FURNACE CONSTRUCTION III

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Pre-Mix burners provide a mixture of gas and air, which exits from a tube or pipe. This mixture is easily ignited and burns off the end of the pipe. For safe and efficient operation, the end of the pipe should have a ceramic burner head to assist efficient and controlled combustion. Pre-Mix burners do not allow for pre-heating of air, because a hot gas/air mix will burn in the pipe, rather than outside the pipe.

Nozzle mix burners allow for instant explosion (combustion) of gas at the point where the air enters and mixes. The diagram of the Burner Block (D in Figure 1) could represent a crude diagram of a nozzle mix burner. Simply eliminate the burner (E) and introduce gas and air directly into the burner block and you have a nozzle mix burner. (Do not try this with a burner block, special design is required for safety). Nozzle mix burners allow use of very hot air, which is more efficient. The air is heated with furnace exhaust. The preheating of fresh combustion air with furnace exhaust is called recuperation. This saves fuel.

A: SIMPLE VENTURI

The venturi burner gives you a very simple, inexpensive way to get anything hot without using electricity or complicated controls. These are available from Ceramic Supply houses everywhere, and from burner supply companies.

Set Up and Use of the Venturi Burner: Screw the ceramic head (refer to Issue 33 for sources) on the venturi tube. Attach a high pressure propane line. Control the high pressure line with a pressure regulator and pressure gauge, or with a high quality needle valve. Propane tanks will provide up to 30 psi gas. Your burner will run on low at 5 psi or less, and it will run on high at up to 30 psi.

Size of Venturi Burner (BTU): The venturi burner and the burner heads are the same physical size for different BTU requirements. A high BTU burner

FIGURE 1

In the last issue we discussed main areas of consideration for furnace construction for C: Roof and D: Burner Block. We will continue with aspects of A to K that are common to all types of glass furnaces. After that we will discuss construction and tips for specific types of furnaces.

The purpose of Figure 1 is to provide information about materials and placement of materials. It is not a diagram of an actual furnace, although some furnaces may look like this. Exhaust ports are not indicated in the diagram because they are a special consideration which will be examined when we discuss specific furnaces.

E: BURNER (Propane & Natural Gas)

There are many types of burners. For our purposes they fall into only two categories:

1. Pre-Mix Burners
   A. Simple Venturi
   B. Forced Air
2. Nozzle Mix Burners
head looks the same as a low BTU head, except for size and placement of holes in the burner tip. The BTU rating of the venturi is changed by changing the size of the gas orifice in the venturi. The gas orifice is a threaded brass plug with a hole drilled in the center. Larger holes give more BTU’s. Matching the "size" (BTU rating) to your requirements is critical. If the burner is over-powered, the operating range may drop to 1 psi to 5 psi. This means that 1 to 5 psi of gas give you all the fire you need, but you have a very small range of control and the gas velocity will be very slow at that low pressure. Low velocity can lead to hot tubes and combustion inside the tube and burner head. This is dangerous.

For precision temperature control, it is better for the operator to have a wide range of numbers to look at on the gauge. I prefer a range of under 5 psi to over 25 psi.

If your burner is overpowered, simply put in a smaller orifice, and if necessary put on a "smaller" burner head.

The reason a Venturi requires no electricity: High Pressure Gas exits the orifice at sufficient speed to entrain enough air for combustion. The air and gas mix while traveling down the tube and provide a good mix at the end of the tube.

The Simple Venturi is normally used with propane bottled gas which provides up to 30 psi. It will not work with low pressure gas.

The pilot light burns constantly. It functions as a re-light for the Venturi if it goes out. The pilot light also heats a thermocouple tube connected to the BASO valve. This is the main gas valve which functions full on or full off. If the gas is interrupted, the thermocouple tube cools and shuts off the gas. It must be re-lighted manually. This provides safety in the event of a malfunctioning gas supply (for example, freezing problems, gas line blockage, malfunctioning regulator, orifice blockage, etc.)

In the above diagram, the pilot is attached to the burner head area. Most glassblowers using the pilot burner and BASO valve, mount the pilot burner and thermocouple tube at the door opening, because the door opening is used for exhaust. This means that the door does not shut tight against the furnace, and the small area around it provides for exhaust. It also allows a pilot light to ignite gas. It is a primitive system, but workable.

The gas valve changes the gas flow (manual) and this is indicated on the gas gauge.

The manual air control is a metal disk that can be rotated on its’ threaded center to make the air entrainment opening larger or smaller.

