick on top of the bar to find its location. The fire brick should be level and the ½ square bar supporting the center. Remove the fire brick gently and tack weld the ½ square bar into position. You do not need a full weld here. 6 tacks per side is plenty.



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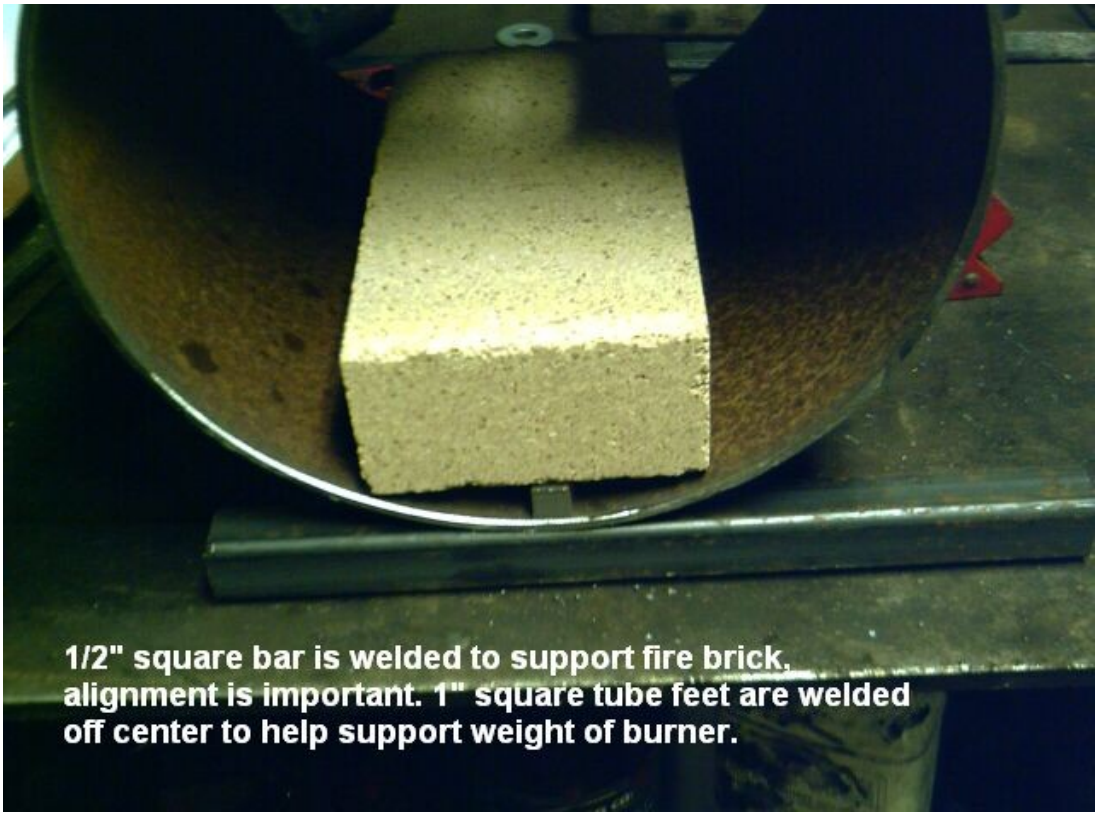

Once this welding is done the basic forge chamber is complete. The next part of the construction is to insulate the chamber.

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Insulating The Chamber

The insulation that is used goes by several different trade names depending on the supplier that you have. It is 1 inch thick 8 lb density rated to 2300 deg F fiber blanket with trade names of Kaowool, Durablanket, Fibrofax .

This material can be cut with a cheap pair of sharp scissors. It will dull a good pair very quickly so use a cheap pair. A particulate mask should be worn as the dust is harsh on the lungs. If in doubt read the material safety data sheet. This material can be gently bent to the shape of the forge. You will need two pieces 12 inches wide 24 inches long.

The first layer is gently bent in a horseshoe shape and slowly coaxed into the large pipe. You will see that it doesn't go all the way around. The two ends should be placed down so that the fire brick will sit level between the two ends.

At this point leave the fire brick in and coax the next layer into a circle that will fit inside the outer layer of Kaowool. You will need to cut off about 6 inches off the 24 so that it will allow for the fire brick. Measure this amount to cut off with the fire brick in

place. Remove the fire brick and cut the Kaowool to fit. Gently insert it inside the first layer. Pad it against the chamber wall to close any gaps.
Now you will have to test the fit of the fire brick. With out putting it in you should see that it will fit but not be too tight. You can squish down the insulation a bit if need be.

You will need to coat the center support bar, with refractory mortar as well as the sides where the edges of the brick touch the wall of the forge. Mix the mortar well for an even consistency. At this point you should have one full length brick and a cut brick 3 inches long ready to make the floor of the forge. Gently coax the brick into position so

as to not disturb the Kaowool. Large brick first. Mortar the inner ends of the bricks and set the smaller one onto the waiting mortar. Please note you do not need to fill the gap between the support bar and the side wall. Just the edges of the brick and the top of the center bar.

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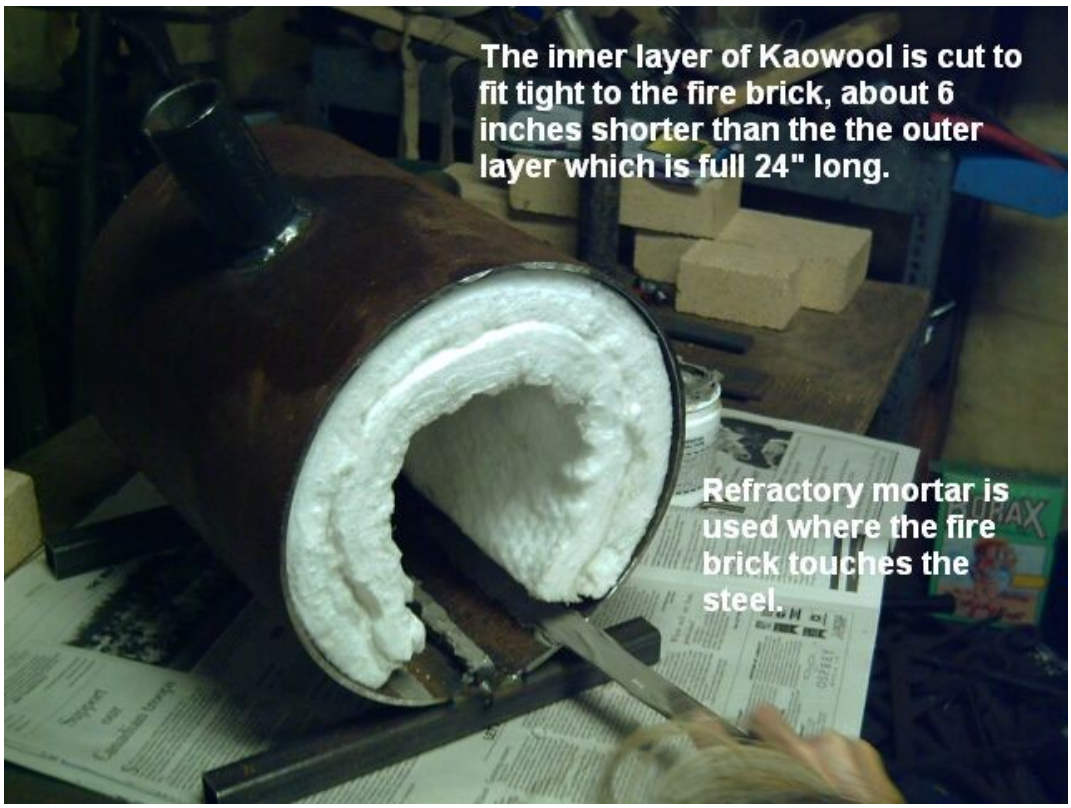

Once the fire bricks are set use a hacksaw blade to cut the Fibrofax from underneath the burner socket. I do this by gently forcing the blade through the insulation then slowly working the blade up and down cutting around the inside of the hole rubbing against the metal all the time. The hole you make should be slightly conic in shape with the large end of the cone being closest to the chamber. The 1 ¼ inch pipe should slide in with no trouble.

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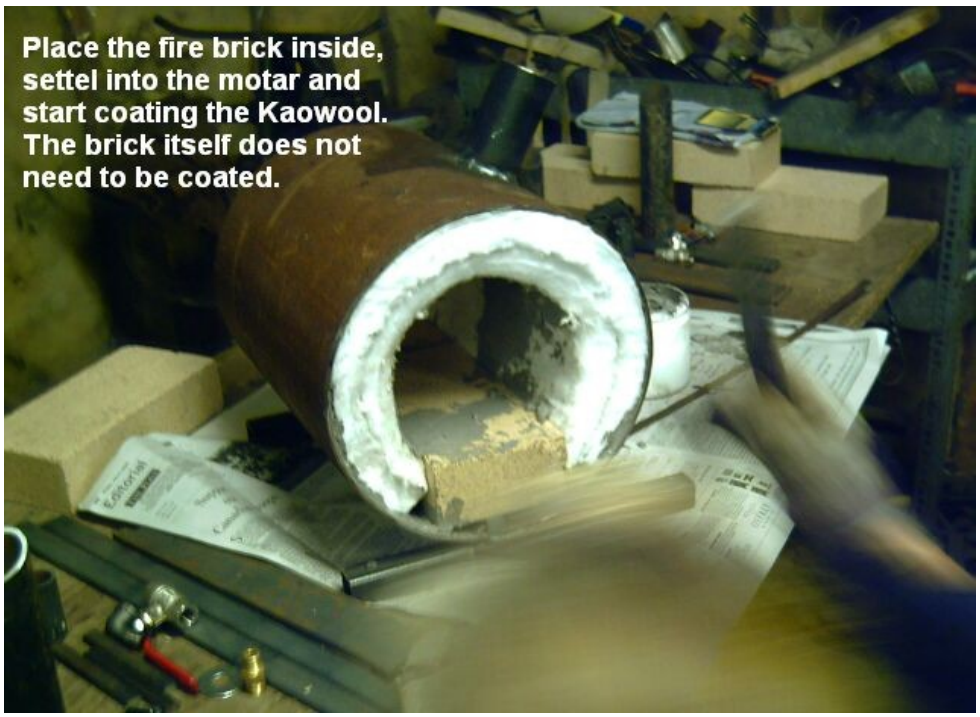

In the above picture the with flat stick or piece of small flat bar trowel on the mortar thinly on all of the inside of the insulation. Do not put the refractory mortar into the hole that you cut for the burner. Leave it bare. Once the inside is smoothly and thinly coated cover both ends the same way. For the forge to be operational the refractory mortar must be dry. I use 100 watt light bulb inside with the ends covered over with tin foil. I leave this light in there over night. This is a good slow drying technique.

The mortar will shrink as it drys and you may have some cracks to patch if you wish. The next steps you can do with the mortar wet or dry. If wet just be careful that you don't bump it.

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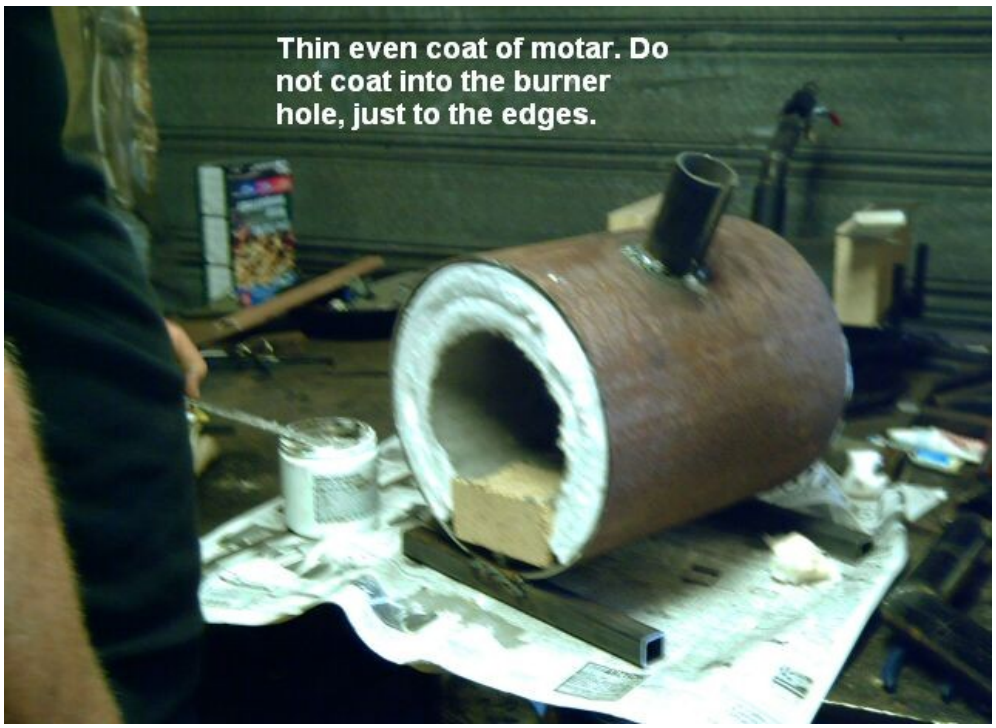

