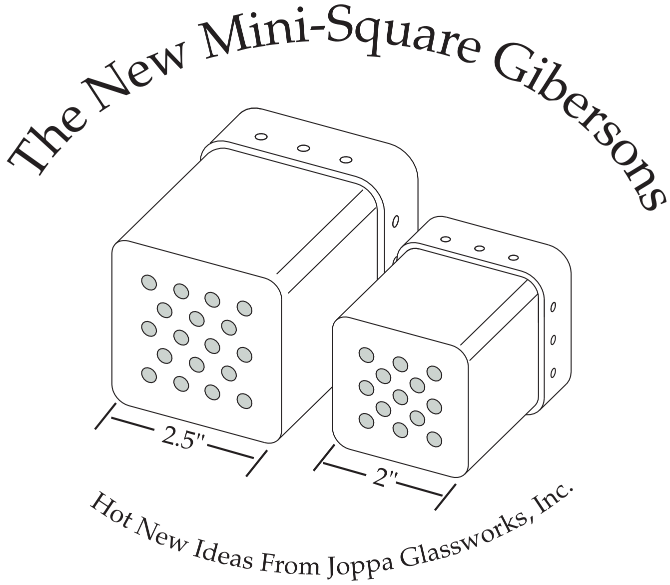
New Ideas for the Use of Small Burners in the Glass Shop, Foundry, Pottery, and Smithy

by Dudley Giberson



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Contact Information:
Joppa Glassworks, Inc.
P.O. Box 202, Warner, N.H. 03278
Phone 603-456-3569, Fax 603-456-2138
e-mail <joppaglass@conknet.com>

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For many years now it has been known that a small glory hole would be of great utility in a glass shop, something of the size of six inches and under. Many parts necessary for larger pieces of glass could easily be made in a small glory, parts like murrine cane, bit bars, goblet stems, spiral marble cane, etc. And these could be manufactured at a fraction of the cost of running a larger glory hole. In the history of the studio glass movement there have been a contribution toward this smallish glory called the "Murphy fire bucket," a notoriously low tech unit made of eight inch stovepipe with a one inch frax liner. The forced air burner is a fan attached to an open ended pipe with no retention nozzle and this causes the problems of noise and inefficiency, not to mention the safety issue of frax blowing all over the place.

In my own practice I have attempted on several occasions to adapt my standard Giberson Ceramic heads to this small glory purpose, especially the B-3/16 model for the the six inch glory. In my opinion this is a poor match because the burner is nearly as large as the gloryhole it is firing. The glory opening is six inches in diameter and the burner head exterior measures five inches in diameter in the back and four inches at the throat. Frankly this combination is a mismatch. To boot, sometimes there are weird harmonic in these small glorys which defeated the purpose of having a helpful tool, especially since such noise would drive anyone nuts. I had one such glory that could not be fixed, so I delivered it in its brand new condition to the landfill.

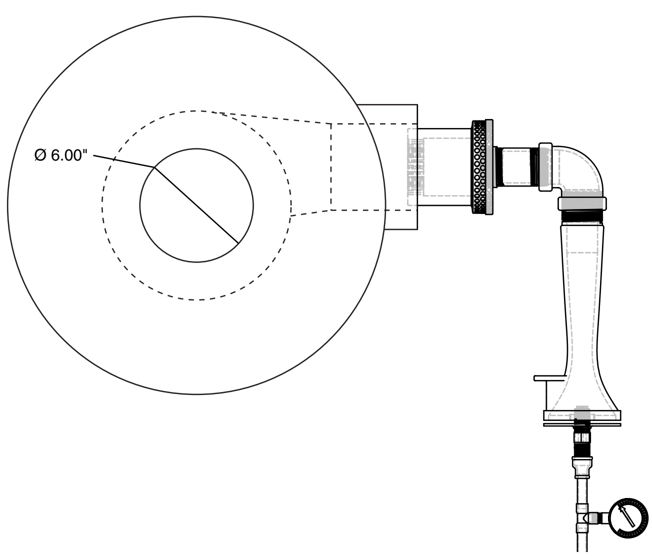


fig. 1 The rather traditional small glory hole–a six inch hole with a slightly larger interior.

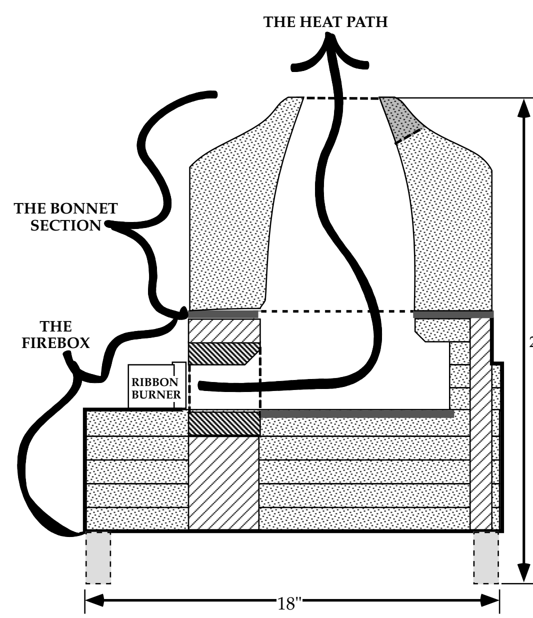


fig. 2 This is the Giberson Bead Furnace with its unusual mini ribbon burner with a combustion chamber of about 300 cubic inches.

In the early 1990s I perfected another small glory, though vertical in orientation, which I've written about at length in my book, *A Glassblower's Companion*, in chapter One, pages 21-24. The design is called a bead furnace (see figure 2). It is fired with an unusual ribbon burner, frax-faced for insulation and coated with a zircon shell for durability. The head which takes about 12 hours to manufacture currently sells for $395.00. Though a little pricey it has great thermal dynamics with an unbeatable turn down ratio (1:10). I've built several of these for glassmakers all over the world. I made one for my friend Josh Simpson who uses it to manufacture the inclusions for his planet series. The firing chamber for this vertical glory is just under 300 cubic inches which is about 25% of the interior volume of the glory in figure 1. The burner system actually solves the small space/combustion problem but the burner is incredibly difficult to make. It is not financially viable: hard to make and hard to sell. I will make one of these every once in a while for a favor. Because I felt there was a developing need for a small space burner I pursued experimentations.

