The Joppa Blog No.6:
The Burner Block
(More than a hole in the furnace wall)

In the early days of the studio glass movement we used what was called a Toledo Day Tank for melting glass and it was also our glory hole. We put what is known as a "pipe burner" right down a hole in the top. It was a pipe that fit into a specially shaped brick that you carved yourself, a rudimentary burner block/burner head all in one. This worked to some degree but not too well as it was in a perpetual state of loud burnback, always noisy and potentially dangerous: you really want the ignition/combustion to be in the furnace and not burning in the pipe work. Figure 1, to the right, shows the original "home-made" **burner block** idea which helped to give birth to the studio glass movement.

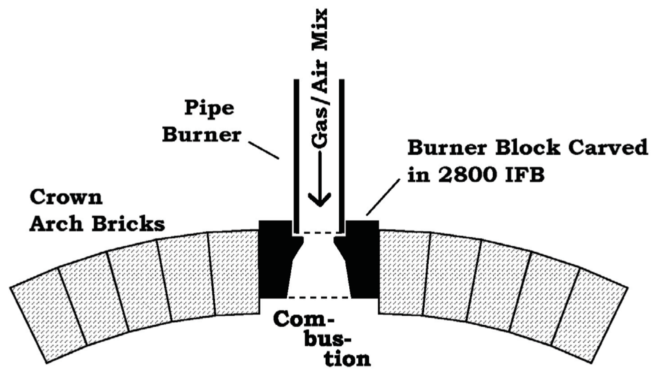


Fig. 1, Here is the original burner setup showing the mixed gas and air moving down the burner tube and going through the burner block which was a carved piece of IFB 2800. This worked but it functioned on a the edge of "Burnback" most of the time. "Burnback" is where the flame is burning back into the pipe work and is a potentially unsafe condition. Well, this may have been unsafe but it was a part of the genius idea that gave birth to the American Hot Glass Movement

For this blog on Burner Blocks I have chosen to ignore the complicated discussion of gas/air mixers. Suffice it to say that the original furnace used a burner/mixer popular with studio potters called an Alfred mixer mated with a Dayton blower. This combo was in common use with potters as it had been developed at Alfred University. (hyperlink to pages on joppaglass.com).

My first lesson in burner design came from Norm Schulman, potter and original member of the Toledo Glass Workshop. He was teaching ceramics at RISD in 1966; I was a student there, and he invited me to participate in the building of a glass blowing set-up in his garage. For me it was a credit course toward my BFA in Sculpture, '67. By participating in this building project I learned the basics of furnace and burner design and how to wire an annealer. and wind kiln elements. I also learned that hot glass was wicked cool ***and I loved it*** and knew I would likely follow this ***MUSE*** for my life's work– not bad for a little college art course.

In the Fall of 1967, after graduation, I set up my own shop in an old New Hampshire farm. Here I constructed my own version of the Toledo glass melting furnace which included one of these pipe mixers. It melted the glass but it mostly just got too hot and dripped iron into the furnace which made a nasty green glass. It didn't take long, however, for this adversity to force a change. My background included lots of foundry work and I knew about fused silica shell molds and the potential of ceramics. This molten iron burner business caused a "Eureka moment" from which sprang an invention, the Giberson Ceramic Burner, US Patent #3697000, a quiet burning, non-melting retention Nozzle. This was my initial contribution to our fledgling Hot Glass Culture.

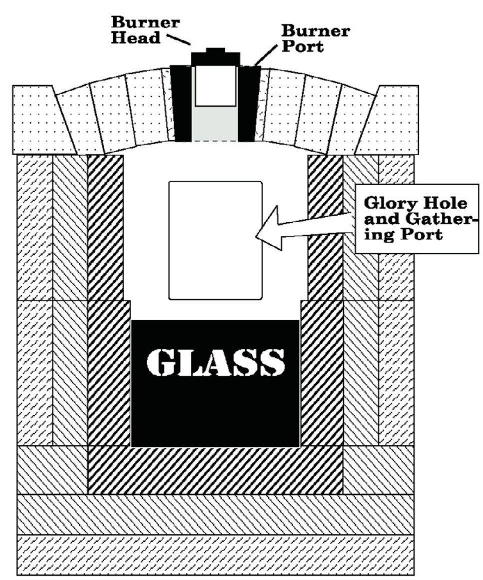


Fig. 2, In the beginning we just put the burner into the burner port up to the flange