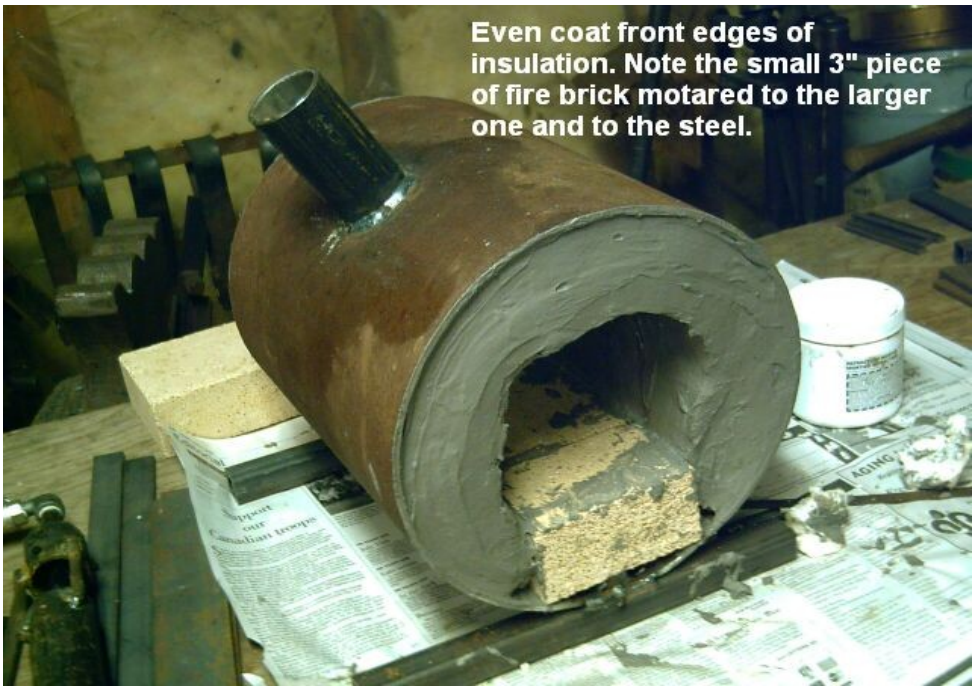

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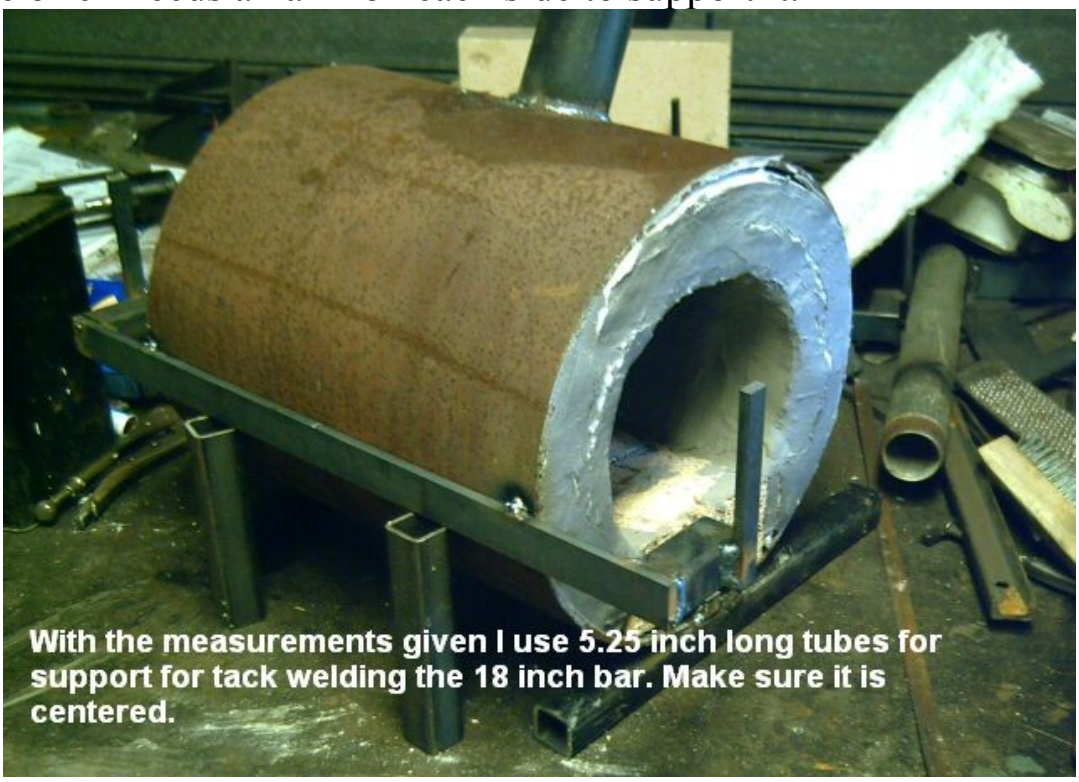
Fire Brick Supports

The fire brick needs an arm on each side to support it.



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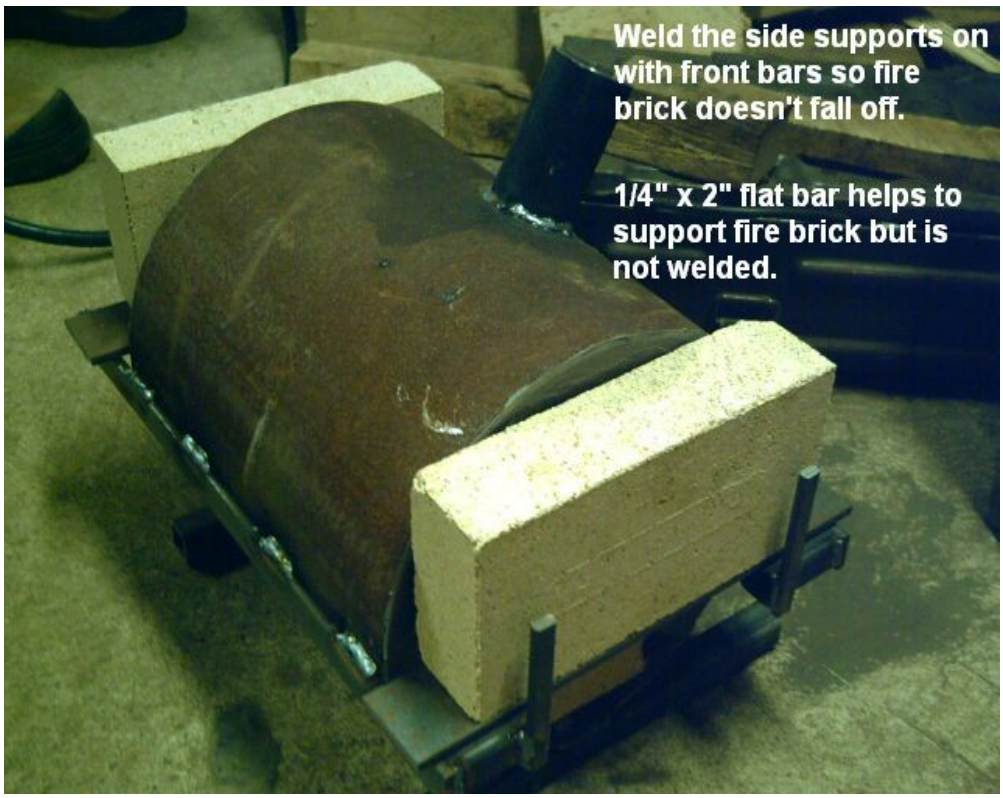

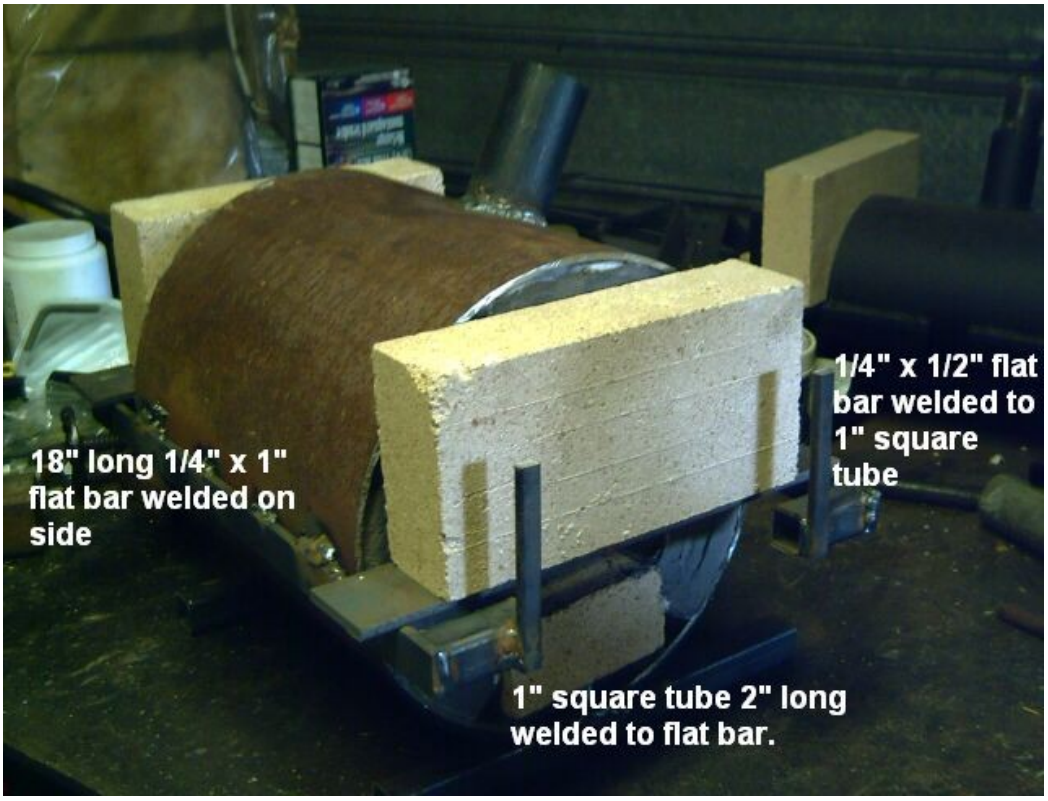

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The ¼ inch by 1 inch by 18 inch flat bars are the main side supports. These welded to the 1 inch square tubing 2 inches long and the ¼ by ½ flat bar by 4 inches long make each side support. The welding process. Weld the ends of two of the square tube to the same side of the flat bar but at opposite ends. This should sit flat on the table. Weld the small flat bars vertical on the inner edge of the square tube. See the photo.

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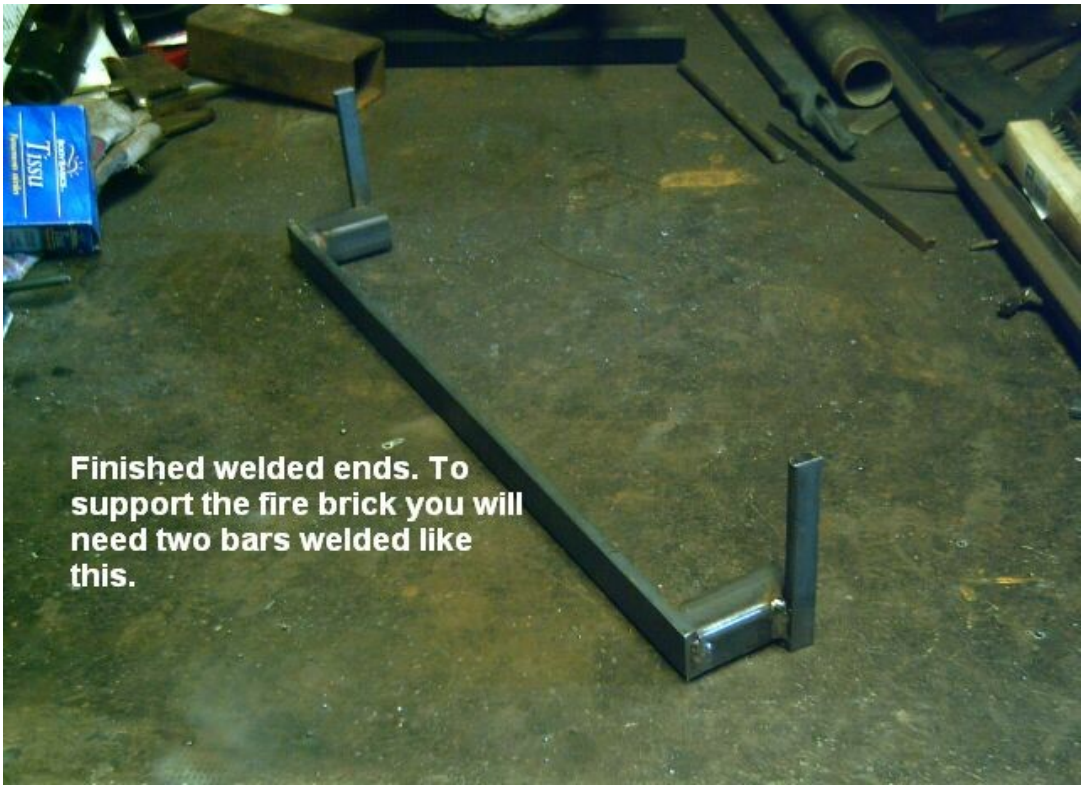

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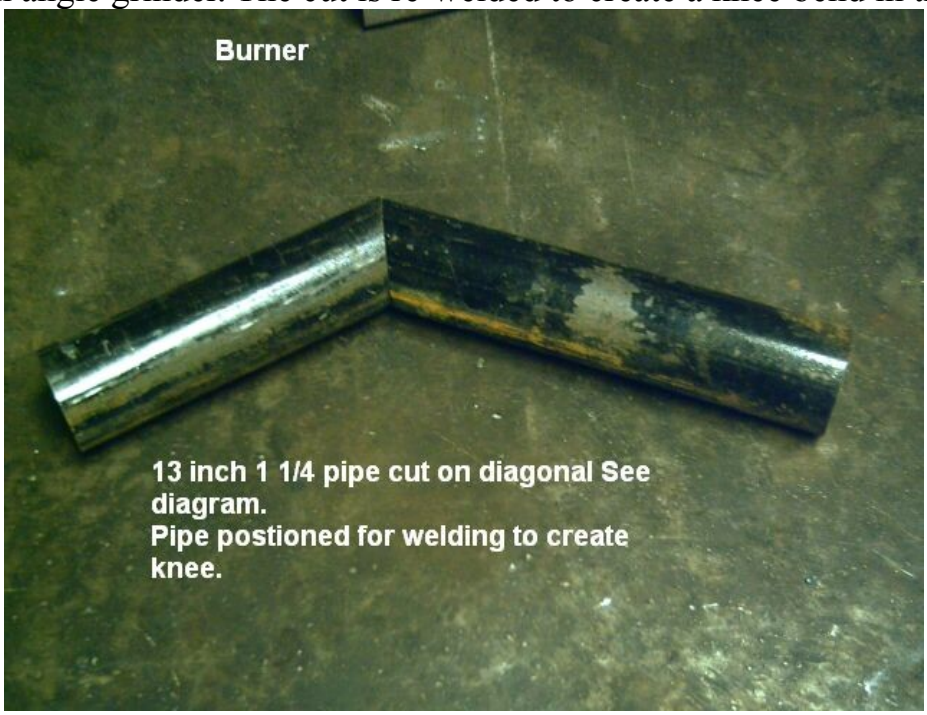
Burner Construction

The burner is the heart of the forge and requires special attention. The burner for this forge uses common pipe sizes and only a bit of welding, drilling and tapping to make the finished burner.

Start with the 1 ¼ pipe that has been cut on the diagonal. I cut these pieces with a metal cutting band saw set to the angle I want. You could make the cut on the pipe with a cut off disk on an angle grinder. The cut is re-welded to create a knee bend in the burner.



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This knee construction creates a high degree of turbulence thoroughly mixing the propane and the air. This gives a more complete combustion and has an added advantage reducing the critical nature of the alignment of the orifice.