The only other mini-glory experience I had was an actual model I built in 1980 as a design concept for a large glory we were going to make at the Haystack School. The drum for this model was a piece of six inch stove pipe that had a one inch layer of frax for insulation, pretty much like the Murphy fire bucket already mentioned. Its only saving grace was it had a very elaborate door which actually worked. The full sized glory was going to be large, like an 18 incher, but it never came to reality. Instead I have lived with this rather quaint relic ever since. For some years I used this four inch glory for our annual Christmas cane production, for rounding off mini glass cane handles. The glory burner was a Ransome B-1. The problem was the metal head would melt and need replacing every three or four weeks, but the "glory hole" part of the idea worked just fine. This was the same problem which caused me to invent the original Giberson Ceramic Head, U. S. Patent 3697000, back in 1968, the melting of the metal heads. But this situation was a problem of scale, like how to make a mini-burner that could fit these small spaces and provide complete combustion in, say, 150 cubic inches or less and burn relatively quietly like the traditional Giberson Ceramic Heads. Even this B-1 was not a good match as some of the flame burnt outside the glory.

So this has been my December 2009 to March 2010 project, to develop a new series of burners for this small combustion requirement. At first this was a pretty academic challenge: Could it be done? Well, the answer is yes and they are pretty marvelous! Figure 3 is a comparison of sizes of the original round 4″ Giberson Head to the new 2.5″ Mini-Square Giberson and the 2″ Mini-Square Giberson. Further comparison shows the traditional round Giberson has 24 holes of various sizes. The 2.5″ Mini-Square has 18 holes and the 2″ Mini-Square has 13 holes. The Mini-Square series come in 7/32″ or 3/16″ holes which develop different Btu capacities (figure 4, below).

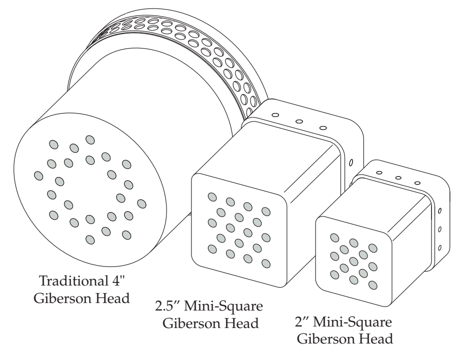


fig. 3 This is a comparison of shapes between the traditional round Giberson Head to the new Mini Square Series.

	Model	Orifice for HP Propane	**Venturi Mix** Btu Range (1000s)	**Forced Air** Btu Range (1000s)	Various Uses	No. of Holes	Hole Size
			HP Propane	Nat. Gas			
New Mini-Square	SQ 2 3/16	75	6-24	6-28	for mini-glories and furnaces (5 Tto 10 lbs.), pipe warmers, bead furnaces, & gas annealing kilns	13	3/16"
	SQ 2 7/32	72	10-34	10-40	for small foundry furnaces and glass furnaces (5 lb) small 4-5" glories	13	7/32"
	SQ 2.5 3/16	73	9-31	9-39	for small furnaces and annealers, furnaces (5 lb) small 4-5" glories	18	3/16"
	SQ 2.5 7/32	69	13-47	13-52	for small foundry furnaces and glass furnaces (10 lb) small 5-6" glories	18	7/32"
Traditional Giberson Round Burners	B-3/16	65	30-68	30-75	for small glories and furnaces (25 to 35 lbs.), pipe warmers, bead furnaces, & gas annealing kilns	24	3/16"
	B-7/32	60	39-88	39-95	pot furnaces & various multiple burner applications	24	7/32"
	B-250S	59	41-93	41-99	small to medium glories (1 cubic foot, with 8″ door), medium pot furnaces, etc.	24	1/4"
	B-250	58	44-98	44-120	day tank furnaces (100 lbs.), invested pot furnaces (150 lbs), glories (9″ to 11″), freestanding pot furnaces (200 lbs.)	24	17/64"
	B-255	57	46-103	46-150	day tank furnaces (200 lbs.) & medium glories (11″ to 15″)	24	9/32"
	B-650	56	54-120	54-195	large glories (16″ to 18"), day tank furnaces (to 300 lbs.), salt kilns, & forges	24 Plus one lg. ctr. hole	9/32" 5/8"

fig. 4 A chart of all the Giberson Ceramic Burner Heads and some suggestions for their use. The new Mini-Square series are the first four at the top of the chart.

Thoughts on the Installation of Burners

The purpose of a burner system is to provide two basic functions: 1, to properly mix and deliver the fuel and air to the combustion chamber; and 2, to provide a platform to control the combustion so as to get the most use out of the delivered mix (a measure of efficiency).

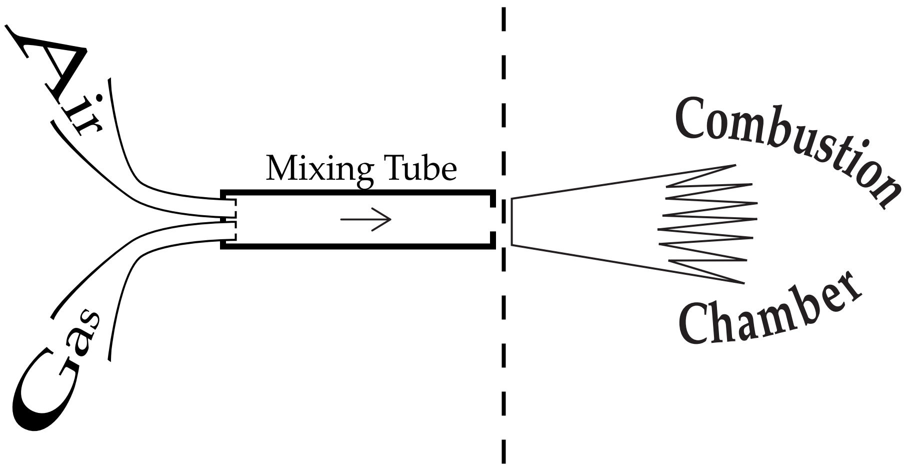


Fig. 5 This is your basic mixing system schematic. The air and gas enter a mixing tube and are delivered to the combustion chamber where they burn.

Notice the hole at the end of the mixing tube next to the dotted line. It is a little smaller than the diameter of the mixing tube. This orifice is the retention nozzle. You see at this point, this stricture or narrowing of the tube, the gas/air mix is forced to go faster, like at a rapids in the river, a narrower point along the regular flow of things. The purpose of this narrowing is to keep the combustion on the other side of the dotted line. The fact is any specific gas/air mix will burn at a calculated speed, so the speed of the mix at the exit orifice must be greater than the burn speed, otherwise you will have burnback. Burnback is the unfortunate and sometimes dangerous situation where the combustion is occurring within the mixing tube. Once burnback begins it is compounded by the fact that the gas/air mix expands seven times its volume when it combusts, what you might call an explosion– BANG, BANG, POP, BANG. At this point the system is no longer working and it could cause further problems because the gasses produced by poor combustion are carbon monoxide and particular carbon, both of which could fill the room and cause a major explosion. So the point of the rest of this document is to clarify what goes on around both sides of the dotted line, the place between the mixing tube and the combustion chamber.