There were several great advantages for using this burner: It was quiet and- it had an efficient burn with a short combustion pattern but it also had a burn back issue on a too low of a setting. An analysis of what was going on goes like this: the burner is going along keeping the furnace at, say, 1900 degrees F. The combustion gasses moving through the burner are keeping it cool so at the end of the day you turn the burner down for an overnight setting. Now there is less stuff going through the burner to cool it. Scientific fact: is any part of the inside of the burner gets to the 1000 degree mark it will ignite the gasses inside the burner and you have pop back or, a.k.a., pre ignition.

So the challenge becomes how to install the head so this does not happen. Initially the best Idea I had was to move the head back out of the heat, see figure 3.

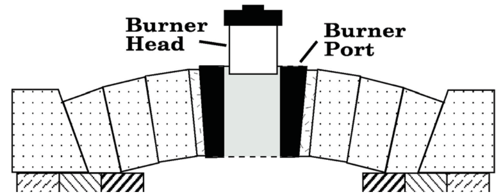


Fig. 3, Here to minimize the heat encroachment we have moved the head out of the heat so only the front 1/2" is in the burner port.

I am not sure why the idea of a top fired furnace was so pervasive. If you think about it heat rises which feeds into the problem. The natural propensity for heat leaving a structure is through the roof or ceiling so why not make it less of a problem and side fire the furnace. By using this idea you can build a very efficient monolithic crown to a furnace that is way more efficient without the burner and burner block in the way.

The top fired furnaces soon gave way to the Pot Furnaces, mostly side-fired or bottom fired with way less pop-back problems

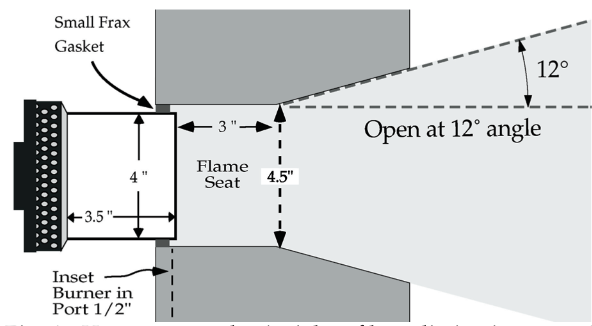
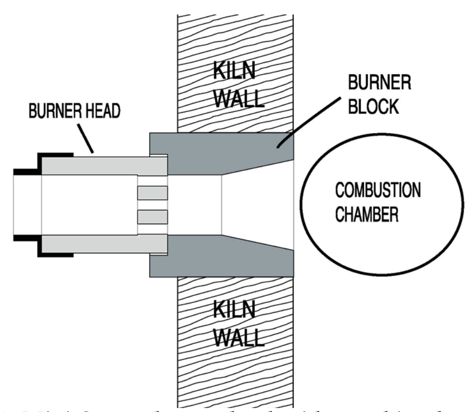


Fig. 4, Here are several principles of heat dissipation at work: We have only the front 1/2" of the burner set into the port which minimizes the amount of convection heat on the head. The burner block is made of a dense material which absorbs heat. Further the port is tapered which causes the heat to reflect away from the burner head toward the combustion chamber.

The idea here is to install the head so it stays coolish by just putting the front 1/2" of the burner in the port. I also like to seal the burner into the port as that helps to keep the back of the burner head cooler and eliminates flame blowing back out of the burner block. Additionally, if the port is made of a high temperature, dense material that will absorb additional heat which is beneficial. **It definitely should not be a fiber frax burner port.** The glory hole or furnace can be frax but the burner port needs to be of a hard substance like Mizoo Castable or Super G 3000 Ram Plastic as these hard materials absorb a good amount of heat and make a happier place for the burner to do its work.