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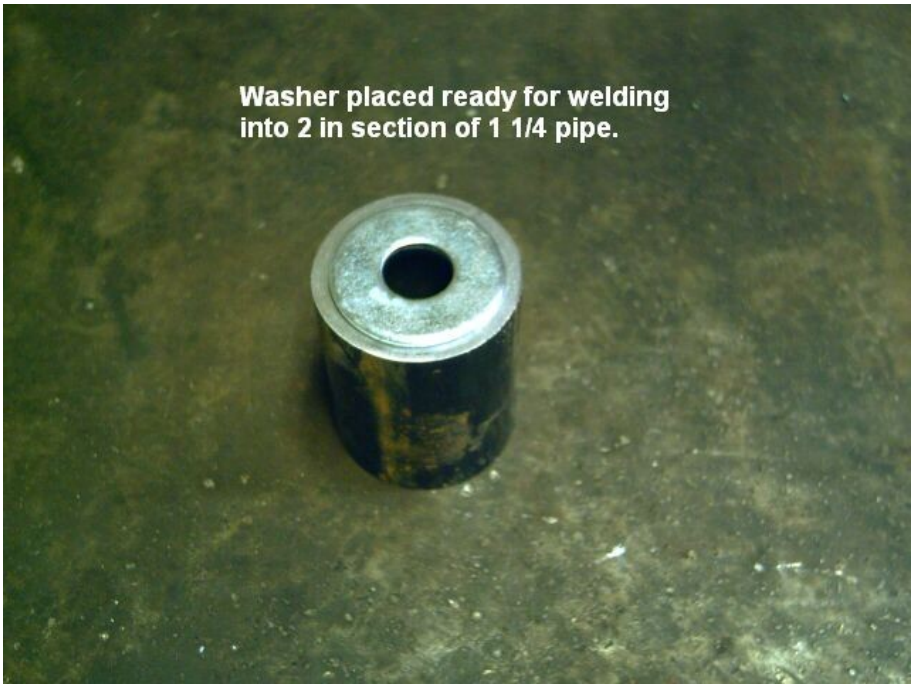

Next we set the ½ inch washer in the end of the 2 inch section of 1 ¼ inch pipe for welding. This becomes part of the alignment for the orifice. Weld the washer into the end of the pipe keeping it square.

Next take the 2 inch section of ¾ inch diameter pipe and weld 3 tack welds 120 degrees apart at both ends. These tack weld have to be high enough to stretch to the inside wall of the 1 ¼ inch pipe. This positions the smaller pipe in the center of the larger one creating the nozzle.

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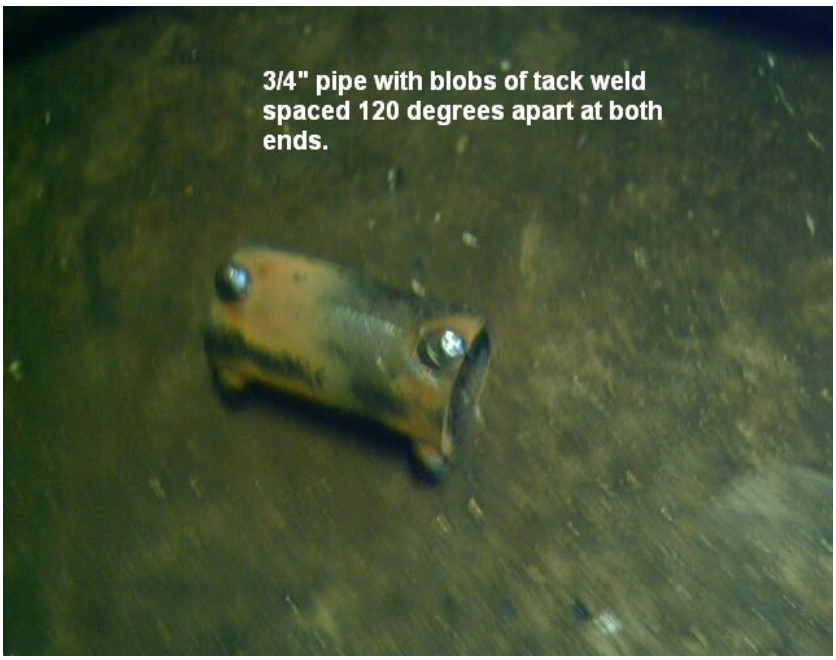

The smaller pipe is place inside the short end of the elbow pipe and tack welded on top of the tack weld to the wall.

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The inside short 2 inch piece of pipe really doesn't need more than just the tack welds to hold it in place since it doesn't get terribly hot. If you want to be extra confident you can drill 3 holes 120 degrees apart on the large pipe. These should match the distance of the tack welds from the end of the pipe. Then weld plug welds to secure the pipe higher up the burner. Grind all these welds smooth.

You may have read about using a flare nozzle on burners. This system works, but the downfall I have found with flares is that the flame originates inside the flare. This causes the flare to become hot and even if it is made of stainless steel it will eventually degrade. The system I use with the inner pipe, sometimes called a flame stabilizer, the flame originates at the end of the steel pipe. This means the steel doesn't get very hot so doesn't degrade.

In my primary forge I have this type of nozzle and I haven't had to make any repairs to it for over 10 years now. I use this forge almost every day and is my production forge. Some people say the flare is more efficient, but I believe the added efficiency of the knee bend makes up for any loss at the nozzle, and I prefer the lower maintenance.

Next drill 3 holes 3/16 diameter 120 degrees apart about ½ inch from the open end of the two inch pipe. These holes will be threaded to take ¼ by ¾ inch long set screws.

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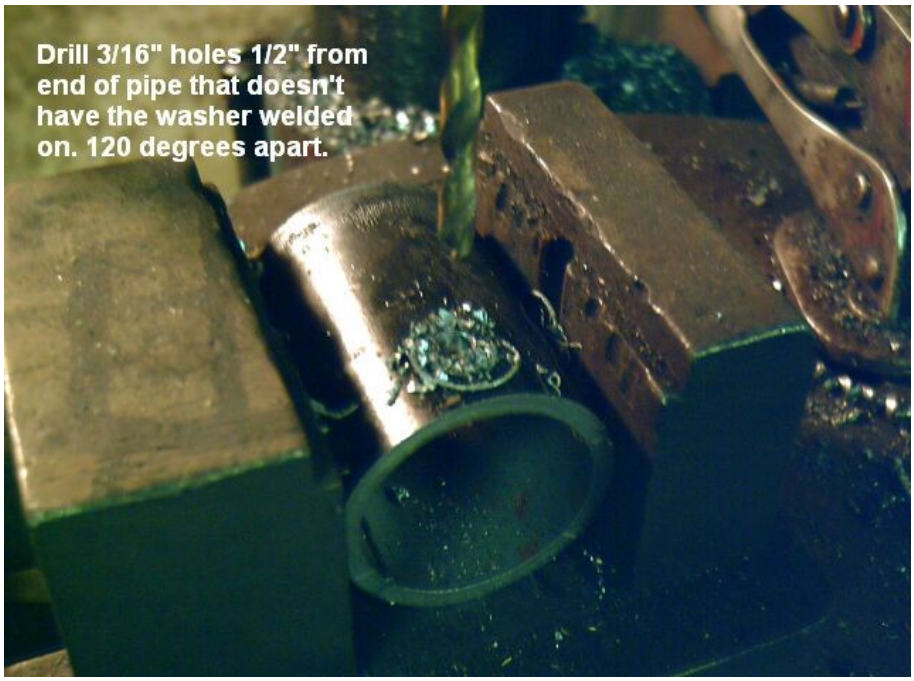

Now weld the 2 inch pipe with the washer welded in its one end to the main pipe. I space the gap the same distance as the diameter of the pipe. I then use 3 pieces of 5/16 round rod 3 inches long spaced 120 degrees apart. Weld securely as this will take a bit of weight from the hose ball valve and orifice.

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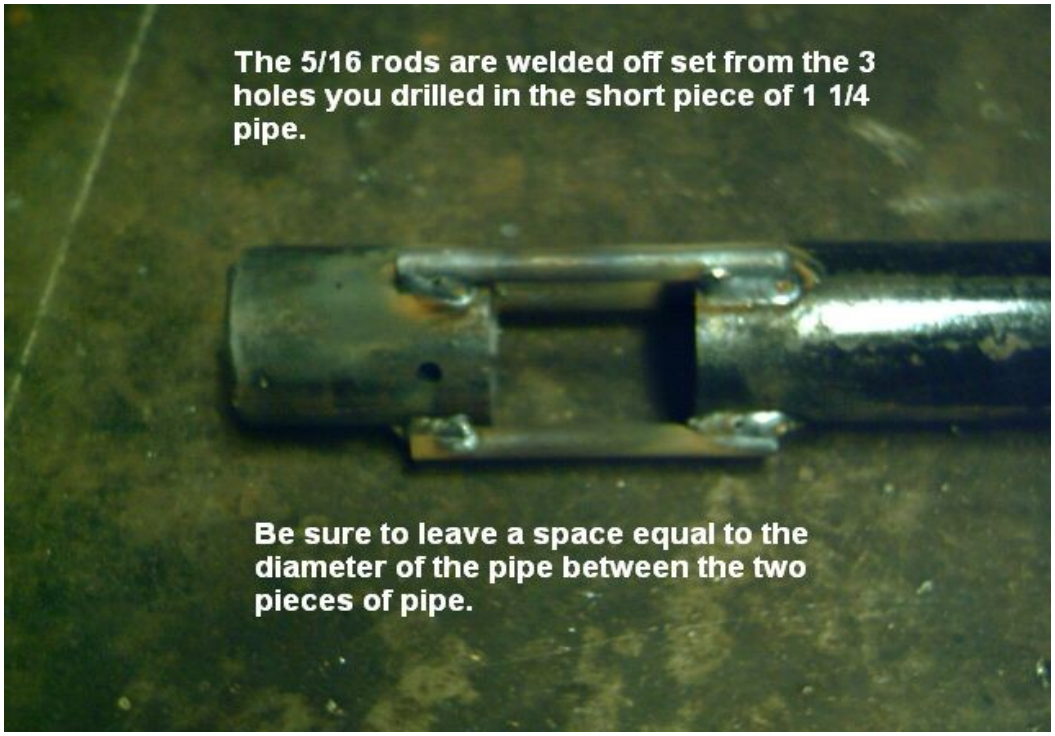

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Tap the holes slowly with ¼ inch tap. Remember ½ a turn reverse ¼ turn to break off the cuttings, continue the next half turn. Make sure the tap is straight, use cutting oil. The other alternative is to drill ¼ holes and weld nuts (with bolts threaded in them for alignment) to the out side of the pipe. I find the tapping looks cleaner. This is thin metal and taps quite easily.

Thread in the three set screws (allen screws) and leave a gap that the ¼ pipe will fit through in the center.

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At this point the burner is complete except for the orifice.

Orifice Construction

Using common plumbing ¼ inch schedule 40 pipe nipples and ball valves we can make an orifice that works surprisingly well. Other systems use mig tips threaded on to the end of the pipe nipple. I find it is more of a challenge to weld and tap the nipple and keep the mig tip straight. If you do use a mig tip solder it into the threaded socket so it doesn't rattle loose.

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These are the components to make the orifice.

Start with the 6 inch ¼ pipe nipple and we weld a 1/8 th inch thick slug of ½ inch round bar, on the end that acts as a cap. Mig weld works best for this unless you can turn your stick welder way down. This must be a clean weld with **NO HOLES!** If you are not confident of your welding abilities for this pay someone to do it for you.

The trick I use is to cut a piece of ½ inch round bar 75% through. Leave the nearly cut off slug attached to the parent bar. (parent bar should be about 6 inches long). Cut the pipe nipple at the point of the threads creating a smooth surface for a join to the slug.

Use a straight piece of square stock to rest the pipe and the ½ inch round against. Tack weld the slug to the pipe. Check alignment and full weld around the pipe and slug. Now finish the cutting of the slug. Grind the weld smooth looking for any holes or pitting.

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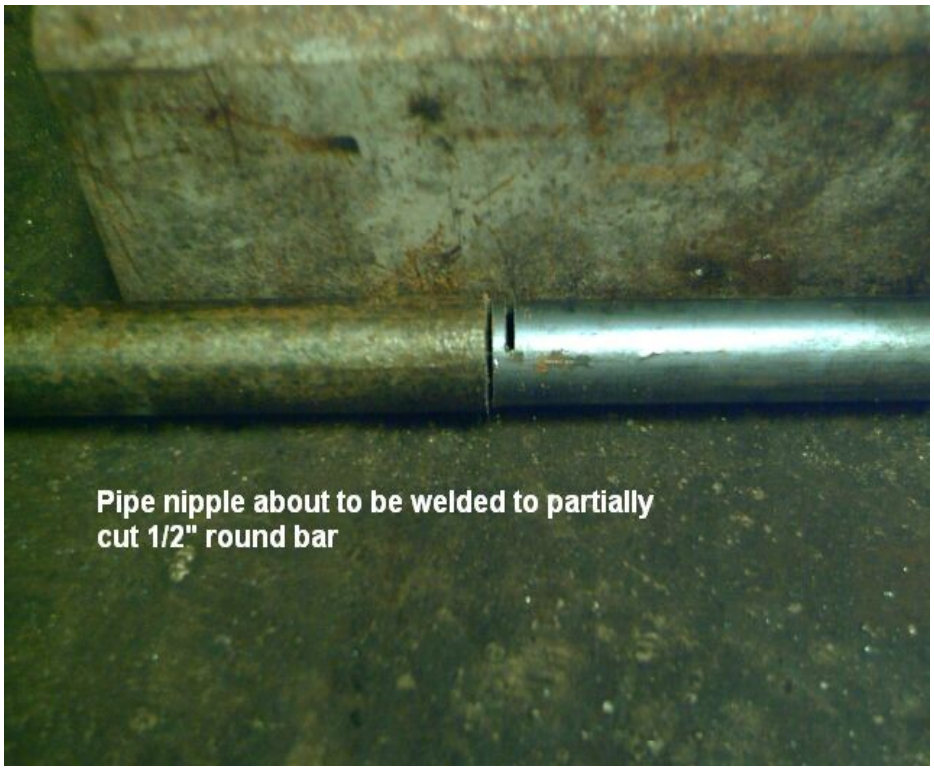