Traditionally part of this place is called the burner block shown in figure 6 as a black tapered block just in front of the mixing tube. Our image shows an example of what is called “gap firing,” where the air and gas are mixed and blown into the side of a glory hole or furnace. This is typical of the old Eclispe Nozzle Mix and it works pretty good for foundry furnaces and other periodic heating operations where it might be on for just a small portion of the day. This system is a big polluter of noise and heat, those being two of the three factors of its inefficiency. The third is the ratio of air/gas mix which changes with any change in the back pressure of the combustion chamber, as occurs with opening the door of a glory hole or a glass making furnace. In these situations (most glass shop applications) we prefer to close off the source of secondary air, that is to seal off the gap between the burner head and burner block thus locking in the ratio of gas/air mix presets. But as with most complicated systems this introduces other problems whose solutions are best explained step by step.

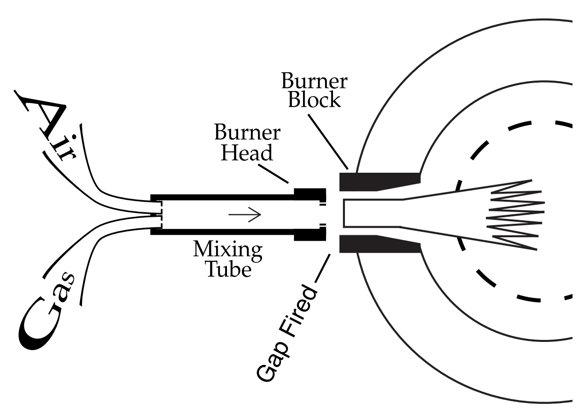


fig. 6 This is the traditional gap fired burner system which is filled with inefficiencies of noise, escaped heat, light, and poor control of the secondary air caused by varying changes in back pressure in the combustion chamber.

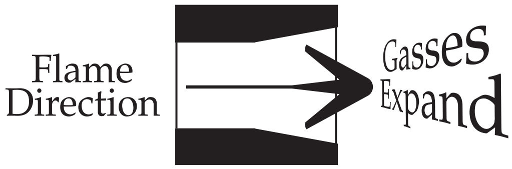


fig. 7 The burner block begins with parallel sides for setting the flame and then tapers outward toward the combustion chamber to accommodate the expansion of gasses.

To begin with the shape of the burner block is really pretty important. As already mentioned the air/gas mix when it combusts expands at a rather brisk rate to seven times its volume. If you place this inside a straight-walled burner block you will get a slight stutter like the corduroy of a gravel road. By tapering the burner block (at about 12 degrees) the forces of expansion move more smoothly toward the center of the combustion chamber. The second aspect of a burner block is an area at the beginning where the flame can become stabilized, where the flame pattern is set. This area needs to be somewhat narrow and short, a place where the walls are parallel to the flow of combustion. These characteristics are shown in figure 7 at left.

I have briefly passed over the rather dire necessity to make these burners out of ceramic. Up to the time of my invention of the Giberson Ceramic Burner Head in 1968, burner nozzles were made of iron. If you put an iron head into a glass furnace you will soon learn about the melting point of iron which is somewhat short of your target temperature. The Giberson Tips have a melting point somewhere near 3400˚ F. Another feature of ceramic is it is somewhat insulatory, well, more so than iron. Another is it will not rust. I think the worst feature of iron heads is their holes will close in all by themselves, over time, especially in an outdoor kiln setting. The one really great feature of iron heads is you can be rather cavalier in your handling of your burners, but try tossing a new Giberson onto the concrete floor during a fit of memory loss and you will notice this technique does not work. All systems have weaknesses and strengths. Ceramic is not iron, thank goodness! But the difficulties of ceramic can be easily overcome to produce a superior system, however it does take planning and design.

The first part of this planning is for the placement of the head in the burner block. With the round four inch Giberson head we found the best installation was to inset the tip a half inch inside a 4.5" diameter burner block. The flame path goes straight for three inches then tapers out toward the combustion chamber at a minimum of 12 degrees as shown in figure 8 to the right. (For more specific instructions please refer to the *Joppa Glassworks Product Catalog Spring 2008* pages 3-5).

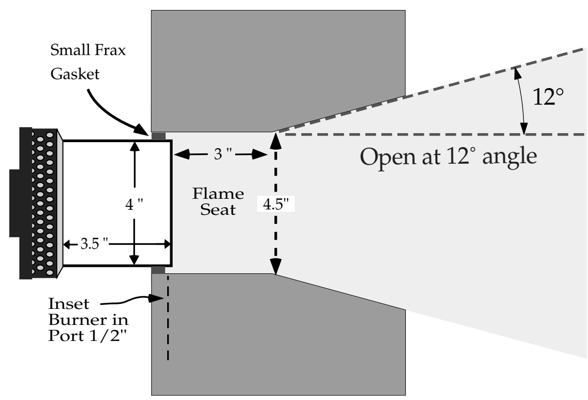


fig. 8 The recommended installation of a round Giberson 4 inch tip shows the specific dimensions of the components involved. The burner block should be made of Super duty ram plastic or super duty castable good for 3000˚F service.

We have already touched upon the issue of burnback (pg. 3, paragraph 2), where the air/gas mix combusts in the mixer tube. Burnback is an extremely complicated issue caused by many possible scenarios. With glory holes and glass furnaces the main problem is heat encroachment into the interior of the burner head. You see, any gas/air mix will have an ignition point, a given temperature which will cause ignition. The most common time for this pre-ignition (a. k. a. burnback or pop-back) to occur is just after a melt when everything is good and hot. Things go well during the melt because the gas/air mix going through the burner system is actually cooling the interior of the burner head. But when the turn down occurs, less of this cooling gas mix is going through the components and heat from the interior of the furnace begins moving into the burner head. At some magical point when the interior of the head gets to 1000 degrees or so, that's where you get pre-combustion. Pow! Bang! Rumble, Rumble. Not fun.