As I have gone along, the daily challenge is to learn new things. With equipment making it 's there all the time. But you also have to stay out of the weeds and not go into too many rabbit holes. It is an ever-present temptation. About 20 years ago I went into the weeds and came out with a couple of new burners which are called the Mini-Square Giberson Burners, 2" and a 2.5" size. The idea was to make a burner that would function in a smaller space with the same great properties of my larger burner line. However, I did one thing a little different– I made a matching burner block that would embody what I had learned about shielding the head from the heat whilst promoting a great flame pattern. This burner block turned out to give the burner heads a much longer shop life and it reduced problems with pop-back. This is one of those many ideas which has worked out terrifically well.



Gig 5. Mini-Square burner head with matching burner port that shields the head from the main blast of combustion heat. This turned out to be a great solution which has lead to great longevity for the ceramic burner heads.

Further comments on the value of the burner block:

A lot goes on with a pre-mix burner system as we have here: the air and gas are mixed at room temperature and blown through the mixing tube to and through the restrictive holes in the burner head where the mix combusts at maybe 3000° F. — like 0 to 60 in a nanosecond. The design of the burner head holes form an organization to the flame to make it burn in a particular pattern, like long and skinny, or short and intense. The Giberson heads produce the short and intense flame needed in a glory hole or furnace. One of the most important things that happens during combustion is the gas/air mix expand something like 7 to 8 times in volume. This exhaust must be removed to make room for more combustion which is the ongoing job of the flue system. If you choke off the exits the whole system collapses. The basic shape of the burner block can assist in moving the heat away from the burner head into the combustion chamber as well as help flue gasses move away from the ignition point.

The Giberson Mini-Square burner blocks have achieved what I consider a really terrific solution to the burner block problem. In our tests the mini-square burner blocks have proved 100% successful with no burner failure for thousands of hours, now approaching 16 years. And yes, the burner block has a crack. Well it turns out that all burner blocks crack, but the burner heads are in perfect shape. With this arrangement the burner block is at the center of all the abuse: it is where all the tension is expressed.

In figure 6 below I have illustrated the principles that would improve the longevity of any pre-mix burner head you wish to protect. The design gives the burner head an exact location, a small recessed pocket. Here the gas/air mix flows through the burner head and enters the flame seat where ignition begins. This feature identified as the "flame seat" promotes stability to the process of combustion. The tapered walls of the burner block move the heat away from the ignition point and reflect the radiant and convection heat into the combustion chamber. With this type of install you should be able to put your hand on the back of the burner even during the heaviest use. This keeps the head cool and the furnace hot.

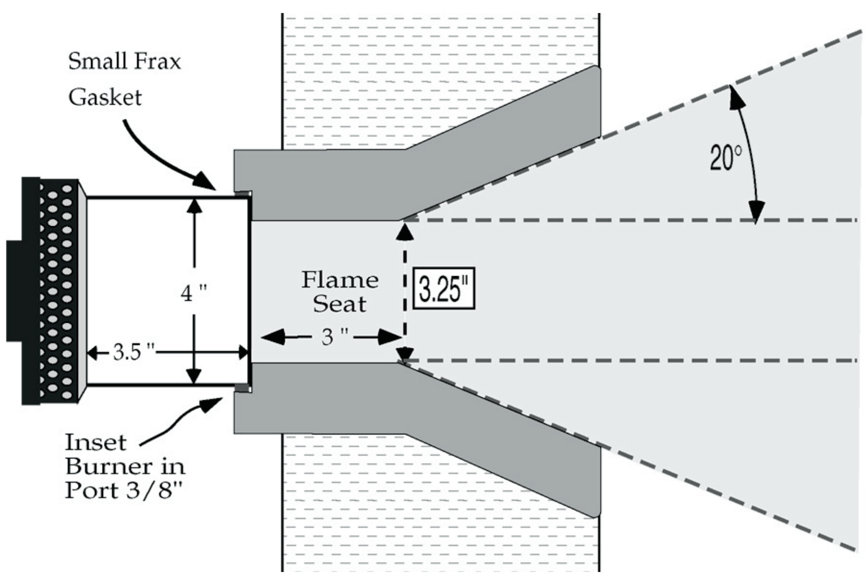


Fig. 6, This illustration depicts what I consider the "best principles of burner block design." These ideas were developed with our mini-square series and are shown here enlarged to fit the regular Standard Giberson Ceramic Burners.

If you have questions, please give me a call: ask for Dudley– 603-456-3569