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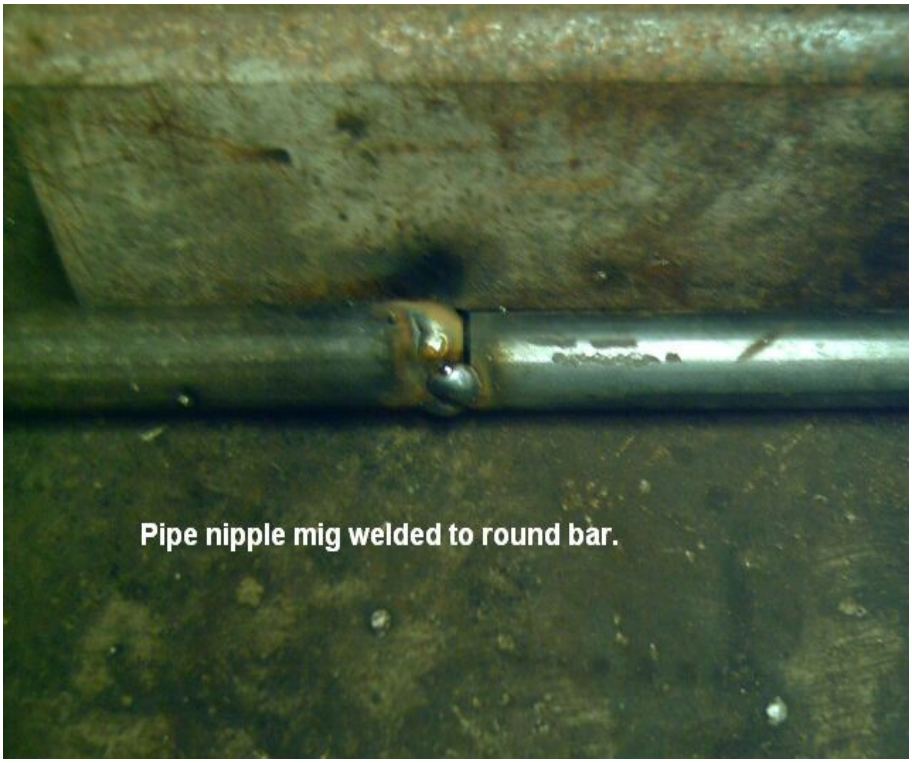
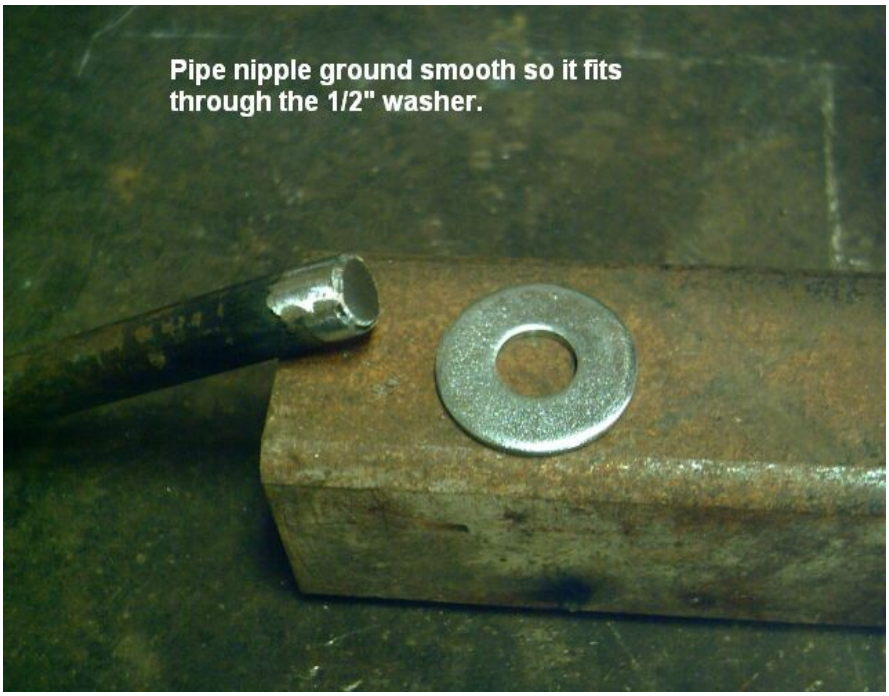


Pipe nipple mig welded to round bar.

Pipe nipple with round bar cut off.
The cut off bit is like the slug next to the nipple.

You should now have a capped pipe threaded on one end. The weld needs to be ground so that it will fit through the ½ inch washer.



The orifice has to be drilled in the center of the slug.

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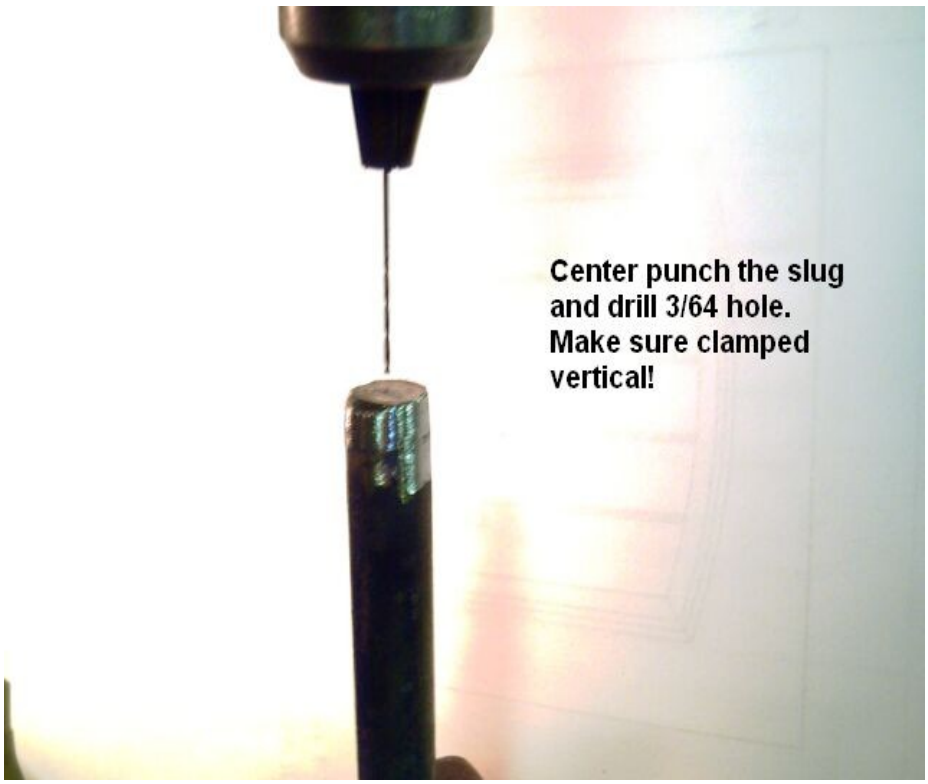

Use 3/64 drill bit. Center punch the hole and clamp in a drill press vertically and slowly drill the hole.

Now wrap the pipe nipple with propane rate T-tape or similar propane rated sealant. The same with the 90 degree street elbow and the right hand thread portion of the brass fitting.

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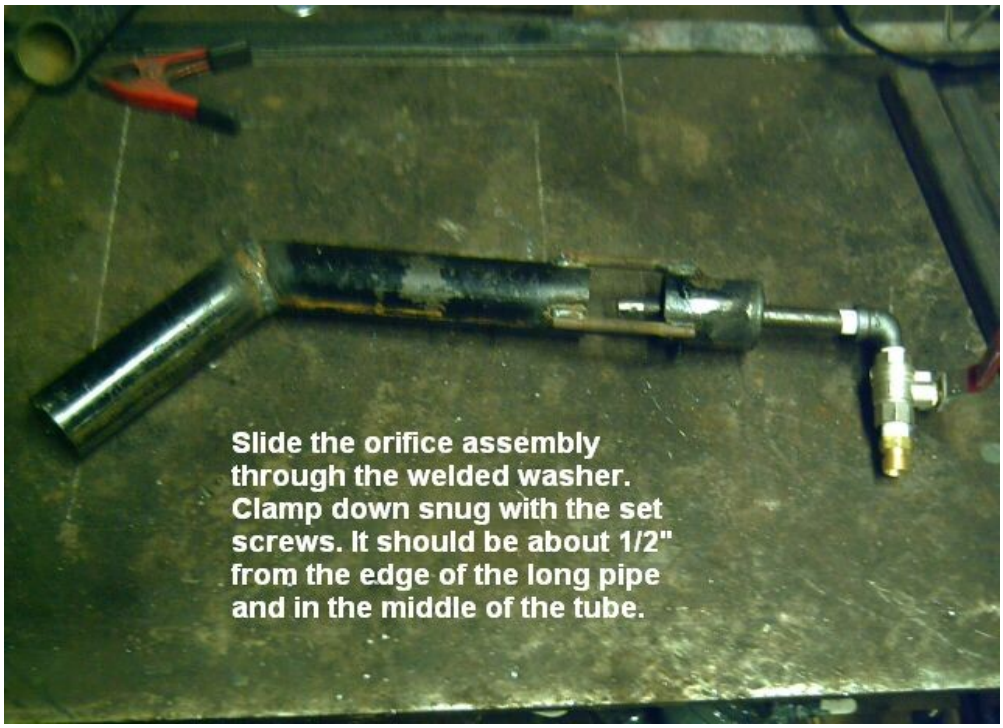
Thread together all the components and tighten snugly. You don't want any leaks.

The orifice is ready to be added to the burner. Simply slide the orifice through the ½ inch washer and past the set screws. Clamp it down with the set screws so that it is in

the middle of the pipe and about ½ an inch from the opening of the mixing chamber of the burner.



It is now ready to test fire and tune the alignment if necessary.

Test Firing

Attach the hose to the brass fitting (left hand thread) don't loosen the join into the ball valve when you attach (use two wrenches). Attach the regulator to the other end of the hose (left hand thread). Attach regulator to the propane tank (left hand thread).

Clamp the burner in a vise away from any flammables. Ball valve should be off. Slowly turn on the main tank valve. Check for leaks by rubbing a mixture of dish soap and water around all joints check for bubbles. Tighten as needed. Use a barbeque lighter lit in front of the nozzle and slowly turn on the ball valve. It may take a couple of trys before you get a stable flame that doesn't blow itself out.

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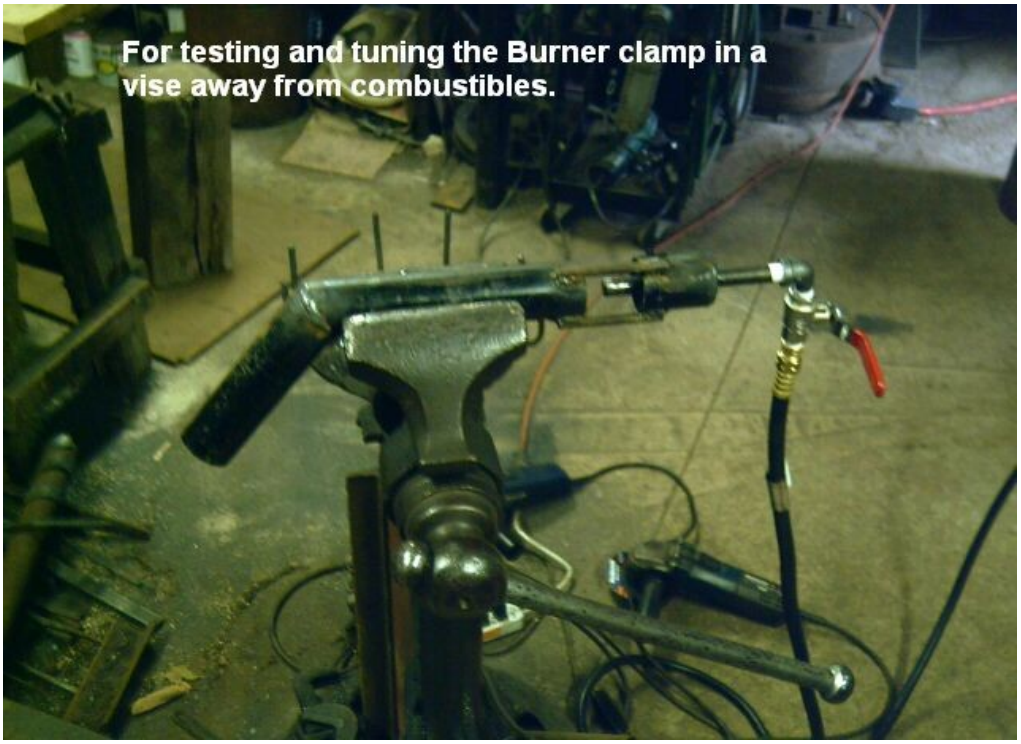

Once your flame is going release pressure on the set screws enough to slide the orifice in and out. Try moving back and forth and see how the flame changes. It is subtle. If you can find no change use the original ½ from end long burner tube position.

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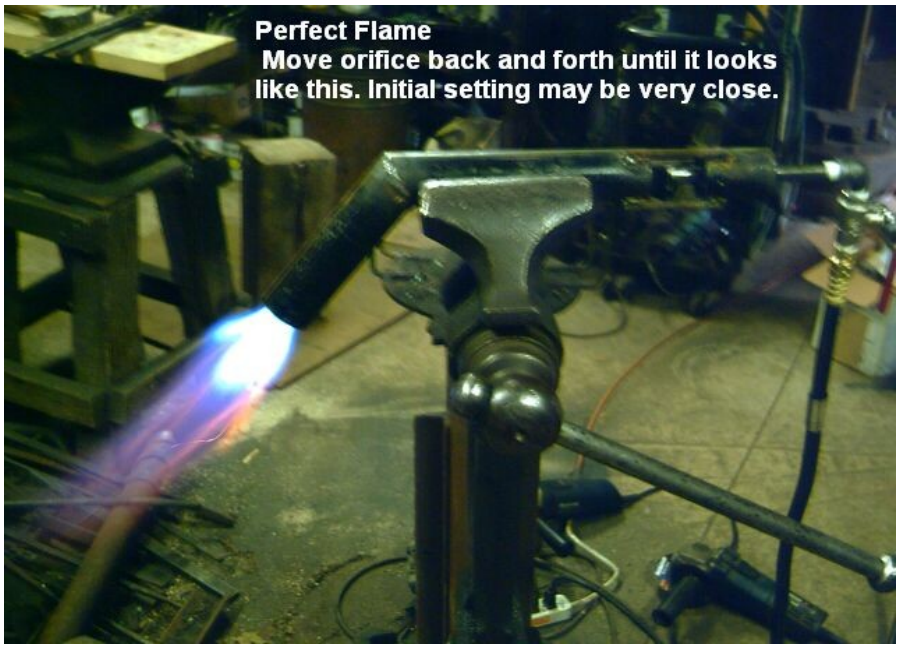
Your flame should look like this at 8 to 10 psi on the regulator gage.



Once you get this shape and intensity of flame clamp your set screws down tight, but don't strip the threads. When tuning the burner you are looking for maximum blue flame with a minimum of yellow.

Initial Forge Firing

Now all the components have been made to create this forge. If you have used all my measurements you simply slide the burner into the socket on top of the forge and you are ready to go.

The refractory mortar that we used to coat the Kaowool has dried but not been fired yet. This means there is still a lot of water vapor that is locked in the mortar and has soaked into the Kaowool. You must slow fire the forge first to drive the moisture out of the insulation and the mortar. If you quick fire the steam will cause the mortar to scale off the walls. This means you will have to replace it and dry it all over again.

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Slow firing.
Use pieces of duct tape to close off the the air intake on the burner. This should be completely sealed. Back the propane pressure off to just barely registering on the gage (less than 1 psi) light a strip of newspaper and put it inside the chamber with the fire bricks front and back. Open the ball valve slowly.

You should get a lazy flame that gently warms the interior of the forge. Let this run for 20 minutes.

After 20 minutes peal a piece of the duct tape back so a little air gets in . The sound of the flame should change a bit and it should look a bit hotter. Run like this for 20 min.

After you have run like this for at least 20 min. peal half of the duct tape off. This is allowing more air in creating a hotter flame. Again 20 minutes at this new setting.

An hour has passed and you can open all the duct tape so full air flow is allowed. At this point you can up your pressure to 2 psi. Again 20 minutes. Now the forge should be getting hot inside.

After 20 minutes up the pressure to 8 psi and run for 20 minutes.