The solution is to not let the inside of the head get to that problem temperature. Pop-back is not the end of the world, but it is pretty startling at first encounter. It's a rude experience like falling off a bicycle for the first time, then you learn you cannot just stop without putting your foot down. To plane-off a furnace (like after a melt) the most successful technique is to open the door and let some of the heat out (which is the object of planeing in the first place) and couple this with a lower setting for the burner and you will get no pop-back. Another approach is to design the burner block to give us additional protection from this potential heat encroachment.

By redesigning the burner block we can eliminated the heat encroachment problem. Figure 9 shows the current state of the art burner block where we have moved the head out of the combustion tube and set it in a shallow seat coaxially aligned with the combustion tube just in front of the flame seat. We have narrowed the combustion tube by 1.25 inches to a diameter of 3.25 inches in the area of the flame seat. Then, like before, the burner block tapers outward toward the combustion chamber. This arrangement is very beneficial to the burner head because the head is exposed to easily 50% less radiant heat from the combustion chamber. The one drawback is this burner block is just slightly more technical, and thus a little more difficult to make. Later in the paper we will discuss the manufacture of these burner blocks. All things considered this is a vast improvement.

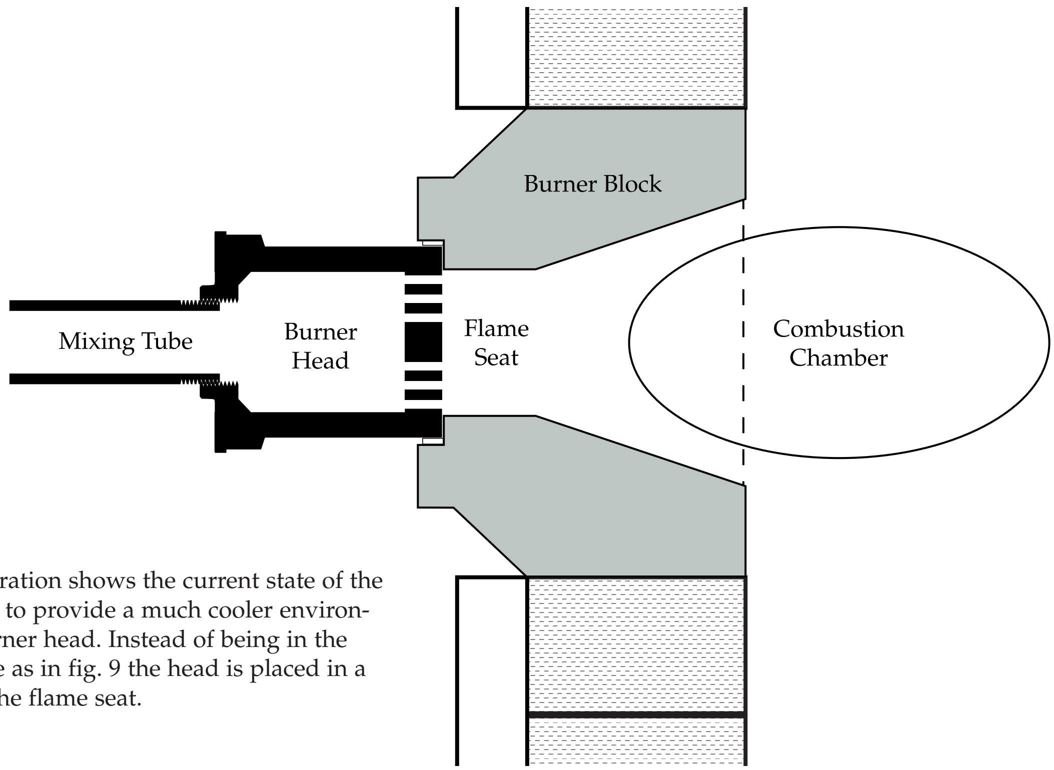


fig. 9 This illustration shows the current state of the art burner block to provide a much cooler environment for the burner head. Instead of being in the combustion tube as in fig. 9 the head is placed in a seat in front of the flame seat.

In the course of my day I get calls from all sorts of people, some highly knowledgeable and others with hardly a clue. I had one fellow call me to complain that the burner I sold him did not function very well as it had melted into his glass furnace. It turned out he had actually plumbed the venturi mixer and head completely inside of the glass furnace and the cast iron had melted as did the steel backplate on the burner. It was fused into an unrecognizable pile of metal slag with the ceramic part of the head sticking out. He actually sent me the artifact which I placed in the outdoor museum at the top of the cullet pile. I was speechless.

I can say with some confidence that you should not duplicate that experiment.

Installation of the New Mini-Squares

The new Mini-Squares work pretty much like a regular Giberson burner only they are for small spaces. Even so they need the same if not more care in how they are installed, and just like the above example, you cannot just put the burner into a kiln space and turn it on. It first has to be mounted properly in a mini-burner block and then you can turn it on and go like hell.

When I was a student we did our foundry work in the old foundry which was located in the basement of the R.I.S.D. Museum in what was truly a crawl space. We built burnout kilns using just a stack of soft brick. In the base of the pile we built burner ports by removing a couple of bricks and into these we put the trusty old Buzzer Burners. I think we went up to 1200˚F over three days and held it there a few hours then removed the burners and bricked it up. In a day or so when it was all cooled off the bricks went back into boxes and we poured bronze in the ludo molds on the basement floor. If you did that today you would be arrested as a counter-terrorist, and the headlines would read, “Artist threatens priceless objects in museum with conflagration in basement.”

In those times the art world was a "seat of the pants" operation. We just threw things together and used them for a short while and "poof" onto something else. We would often build a glass furnace in a couple of days, cut a 4-1/2 inch hole in the top and put the ceramic part of the burner in there and turn it on. I don't know how we got things to work. Some things work and other things work better. Basically we went with the better ideas down the line. Now looking back we have a pile of rules which hopefully eliminate all the sore spots. The point is these new Mini-Squares are not designed for just tossing into a hole in the wall of a kiln like we did with the old Buzzer Burners. They would work that way, in a way, but they will work a lot better if you build a burner block as per directions.

Figure 10 is a sectional drawing of the new 2" Mini-Square and its mated burner block in the wall of a kiln shown in Figure 11 which is an isometric view of the burner installation. Notice the mixer is supported with a solid attachment to the frame of the kiln (x).