After this last sequence you are ready to use your forge any time. Now you can start at 8 to 10 psi right away any time. Start with small stock to allow the heat to soak into the bottom fire brick . Then shortly you can move to bigger stock.

This size forge will effectively heat 1.5 x 1.5 bar 6 inches long. Larger bars will have to soak a bit longer. Most of what I work on is ½ x ½ and down.

Reminders

Due to the extreme temperatures inside a forge the forge is actually a consumable item. You will have to replace your insulation and fire brick. This may be after years of use. If you are forge welding (running the forge at 15 psi or above) place a steel plate in the bottom of the forge to catch the flux as this will eat the insulation of the forge the fastest.

Be gentle on the side walls as they are pretty soft and you don't want to replace your insulation sooner than you have to.

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If you need a larger interior the forge will run adequately with one layer of Kaowool inside but a little less efficient (more heat loss).

Always wear safety glasses and have a fire extinguisher handy.

See precautions below.

Gas Forge Precautions

You are the proud owner of a new gas forge so how do you use it with out blowing yourself up?

1)Make sure the forge is set up on a stable surface well away from any combustible material.

2) The forge should be placed with the fresh air coming to you first then the forge. Remember the forge produces a lot of carbon monoxide, and produces a lot of carbon dioxide. It also uses oxygen at a high rate. Carbon monoxide is poisonous. **ALWAYS HAVE FRESH AIR !** If you feel light headed or nausea then shut the forge off and move to fresh air immediately.

3) Place the burner in the forge as far down as it goes. Make sure it is secure.

4)Attach the hose and regulator. Attach the regulator to propane tank. Remember fuel threads are left hand threads. All attachment points should be secured with a wrench.

5) Check for leaks with dish soap and water. Also sniff the joints to detect any leaking propane.

6) Start the forge with pressure set to about 8 psi registering on the regulator.

7) Ball valve should be off. Place a lit piece of paper in the chamber and turn propane on. If you have an atmospheric burner (no blower) that should be it. If you have a blower right after you turn on the ball valve you need to plug the blower in.

8) A flash back can occur if the propane velocity is lower than the air velocity. This can happen at low pressures. The flame will go out in the chamber and start combusting inside the burner. The sound will change and you will need to shut the ball valve IMMEDIATELY ! Increase you propane pressure and try again. This usually is not a problem with a blown system but could happen if the power went out.

9) Make sure your hose is out of the way of falling hot steel. Hot steel could melt the hose and ignite a fire. When the hose is connected make sure it is out of the way of direct heat from the forge as it could soften and melt causing a fire.

10) When finished for the day shut ball valve off, turn off blower if any, shut main tank valve off. Always shut the main tank valve so if there are any small leaks in the system you don't come into a pool of propane when you next start your forge. Propane will pool if there is a leak. This could ignite just by turning on a light switch.

11)General work usually about 8 to 10 psi. Forge welding 15 to 20 psi. If you are going to forge weld put a piece of sheet steel in the bottom of the forge to catch the drips of flux. Flux will eat the lining and the firebrick. These you will have to replace over time but why speed the process up. Fire brick on the front and back will eventually break and the support steel will sag. Replace when needed.

12) If you are working a long bar make a separate support that stands

on the floor. This will help prevent the forge from tipping over.

13) Always wear safety glasses, and have a fire extinguisher nearby just in case.

Trouble shooting

A recent problem with some of the new propane regulators is they have a small check valve in the pol fitting. (The brass fitting that fits inside the propane tank) This check valve is a ball with a small spring behind it. If the propane tank valve is turned on suddenly the pressure can force this ball up against the spring and it can stick there. This is designed as a safety feature in case the hose is cut and limits the amount of propane coming through the hose.

If the check valve is stuck closed your forge will not work properly. You will see the right pressure on the gage before you light it but as soon as you open the ball valve the pressure will quickly drop to zero.

To fix the problem take a piece of wire and poke at the ball through the mesh that keeps it in place. It should loosen with a couple of pokes and pop back onto the mesh. Try reinstalling in the propane tank and open the main valve very slowly. Then try to light the forge also by opening the ball valve slowly.

I can't recommend removing the check valve as it is a safety feature although it would be easy to do. Best to find a way of opening your tank valve and ball valve in a way that the check valve doesn't kick in.

The older regulators have a stronger spring and seems to kick out with less trouble.

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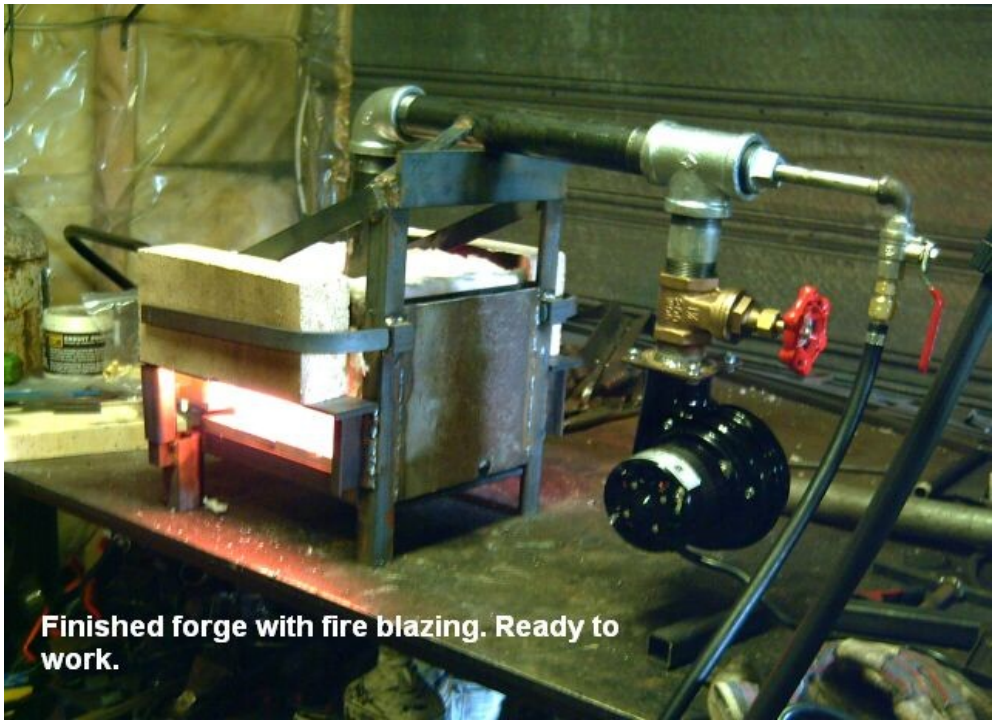
Bonus
Square Box Forge
With Blower



Finished forge with fire blazing. Ready to work.

This forge is not as elegantly shaped as the previous forge and requires a great deal more cutting and welding of components to make it work. This forge is much more versatile and if you are able to weld well and don't mid piecing together little bits this forge will work very well for you. My primary production forge is the forerunner of this design.

Box Forge Cut List

- 2) 1x 3/16 angle iron 3 inches long (feet)
- 2) 1 x 3/16 angle iron 15.5 inches long (feet and side supports)
- 8) 1 x 3/16 angle iron 9 ¾ inches long cut on diagonal 45 degrees both ends (frame for sides and bottom and top)

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- 2) ¼ x 1 flat bar 10.5 inches long cut 45 degrees one end
- 2) ¼ x ¾ flat bar 4.5 inches long
- 2) ¼ x 1 flat bar 9.5 inches long
- 1) 7 7/8 x 7.5 14 gage sheet (side wall)
- 1) 7.5 x 7.5 14 gage sheet (bottom)
- 1) 1 ¼ schedule 40 pipe 6 inches long (nozzel)
- 1) 90 degree ¼ inch street pipe elbow
- 1) 90 degree 1 ¼ pipe elbow
- 1) 1 ¼ schedule 40 black pipe 12 inches long
- 1) 1 ¼ pipe Tee
- 1) 1 ¼ inch pipe plug
- 2) 1 ¼ schedule 40 pipe nipple 3 inches long
- 1) 1 ¼ pipe water gate valve
- 1) ¼ ball valve rate WOG (water oil gas)
- 1) ¼ schedule 40 pipe nipple 6 inch long. (orifice)
- 1) ¼ pipe cap (orifice)
- 1) blower (40 to 100 cfm squirrel cage is best) Flange mount is best
- 2) 1 x 3/16 angle iron 9 ¾ diagonal cut (side door)
- 2) 1 x 3/16 angle iron 5 1/16 diagonal cut (side door)
- 1) 7.5 x 3 inch 14 gage sheet (door side wall)
- 2) steel hinges (for side door)
- 1) 10 foot propane hose
- 1) propane regulator from Rexotherm (part number: 567HBTZHS-2) (416)-253-9778 with gage and pol fitting.
- Propane rated T-tape or pipe joint compound.
- 2) 1 x 9 x 4.5 inch fire brick (floor)
- 1) 24” x 24” x 1 inch Fibrofax, Kaowool, or Durablanket
- 2) 2 ½ x 4.5 x 9 inch hard fire brick
- 2) ¼ x 2 x 11 flat bar (fire brick support0
- 2) ½ 1.5 channel iron 3 inches long (fire brick supports)
- 4) 1 inch square tube 1/8 wall 3 inches long 9fire brick supports)
- 2) ¾ square bar 2.5 inches long (fire brick supports)
- 3) ½ square tube or ¾ square tube 1 inch long (door lifts)
- 2) ¼ x ¾ x 14 flat bar (fire brick holders)
- 2) ½ x 1 channel iron 1 inch long (sockets for fire brick holders)

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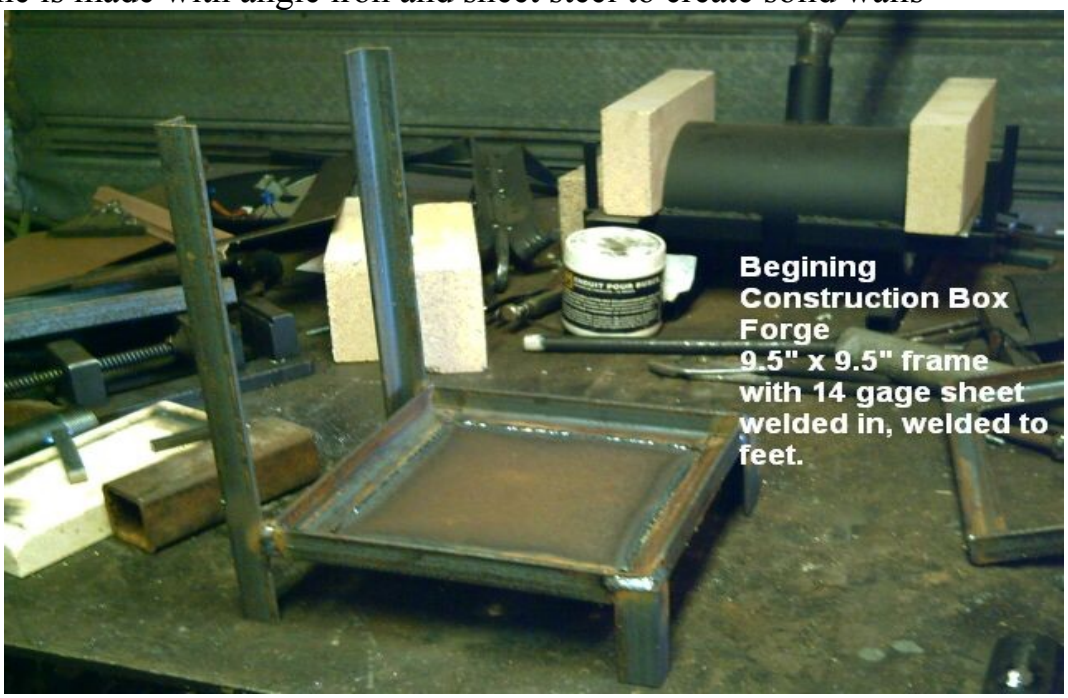
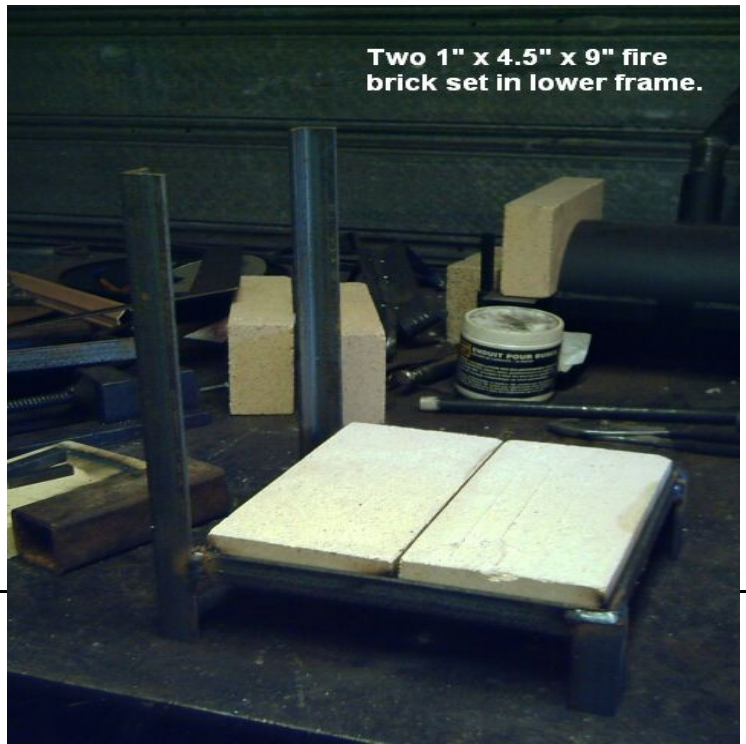
Building the Frame

The frame is made with angle iron and sheet steel to create solid walls



Make sure your supports are straight perpendicular. Start with welding 4 of the



diagonal cut angle iron together for the floor. Two of the thin fire bricks should fit in with a little room to spare. I actually use the two thin fire bricks side by side on the welding table as a form for the angle iron frame so I know that they will fit in. It helps to keep it square as well. Weld in the floor sheet of steel. Weld on the short legs and the long legs as shown in the above picture.

The top frame and the door are next welded together. Top frame is four 9.5 pieces of angle iron with 45 degree cuts both ends welded together to form a square. No sheet steel in this.

The door is two 9 ¾ diagonal cut and two 5 1/16 diagonal 45 degree cut pieces of angle iron welded in to a rectangular frame. Add piece of sheet steel to outside.

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Clamp the upper frame to the tall vertical supports so that it rests ¼ inch above the door resting on the fire brick. Use ¼ x 1 flat bar as a spacer. Make sure the top frame is level and tack weld into position.

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Remove door and weld the upper frame solidly to uprights.

Add diagonal ¼ x 1 by 10.5 inch flat bar supports.

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Once diagonals are in weld remaining sheet steel on to back of uprights.

Cut Kaowool slightly over sized and gently stuff down behind the bottom frame and the side wall. It should also be tight to the top frame and the side wall.

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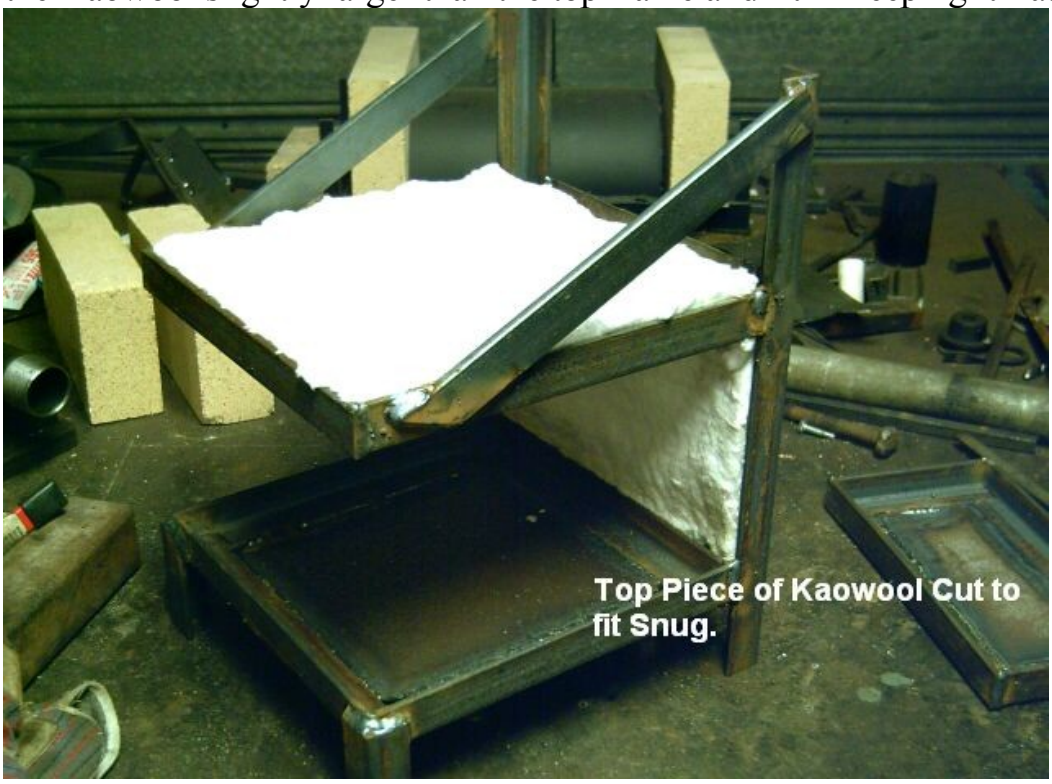
Now cut the Kaowool slightly larger than the top frame and fit in keeping it flat.



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In the center of the top Kaowool you will need to cut a tight hole for the burner. I use a short piece of 1 ¼ pipe and slowly rotate it back and forth as a circular cutter to wear a hole in the insulation. Keep you hand directly under it for support. Wear gloves and a mask. Discard the cut out.

The supporting back plate is welded into position. In the photo I used ¼ x 2 as I cut my

uprights a little short. I recommend ¼ by 1 in the cut list and have given you longer dimensions on the up rights to take this into account. Next we make the burner nozzle and mixing chamber.

The long 1 ¼ schedule 40 pipe 12“ long needs to be threaded both ends, the 6 inch one

only on one end. This nozzle is the same construction as in the first pipe forge with 2 inch ¾ schedule 40 black pipe tack welded inside.

The two tubes are joined with the 90 degree elbow.

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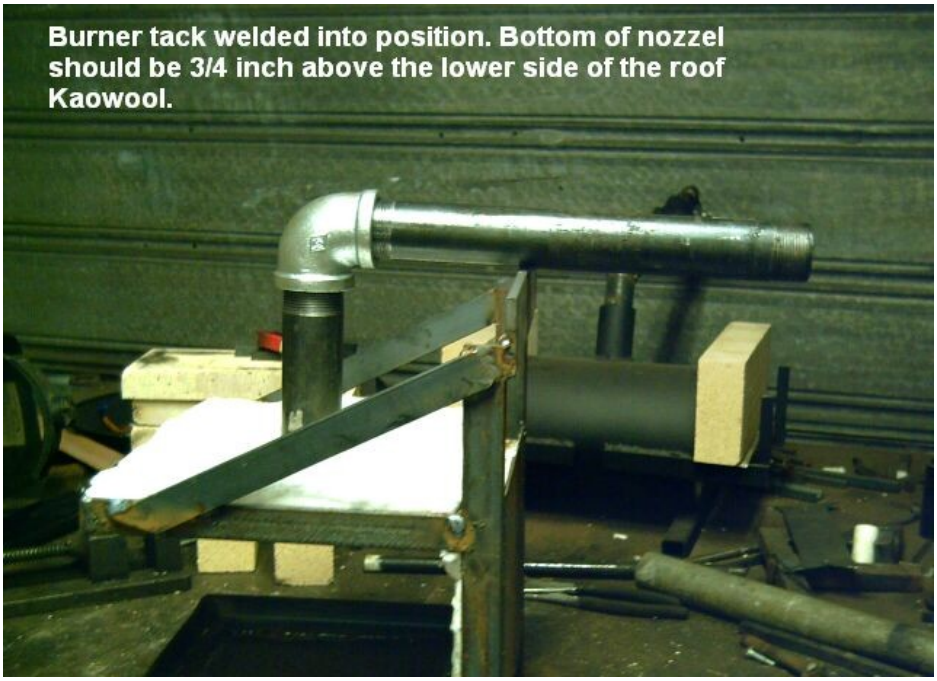
You do not need T-tape on any of the fittings a except propane. Take the assembled burner and place it in the hole so that the twelve inch piece rests on the back support. The burner should come straight down and be in the middle of the back support. The end of the nozzle should be ¾ of an inch recessed from the inside of the chamber. (Protected by the Kaowool) Tack weld the horizontal pipe in position.



Add the 4.5 inch ¾ flat bar as diagonal supports.

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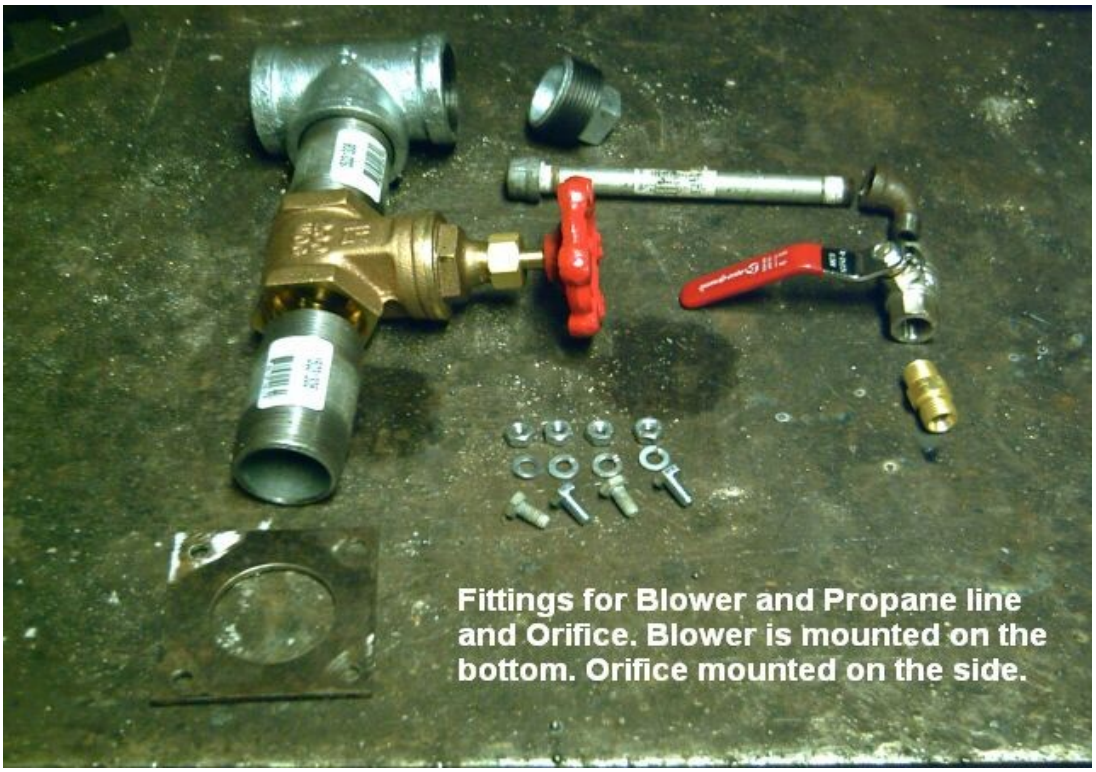
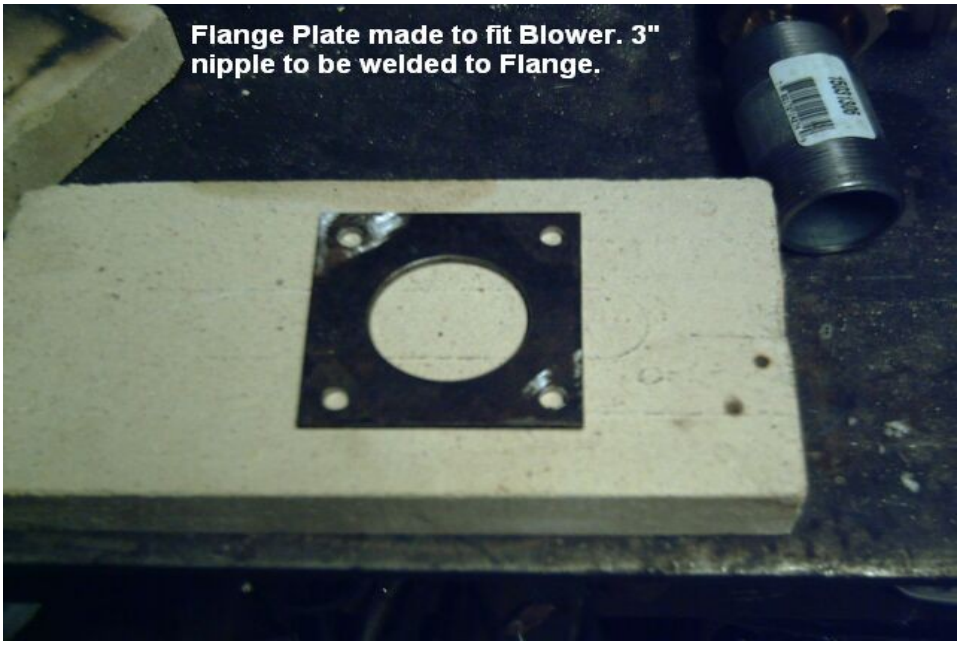
Diagonal supports on both sides of the burner tube for strength. If you ever need to do maintenance on the nozzle it simply just unscrews from the elbow.
The fittings required for the blower and the orifice are seen in the picture below. The

flange plate and the four ¼ x ¾ inch bolts and nuts are not included in the cut list because you may have a different blower mounting than I have. But this is how I mount it.



Fittings for Blower and Propane line and Orifice. Blower is mounted on the bottom. Orifice mounted on the side.



Flange Plate made to fit Blower. 3" nipple to be welded to Flange.

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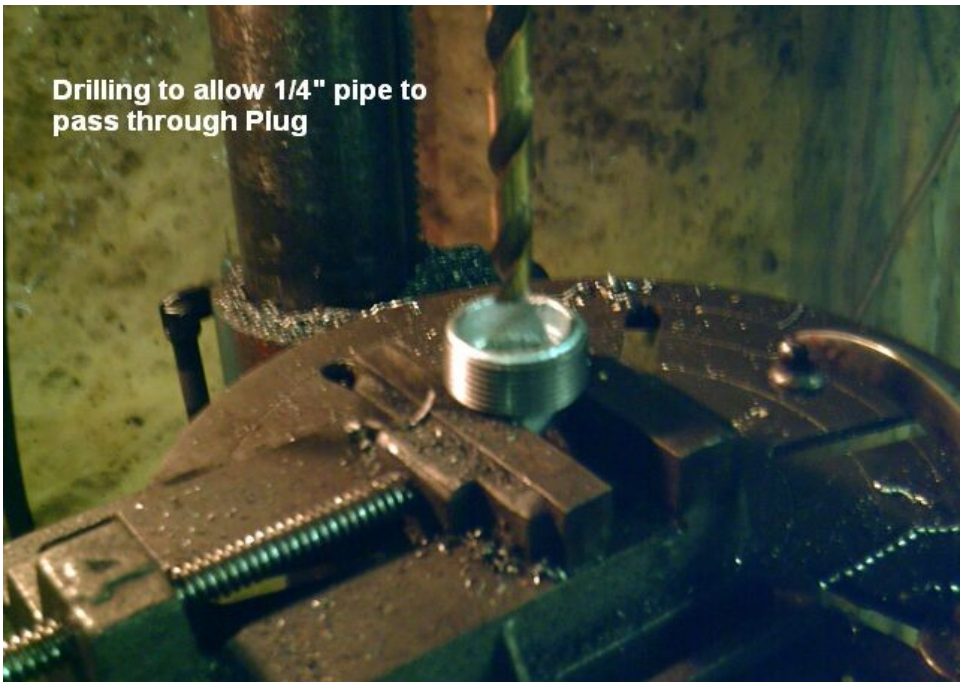
The flange plate is just 1/8 thick 3 x3 plate with a large hole cut into it and four small holes that match up holes in the blower flange. The key is to weld the threaded section of a 1 ¼ by 3 inch pipe nipple to the flange at the hole. This allows the flange to be screwed into the water gate valve giving an accurate way of controlling the air flow.

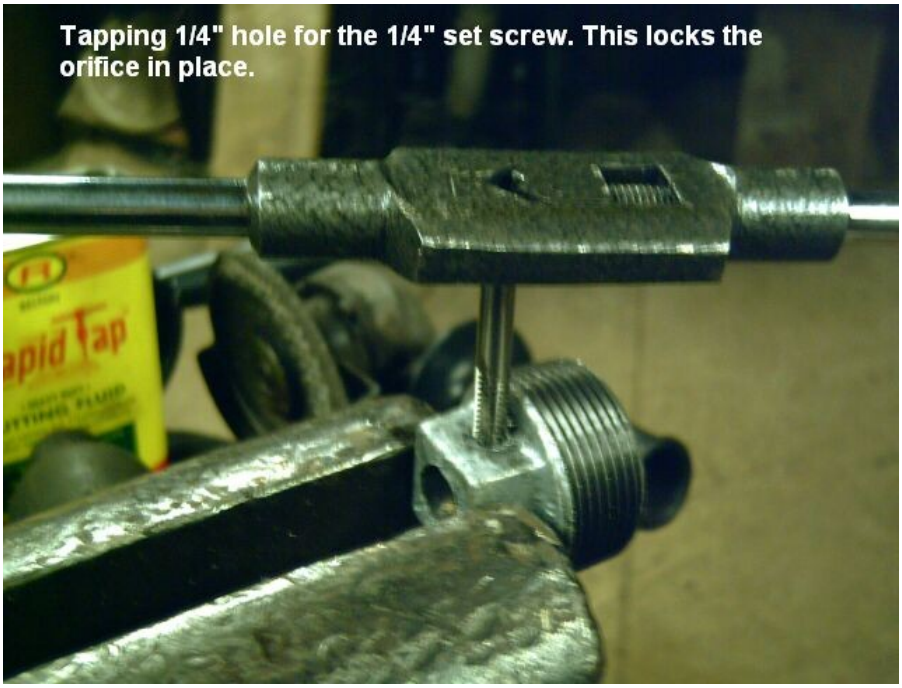
The Orifice and Blower

First drill a 5/8 hole in the center of the 1 ¼ inch plug. This creates a place to slip the orifice through and be able to thread it onto the Tee junction.