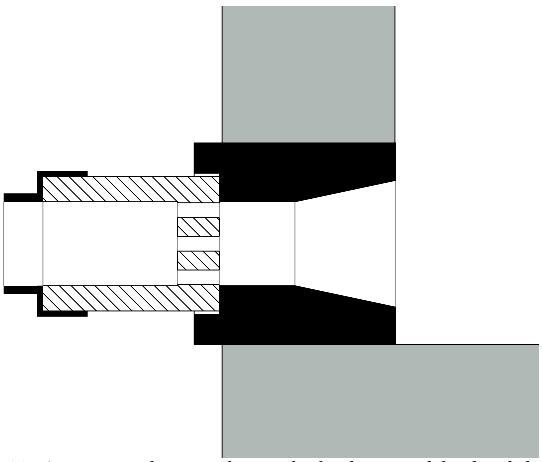


fig. 10 A sectional view through the burner block of the kiln shown in fig. 11. The recessed square seat on the input end of the burner block mates with the front of the burner and aligns the holes in the burner with the combustion tube. The flame travels toward the combustion chamber for a distance of 1.25" then tapers outward to accommodate the expanding gasses.

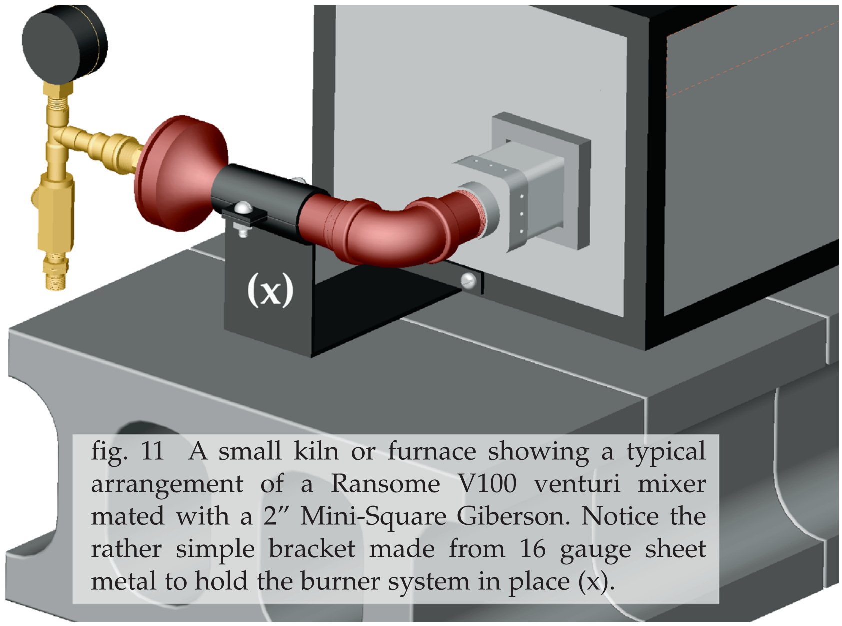


fig. 11 A small kiln or furnace showing a typical arrangement of a Ransome V100 venturi mixer mated with a 2" Mini-Square Giberson. Notice the rather simple bracket made from 16 gauge sheet metal to hold the burner system in place (x).

Making the Burner Block

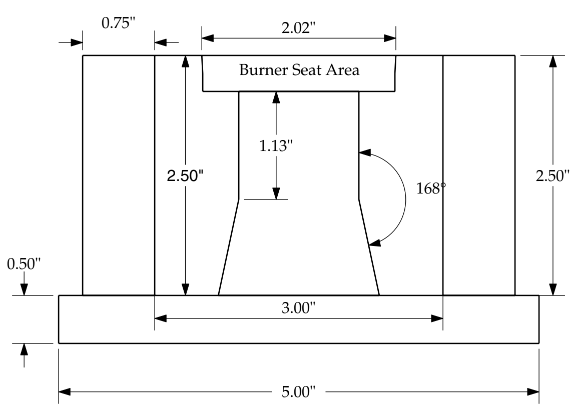


fig. 12 Sectional drawing of the burner block mold. Dimensions shown are in inches. The mold parts are made of simple untreated wood. A damp plastic ceramic, Super G 3000, is tamped into the mold to shape the casting.

Each piece of equipment is unique and will undoubtedly require you to make a slightly different mold. You can either cast them with castable or ram them using plastic refractory. I prefer to make ram castings. In the next few paragraphs I go through the process for making molds for each method.

First, the ramming process: I use pine boards to make my molds and I suggest using a table saw and a band saw for this project, though you could certainly cut all the parts with a jig saw or for that matter a hand saw would work. The sectional drawing in figure 12 shows the general gist for the project. Cut the mold parts and screw them together and leave the wood untreated. There are many suitable super duty ram plastics available that will work fine. However, I recommend Super-G Ram Plastic, a 3000 degree AP Green product. Be sure to get "heat-set" that way it can sit around for years in the dry condition and all you have to do is pour a little water on it to recondition it and it is ready to use. Once you tamp the plastic into the form it should be knocked loose and set to dry. While it's in the plastic state be sure to check the "Burner Seat Area" for clearance with the burner face. You need a tenth of an inch space on both sides. Once dry I fire my castings to about 1800°F to give them a bisque strength. Sometimes these things shrink a little in the process. One block I made was a little tight so I trimmed it out with the diamond saw.

The Progression of a Ram Casting

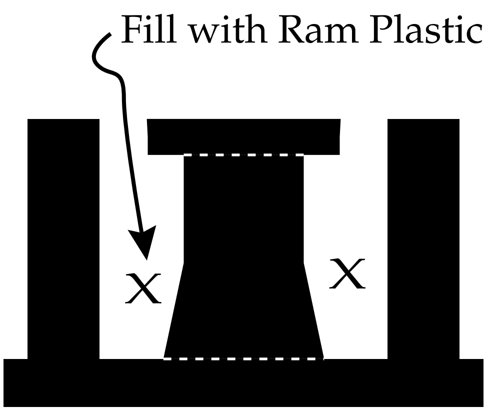


fig. 13-1

fig. 13 A series of images showing the progression of a ram casting, numerically labeled: 13-1 is a sectional drawing of the burner block mold shown in figure 12. The “X” shows the target area for filling with the ram plastic material. I recommend using Super G 3000, an AP Green product. 13-2 shows the plastic mix filled up to the upper dotted line (in fig 13-1). 13-3 shows the mold entirely full. In 13-4 the mold sections are being removed which continues in 13-5. In 13-6 we see the tapered center core being popped out. Figure 13-7 and 13-8 are the completed burner block, front and back respectively.