Next turn the plug on its side and drill a 3/16 hole in the flat side of the plug

This is where you will thread using ¼ inch tap for a set screw. This hole only needs to go through to the larger hole you drilled previously perpendicular to this one.



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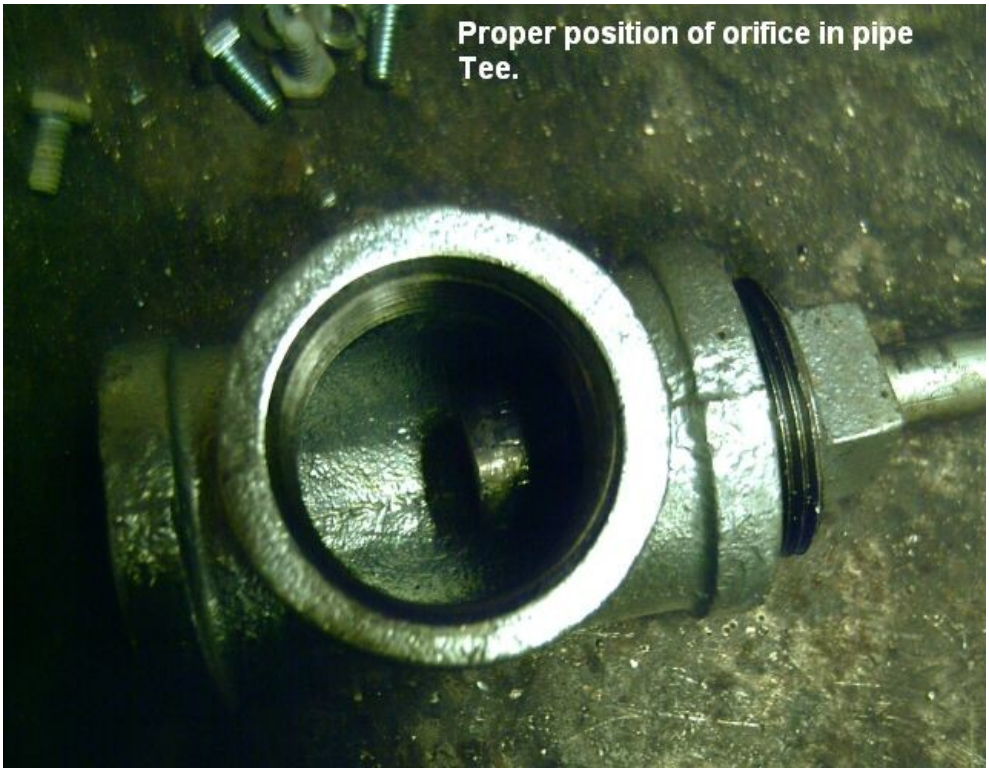
Unlike the previous pipe forge I don't recommend that you plug this pipe and then drill the orifice through the plug. I find it is better to cap the 6 inch pipe nipple and grind the cap smooth and center punch then drill the 3/64 hole in the center of the cap.



The nipple is then T-Taped or pipe compound and the cap threaded on. Then pass the free end through the whole drilled in the plug. Thread the plug into the Tee as shown above so that the end of the cap (seen inside the tee) is little more than half way back from the opposite side opening. Use the set screw to lock the orifice in place. The cap acts as an added safety feature if the set screw ever loosens up it will prevent the orifice from falling out of the Tee.

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Assemble the rest of the orifice components as we did in the pipe gas forge. The other air components are just threaded on, no pipe joint compound required.

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Now thread this assembly on to the horizontal burner pipe.

Blower and Tee junction added to the forge assembly. Two hard firebricks create the floor of the chamber.

I have bolted on the blower at this point as well. Slowly you can see the forge come together. This is a large project in that it is time consuming but not hard to make.

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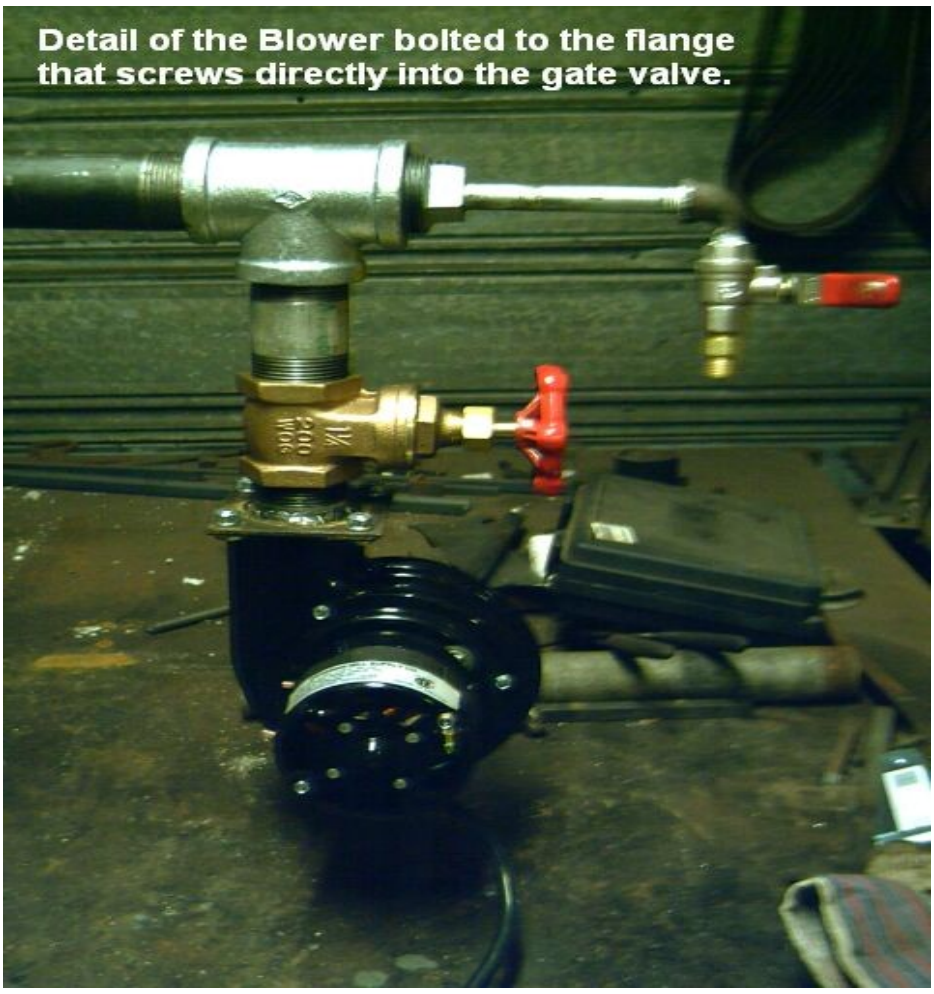

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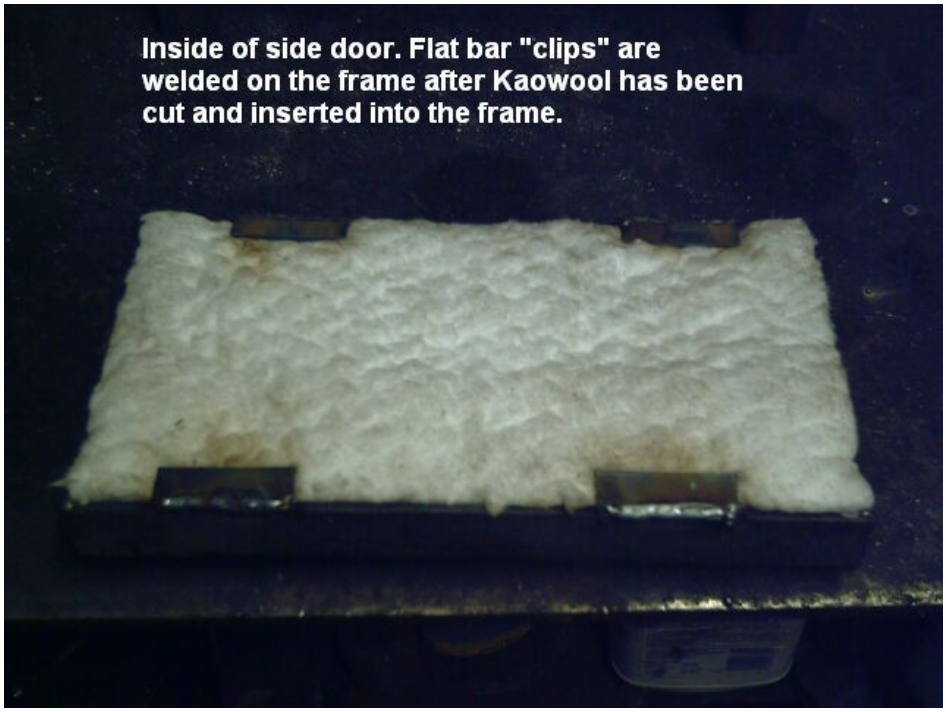
Details of the Door Construction



The frame of the door was previously constructed with the sheet steel welded in. Now cut a piece of Kaowool or Fibrofax that is slightly over size to fit in the door. Gently pack it in to the door as shown. Then weld on short 1/8 th x ¾ x 2 inch flat bar strips to keep it in place. Make sure none of the weld over hangs the edges. Grind smooth if need be.

The door will take the most abuse and you will likely have to cut off these clips and replace them and the insulation at some point.

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Next weld on the short square tubing on the sides as shown below.

The idea behind this tube is that it gives you a place to put a square bar in while the forge is running to open the door if you have to put an odd shaped piece in for heating.

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The above photo shows the inside of the door and the Kaowool coated with the refractory mortar. Follow the same procedure for drying and slow firing as in the pipe forge. You could also slow bake this in your oven or toaster oven at about 400 degrees for an hour to dry it out.

Let cool.

The hinges seen above are welded on to the door with it in place on the forge. You should have your ¼ inch gap on the bottom and a snug fit on the top, with the surfaces being flush at the top.

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Make sure the hinges are straight because when things heat up any little twist is magnified and you may have a hard time opening the door.

You will find that the door hangs a little open this way. You could counter weight it or I prefer to add a little square tube to the lower frame, with a removable pin that keeps the door closed.

The actual Fire Brick Support

In this design I needed a way to both support the fire brick and have it removable so full use of the door could be achieved. The following photos show how I accomplished this.

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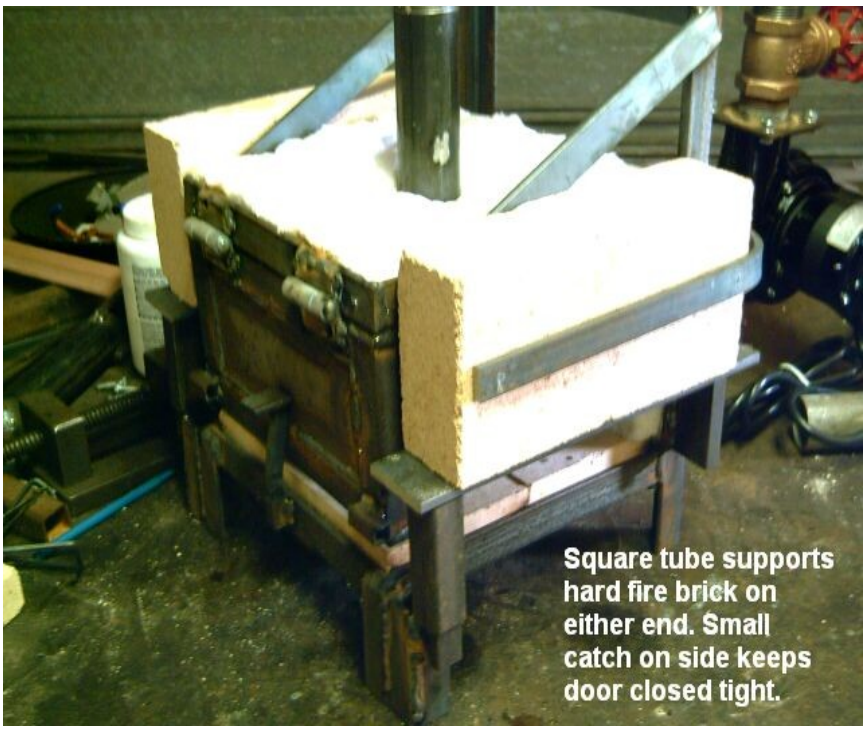

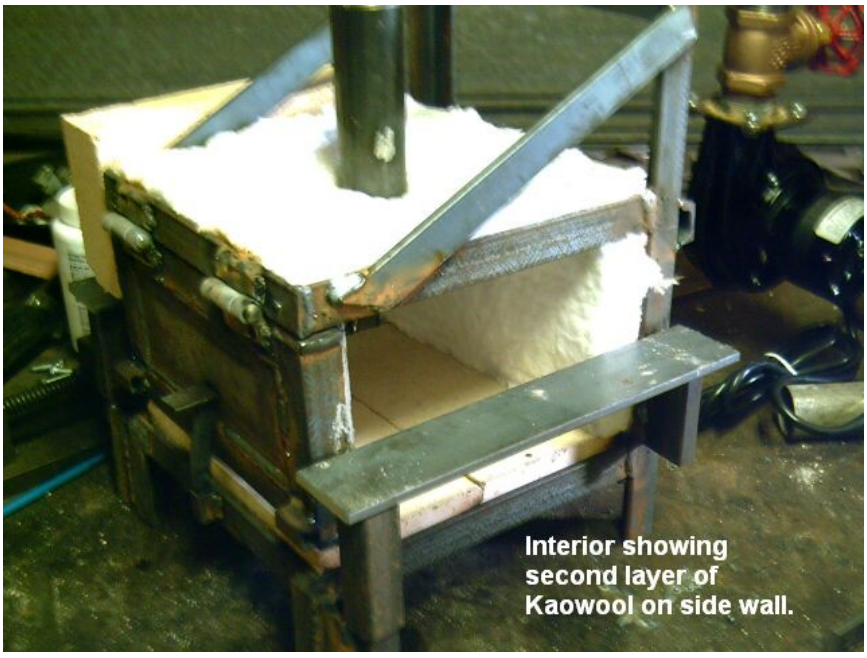

The distance between the floor of the forge to the bottom of the fire brick is 2 inches.