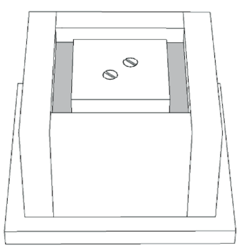


fig. 13-2

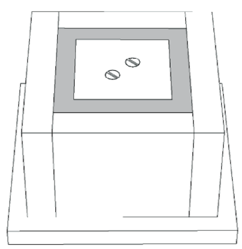


fig. 13-3

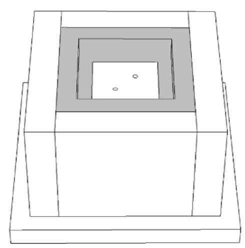
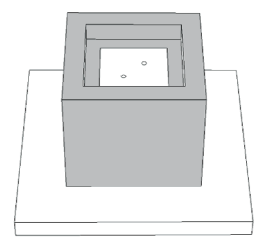


fig. 13-4

fig. 13-5



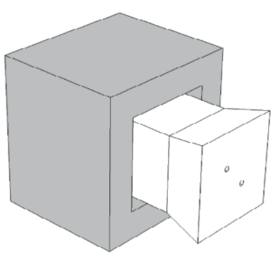


fig. 13-6

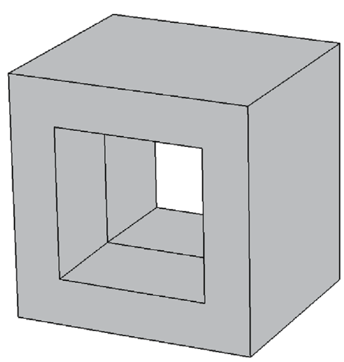


fig. 13-7

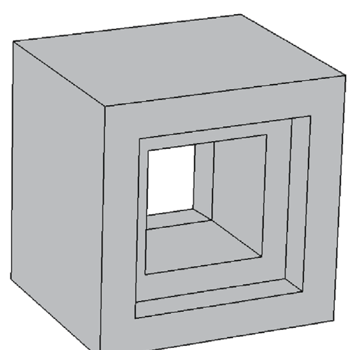


fig. 13-8

Again to reiterate a somewhat subtle point: ram castings are made with a relatively stiff plastic clay that gets packed into a wooden mold form. Within a few minutes of ramming you should de-mold the casting which entails removing the mold parts, then place the casting in a warm place to dry. While it is still slightly pliable make sure the recessed area shown in figure 13-8 (also identified as the “burner seat area” in figure 12) has a bit of spare room so the burner head won’t bind there if it shrinks a little there during firing. Once fired the rest of the construction project can proceed.

The Second Method: Casting a Burner Block Using Castable Refractory (Mizzou, Greencast, etc.)

Some craftsmen would much prefer to cast their burner blocks using refractory castables, a process capable of reproducing delicate dimension requirements with minimal shrinkage, a process similar to casting Plaster of Paris or Portland Cement. The tools used for this operation are a table saw and a band saw, but really this is so low tech that you could use a hand saw and a hack saw blade to shape the styrofoam mold core parts. The outer parts of the mold are made of pine or plywood. I prefer using a table saw to shape these outer mold walls and casting board (see fig. 14-1). Shellac these parts using yellow shellac and when the shellac is dry, screw them together (fig. 14-2). You will need a good mold release. I make my own using micro-crystalline brown wax heated to 225 degrees, then stir in mineral spirits and let cool. Use a ratio of 2 parts wax to 1 part spirits, liquid measure. Decant mixture. Paint this mold release on the inside of the mold and let dry for at least 30 minutes before casting.

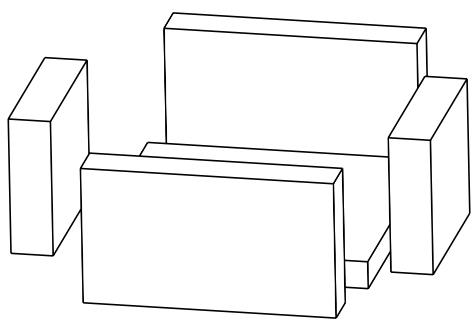


fig. 14-1 These are the bottom casting board and the four walls of our soon-to-be mold into which we will cast a burner block.

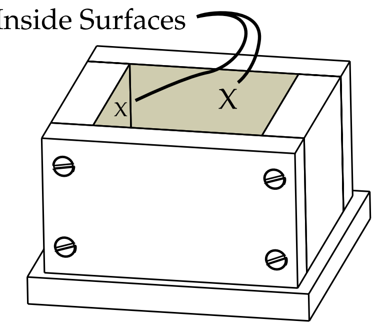


fig. 14-2 Here the exterior part of the mold is screwed together and a layer of mold release (a. k. a.. parting agent) is applied to the inside of the mold.

Next, using a rasp and a hack saw blade, shape styrofoam for core parts a, b, & c, figure 15. Then apply a thin layer of rubber cement to all surfaces to be joined to make the core in figure 16. Let the rubber cement dry completely then carefully align parts and press together. This makes a great adhesion. Next attach this core column to the casting board using two sheet rock screws up through the bottom board. The mold is ready to cast (figure 17).

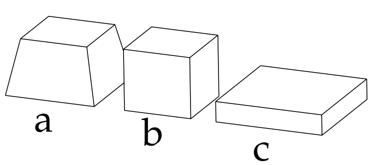


fig. 15 This is a kind of whittling project. The best tool for shaping these parts is a hack saw blade just held in the hand. Sand paper works well too. A fine toothed band saw works well, too. The parts can be glued together using rubber cement. Apply thin layer of glue to both surfaces to be attached and let glue thoroughly dry.

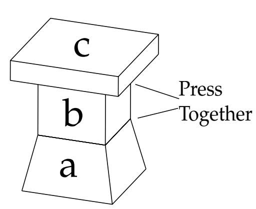


fig. 16 Here is the stack of styrofoam parts. After making many of these castings I have found you do not have to fear air pockets forming under the lip of "C", but while casting, run a wire under the lip to remove any possible air pocket. It will cast just fine. Use a 3000 degree Castable like Mizoo Castable. There are many producers of super duty castable. I currently am using a product called Mt. Savage. Works fine.

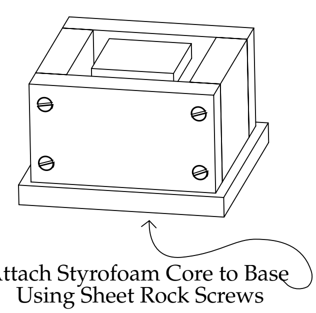


fig. 17 Here is the final mold. The core part of this is called a "waste mold" because, after casting has set, the styrofoam core is dug out and destroyed. If you want to cast several of these burner blocks simply make several cores as shown in figure 16. The wooden parts of the mold, the outside parts, are re-waxed for each casting. Your finished burner block will look like images shown in Figure 13-7 and 13-8.