The fire brick removed from the front shows the second layer of Kaowool that is snug fitted into back wall. This protects part of the upper frame from the heat as well as the vertical upright supports. With extensive use the upper angle iron frame will degrade

with the heat. At some point you will have to replace this. On my forge It looks like I may have to do this once every 7 years or so. I am willing to do this in exchange for the versatility of the forge.

The previous photo also shows the channel iron at the right and the removable square tube on the left that support the ¼ x 2 inch by 11 flat bar that supports the fire brick.

In the next photo you can see the channel iron is welded to the frame, but the 1 inch square tube just slides over the ¾ solid square bar. The bar is spaced out from the edge of the forge with another 1 inch square tube attached to the front leg.

The other end of the forge is the same.

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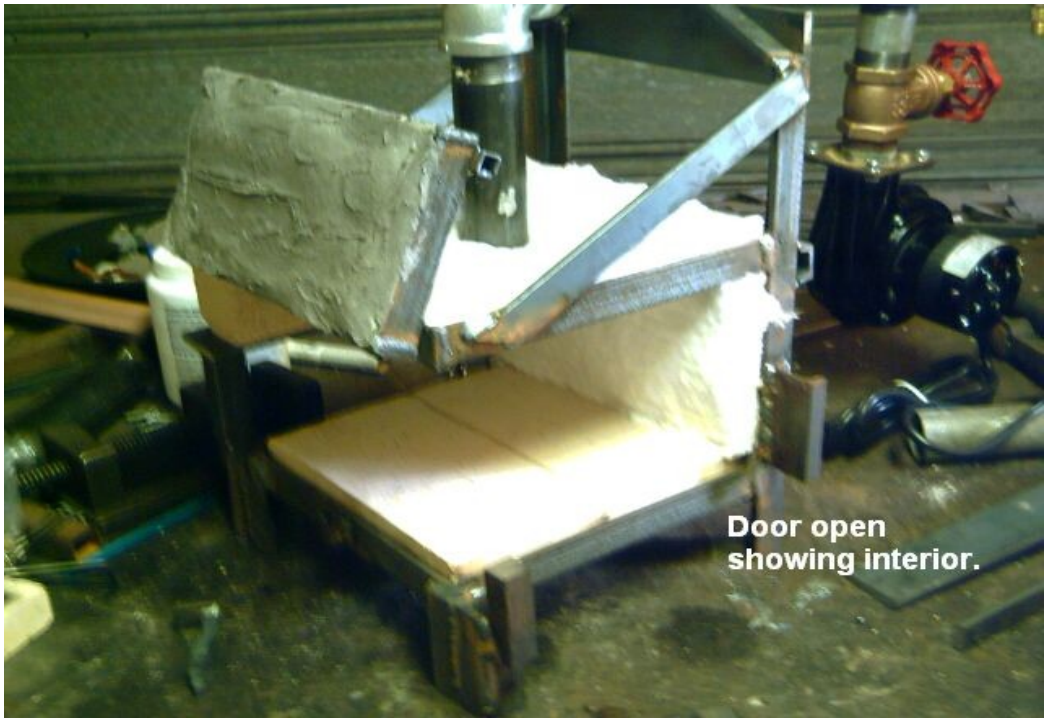

You can see how you have a great deal of access to the interior of the forge with the door open. Your efficiency will go way down so best if you can close the door once you get your piece inside.

You can see a close up of the supporting channel iron in the next photo.

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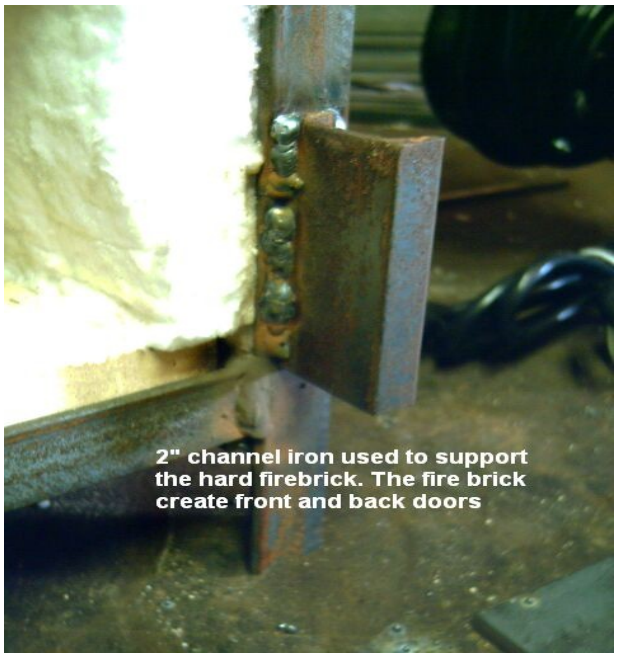
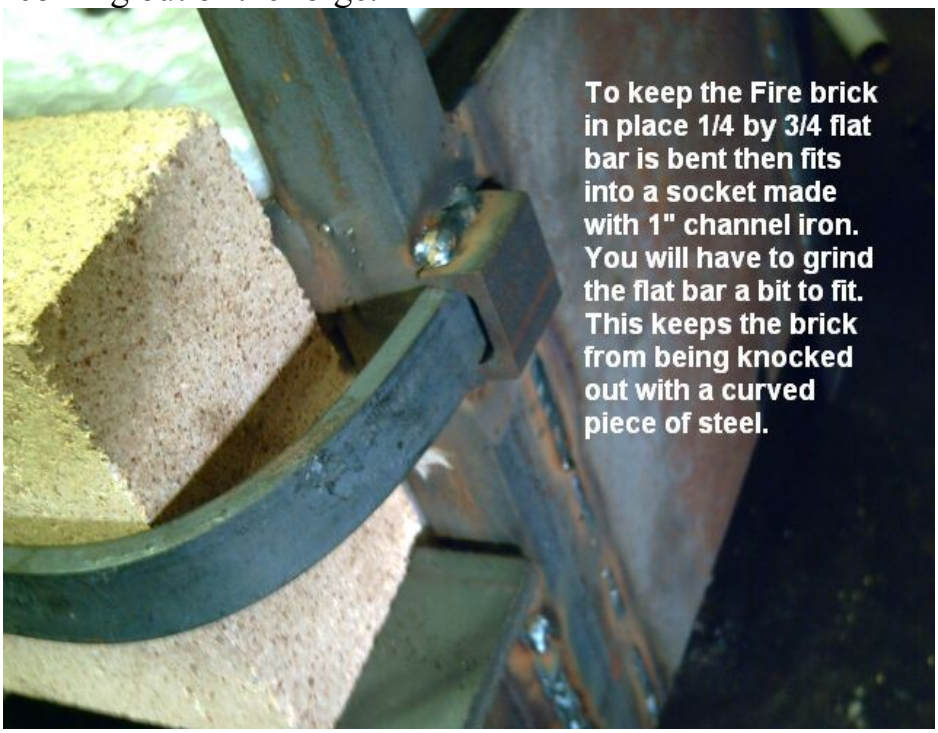


The interior of the forge looking at the top burner you can see it is recessed from the inside of the chamber by about ¾ of an inch to help protect the nozzle from the heat.

Once the bottom supports for the fire brick are welded in place to produce a 2 inch gap between the floor of the forge and the bottom of the fire brick I make and weld on the brackets that hold the fire brick from toppling out onto the floor if it is snagged with a

piece of steel coming out of the forge.



I actually bend this piece of ¼ x ¾ flat bar in my forge over the anvil. You could do it cold or spot heat it with a torch. The end that fits into the ½ x 1 inch channel iron socket will need to be ground to fit. It should be easily removable.

At this point the forge will need the Kaowool coated with the refractory mortar and allowed to dry. I use 100 watt light bulb left on over night. This works well with the door closed and the fire brick in place. Slow fire the forge similar to the pipe forge. I like to have the blower running but the gate valve 99% closed. Just so the there is a little air moving the propane forward in the mixing tube. Low psi too! Less than 1psi.

Slow fire to allow everything to dry out then increase propane and air.

Tuning Blower and Box Forge

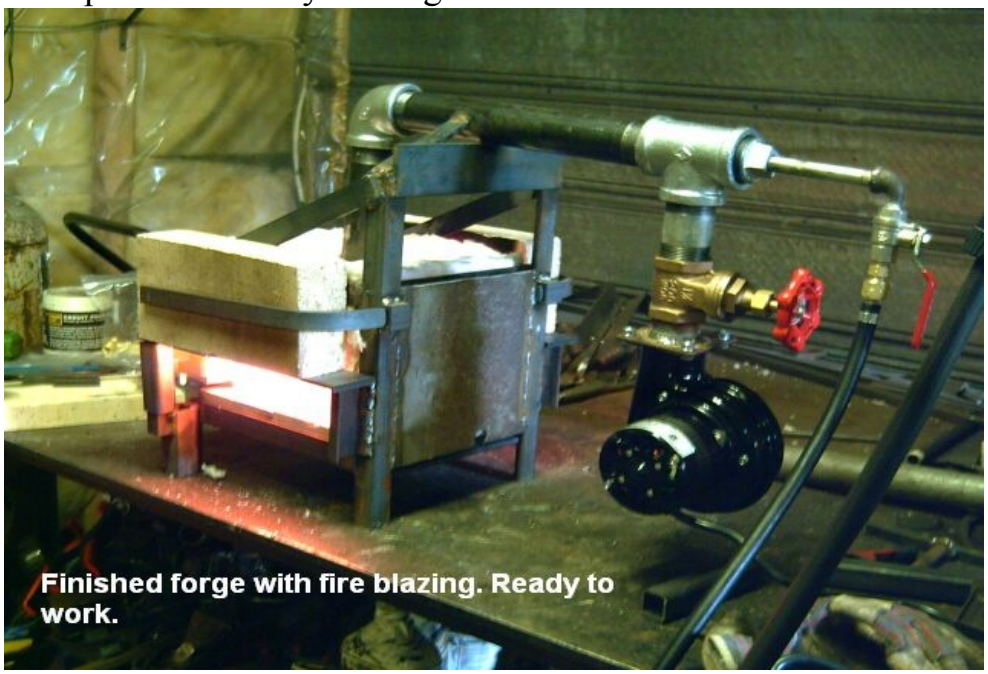
Full running temperatures require mixing the propane pressure and the right amount of air from the blower with the gate valve. A good rule of thumb is run at 8 to 10 psi on the regulator and open the gate valve so that the flames stop at the bottom of the fire brick.

If the flames are coming a long way outside of the fire brick the forge is running too

rich (too much fuel). Either back off the propane pressure or open the gate valve a bit.

If the flames are concentrated inside the forge you are running too lean (too much air) close your gate valve a bit.

You may have to experiment with your forge a bit as each one is different.



Finished forge with fire blazing. Ready to work.

Gas Forge Precautions

You are the proud owner of a new gas forge so how do you use it with out blowing yourself up?

1)Make sure the forge is set up on a stable surface well away from any combustible material.

2) The forge should be placed with the fresh air coming to you first then the forge. Remember the forge produces a lot of carbon monoxide, and produces a lot of carbon dioxide. It also use oxygen at a high rate. Carbon monoxide is poisonous. **ALWAYS HAVE FRESH AIR !** If you feel light headed or nausea then shut the forge off and move to fresh air immediately.

4) Place the burner in the forge as far down as it goes. Make sure it is secure.

4)Attach the hose and regulator. Attach the regulator to propane tank. Remember fuel threads are left hand threads. All attachment points should be secured with a wrench.

5) Check for leaks with dish soap and water. Also sniff the joints to detect any leaking propane.

6) Start the forge with pressure set to about 8 psi registering on the regulator.

7) Ball valve should be off. Place a lit piece of paper in the chamber and turn propane on. If you have an atmospheric burner (no blower) that should be it. If you have a blower right after you turn on the ball valve you need to plug the blower in.

8) A flash back can occur if the propane velocity is lower than the air velocity. This can happen at low pressures. The flame will go out in the chamber and start combusting inside the burner. The sound will change and you will need to shut the ball valve IMMEDIATELY ! Increase you propane pressure and try again. This usually is not a problem with a blown system but could happen if the power went out.

9) Make sure your hose is out of the way of falling hot steel. Hot steel could melt the hose and ignite a fire. When the hose is connected make sure it is out of the way of direct heat from the forge as it could soften and melt causing a fire.

10) When finished for the day shut ball valve off, turn off blower if any, shut main tank valve off. Always shut the main tank valve so if

there are any small leaks in the system you don't come into a pool of propane when you next start your forge. Propane will pool if there is a leak. This could ignite just by turning on a light switch.

11)General work usually about 8 to 10 psi. Forge welding 15 to 20 psi. If you are going to forge weld put a piece of sheet steel in the bottom of the forge to catch the drips of flux. Flux will eat the lining and the firebrick. These you will have to replace over time but why speed the process up. Fire brick on the front and back will eventually break and the support steel will sag. Replace when needed.

12) If you are working a long bar make a separate support that stands on the floor. This will help prevent the forge from tipping over.

13) Always wear safety glasses, and have a fire extinguisher nearby just in case.

Trouble shooting

A recent problem with some of the new propane regulators is they have a small check valve in the pol fitting. (The brass fitting that fits inside the propane tank) This check valve is a ball with a small spring behind it. If the propane tank valve is turned on suddenly the pressure can force this ball up against the spring and it can stick there. This is designed as a safety feature in case the hose is cut and limits the amount of propane coming through the hose.

If the check valve is stuck closed your forge will not work properly. You will see the right pressure on the gage before you light it but as soon as you open the ball valve the pressure will quickly drop to zero.

To fix the problem take a piece of wire and poke at the ball through the mesh that keeps it in place. It should loosen with a couple of pokes and pop back

onto the mesh. Try reinstalling in the propane tank and open the main valve very slowly. Then try to light the forge also by opening the ball valve slowly.

I can't recommend removing the check valve as it is a safety feature although it would be easy to do. Best to find a way of opening your tank valve and ball valve in a way that the check valve doesn't kick in.

The older regulators have a stronger spring and seems to kick out with less trouble.

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Other Resources You May Find Interesting and Useful

The Fundamentals of Blacksmithing
by David Robertson
I give tips and techniques for beginners and intermediate smiths. Examine tools in detail and how to effectively use them to work in this age old craft. There is also a section on knife making and tool steel.

Hobby Metal Casting Made Easy
This book covers casting of small metal parts in bronze or aluminum. Great for rebuilding engines or machines.

How to Weld
Welding secrets using modern electric arc, mig and tig welding. Not directly related to blacksmithing but many of us require refreshers in electric welding.

How to Be Successful at Your Craft Business
by David Robertson
If you are expanding your blacksmithing to become a business, this book explains some of the pitfalls to watch out for. I also give suggestions for retail and wholesale shows. Photography of product and book keeping are touched on as well as many other topics. Please note this is for any craft and is not targeted to blacksmithing only.

The Metal Plating Bible
Learn how to coat different metals by electro-plating. Not related to blacksmithing but may come in handy for accent pieces or sculpture work.