Building a Test Furnace

This is a dandy little project that is highly adaptable to your various needs: to build a test furnace or kiln that can help define the parameters of your project. The idea here is to go from the general to the particular. I used this model to define a small foundry furnace for pouring two or three pounds of brass. Initially I stacked the bricks to make a 4.5 cube interior. But when I put the crucible in the furnace I realized if it were a little larger in width the crucible would have less flame impingement, so I simply moved the bricks to achieve the new configuration. Then I heated it up and poured the metal. It all worked great.

This project takes shape in figure 18 which shows a testing table (***a***) on which sits the furnace floor (***b***) made with a layer of soft brick (IFB). In the back we have a vertical wall (***c***) and a burner block (***d***). For this experiment I have built a burner stand (***g***) for securing the burner in its temporary position. Also shown are the burner components: the 2″ Mini-Square Giberson Burner (with 3/16″ holes) (***e***), Ransome Venturi V100 (***f***) w #75 orifice, with a needle valve and gauge (***h***).

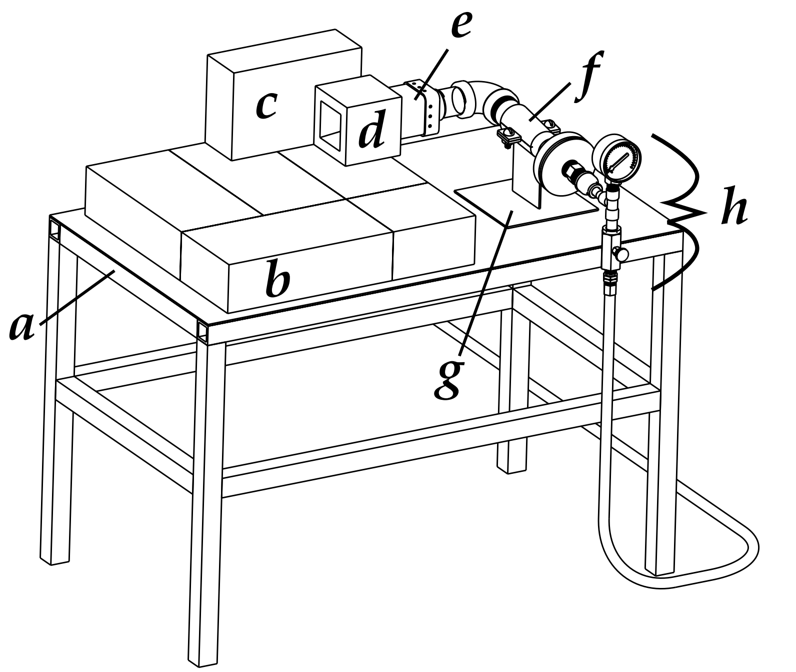


Fig. 18 A rudimentary testing furnace comprised of a metal platform table (***a***), a furnace floor (***b***), the beginnings of the furnace wall (***c***), a burner block (***d***), a 2″ Mini-Square Giberson Burner (***e***) with Ransome Venturi (***f***) held in place with a burner stand (***g***). Also shown is the gas supply attached to the needle valve and gauge at (***h***).

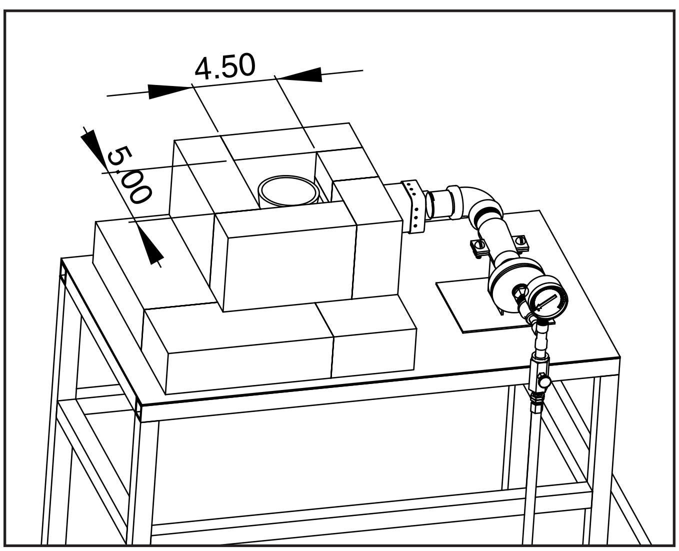


Fig. 19 In this situation we have moved the bricks around to fit the needs of this small crucible which will hold about three pounds of brass. The crucible is offset to minimize flame impingement on crucible wall.

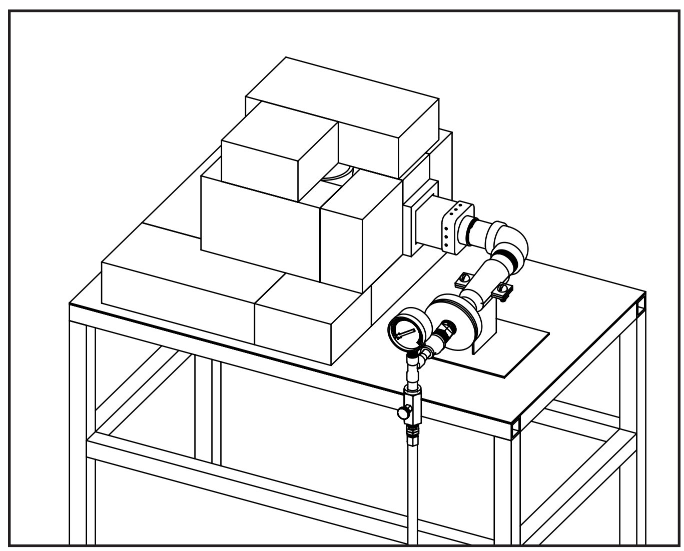


Fig. 20 Here we place a couple of bricks on the top of the walls and start the firing cycle. In about ten minutes the interior of the furnace is a dull red and ready for a turn up. The little half brick is moved to charge the crucible. When the metal is ready to pour the top bricks are removed for easy access.

With the information we have gathered from this simple experiment we can now build a permanent structure that embodies these particular design parameters. The beauty of this is the relative ease with which you can manipulate the components to achieve an effect. And the final thought is you can keep the components just as they are here. Every year or two pull your bricks out of a box, assemble your furnace and pour your bronze– a great little kit for a serious experimenter!

An Idea List for the Application of New Mini-Square Giberson Burners in the Glass Shop, Foundry, Pottery and Smithy

This is an idea list just to get the wheels rolling. The fact is these Mini-Square Giberson burners are brand new and I have not had the time to test all of the design configurations that are below, but having been in the equipment building trade all my life I know from experience these are solid ideas that will work for the craftsman and will save him/her a bundle of money if used for their intended purpose. For example say you are a prototyper and your customer wants a cast brass knob on his desk tomorrow. Fire up your mini-foundry furnace and 30 minutes later you are pouring the metal. Poof. An hour later you've cleaned up the casting and it's in the mail.

You are a glassmaker and you are experimenting on a new series of colors, but you don't want to spend a fortune on the gas to melt 25 or 30 pounds of glass for each color. If you build a miniature furnace that holds a one or two pound crucible you can achieve the exact same melt profile but at a fraction of the cost. And this same furnace idea can serve the chemistry professor who wants to show his/her students how to melt glass. By using a miniature furnace as shown in figure 20 you can successfully demonstrate the glass melting process. Once you have the burner system the cost is minimal: a few bricks, a crucible and a BBQ grill size propane tank which will last several days.

This same approach can apply to a potter. For example you are having a glaze problem but it will cost you a fortune and a lot of time to fire your big kiln. Build yourself a miniature test kiln that will deliver the same gas fired profile as your big kiln only here it will only take a couple of hours to make your samples and at most a gallon of propane to get your test results. This will allow you to solve countless problems that **can not be solved using an electric kiln**.

One glass maker lives on top of a mountain and is off the grid. Though he has solar power his annealer uses up all his capacity. By using a Mini-Square Giberson he can gas fire his annealer for part of the cycle to augment his limited electric power.

Outline: Uses for the Mini-Square Giberson Burners

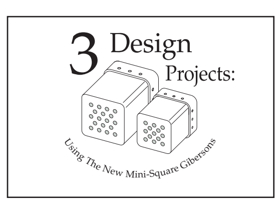
I. Glass Shop
- A. Miniature Melt Furnace
  - 1. Solve technical formulary problems
  - 2. Demonstrate the principles of glassmaking
- B. Gloryhole Designs
  - 1. Make a 6" studio workhorse for making fancy parts
  - 2. Make a 4-5" for specific production work
  - 3. Small glory for end of gaffer's bench
- C. Annealing Kiln (portable, gas fired)

II. Pottery
- A. Miniature Salt Kiln
- B. Miniature Gas Fired Kiln like 1 to 2 cubic feet
  - 1. For Solving technical glaze problems
  - 2. For specific production work like porcelain doll's heads, hands, etc.

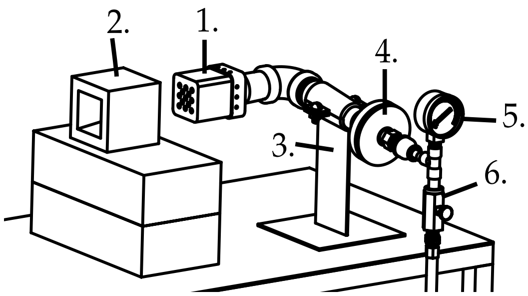
III. Foundry
- A. Miniature Foundry Furnace (for casting 1-10 lbs Bronze)
- B. Small burnout kiln, like shell molding de-waxer
  - 1. Used for Main burner
  - 2. Used in Smokeless afterburner situation for small stack

IV. Smithy (like in a small gas forge)

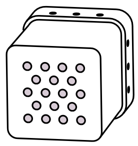
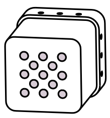
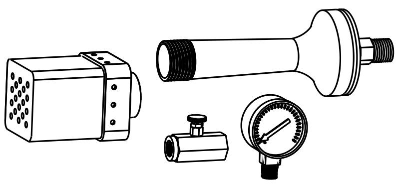
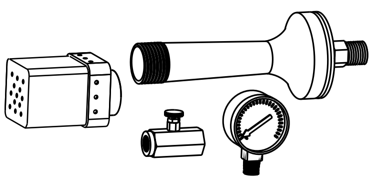
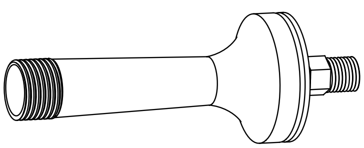
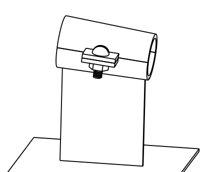
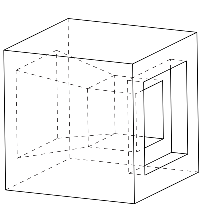
Please see the companion document called:



Components For Sale:



Related Items for Sale
1. Mini Square Giberson Burner Head (2 Models)– $125.00 and $145.00.
2. Burner Block– 2 Models – $30 & $35
3. Burner Stand– $75
4. V100 Ransome Venturi Mixer– $199.50
5. 0–30 P.S.I. Gauge– $16
6. Needle Valve– $23

Image of Items	Description	Price
	2.5″ Mini Square Giberson Burner (18 HOLES 7/32)	$145.00 ea
	2″ Mini Square Giberson Burner (13 HOLES 7/32)	$125.00 ea
	**The 2.5" Mini Square Kit:** Includes one 2.5" Mini Square Burner Head ($145.00), One Ransome V100 Venturi Mixer ($199.50), One Needle Valve ($23.00), One Gauge 0–30 p.s.i. ($16.00), **Total value of $383.50 (A savings of $20.50)**	Kit: $363.00
	**The 2" Mini Square Kit:** Includes one 2" Mini Square Burner Head ($125.00), One Ransome V100 Venturi Mixer ($112.50), One Needle Valve ($22.00), One Gauge 0–30 p.s.i. ($16.00), **Total value of $363.50 (A savings of $21.00)**	Kit: $342.50
	This is the **Ransome V100 Venturi**, an Air/Gas Mixer for high pressure propane. This is a very high quality venturi with a nicely machined air baffle with superior quality brass spud and orifice.	$199.50
	**Burner Stand at 6 Degrees** . This is the type of burner stand used in Figure 18 of this paper. It is made of 16 gauge sheet metal and painted gray. Fits the Ransome V100 also shown above .	$75.00
	Cast **Mini-Square Burner Block**. Made of 100% High Grade Castable Mizoo or better 3000˚F Plus.. This is a precision casting made to fit your 2″ or 2.5″ Mini-Square Giberson Burner Head	Fits the 2-1/2″ Head $35.00 Fits the 2″ Head $30.00

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