BEGINNERS’ TIP: *****DO NOT ATTEMPT TO LIGHT THIS OR ANY BURNER WITHOUT INSTRUCTION AND HANDS-ON EXPERIENCE. These articles are to help you with understanding furnace construction and burner selection. Operation of the burner is another subject, and it does require training and experience. Ask for help from a potter or glassblower before lighting.

B: FORCED AIR BURNERS

1: ASPIRATING OR ZERO-PRESSURE BURNER

This can be classified as a venturi burner or as a forced air burner. It is a variation of the simple venturi burner. Air blows thru a tube with a constriction. At the constriction point, atmospheric pressure gas is available. The gas is made avail-
able by a special diaphragm pressure reducer. The volume of gas/air is controlled entirely by the amount of air fed to the venturi. This works well with low pressure gas, such as natural gas, and it is also used with propane. In this burner, the air entrains the gas. The operator only turns the air up or down to control the furnace. The diaphragm reducer can be set for oxidation/reduction ratio and left at that setting. For details on this type of equipment, contact companies that specialize in burners. They are not easily made by the glassblower, and are usually purchased at more expense than the simple venturi.

Normally this requires a powerful, commercial air blower (high output). The following diagram explains how this works.

This is more expensive than the simple systems. It is very useful for commercial operations because of ease of control. A simple pyrometer feedback system can increase or decrease the air supply to automatically control furnace temperature.

2. SIMPLE FORCED AIR PREMIX BURNERS

Forced Air and Venturi are similar because premixed gas and air burn off the end of a tube. Forced air does not require the entrainment of air by high velocity gas. An inexpensive electric blower forces air thru a tube into which gas is introduced. The gas does not require a tiny orifice for creating velocity. Therefore a large orifice can be used and low pressure gas is suitable. Most natural gas lines are low pressure. With propane it does not matter if you introduce high or low pressure, but you do need a way to control the amount with a valve for either kind of gas source. If you increase the amount of gas, you must increase the amount of air. Air is controlled with a rheostat to the motor or with an adjustable air flap on the intake of the blower.

Most of us make our own forced air burners with threaded black iron pipe. Variations of homemade, threaded pipe burners, are termed "ALFRED" burners. Any hardware store has what you need, T's, Nipples, Tubes, Reducers etc. to make all kinds of variations on the Alfred Burner. The forced air is provided by an inexpensive "squirrel cage blower". Gas and air are regulated manually. This is primitive, cheap, and very effective.

"ALFRED" BURNER

This is one way to make a home-made burner, and it is the type that I formerly used for glass furnaces (before going to nozzle mix/recuperated). I still use these (make your own variations of pipe lengths and placement) for glory holes or anything else you wish to get hot and control manually. These are handy for forging iron to make tools and other things for the glass shop. To increase BTU capacity, get a "larger" ceramic head and a higher capacity blower. To decrease, do the reverse.

The air inlet and gas inlet occur at a T fitting. If you are using 2 inch threaded iron pipe, make the
gas inlet with a 1/2" pipe. This gas tube slides through a 2" to 1/2" reducer which screws into the 2" pipe. Position the gas tube in the reducer and braze it into place. Everything else is threaded and screws together. If you want an orifice on the gas tube, screw on a cap (available at the pipe supply store) through which you have drilled a hole. Use pipe which is the same size as the threaded opening on the burner head. Use high temperature "never-seize" lubricant on the threads to facilitate taking it apart.

I prefer to use a needle valve and flow meter in the gas line. Flowmeters allow you to understand how much gas is actually being used by each burner, and give you superior control. Flowmeters were discussed in Issue #1.

![P-240 Shown with Glberson Ceramic Burner Head](image)

This is a typical commercial "Alfred" type burner equipped with a forced air "squirrel cage" blower. The blower is controlled by the attached rheostat.

The pilot light and BASO valve operate the same as previously mentioned for the venturi burner.

This is equivalent to the diagram for the homemade burner.

Complete burner units like this are available from most pottery supply houses.

**NOZZLE MIX BURNERS**

Nozzle mix burners are used when it is important to save fuel. It is always important to save fuel, but the expense and work of recuperating and installing a nozzle mix burner system is very worthwhile on larger, long running installations. It is not worthwhile for a small furnace that is turned on and off every weekend, or transported for short 3 or 4 day demonstrations.

There are many types of nozzle mix burners. They can be designed for different flame shapes, velocities and fuel types.

The advantage of instant combustion in the burner is increased efficiency by using very hot (up to 1200 degrees F) combustion air, which has been preheated by the furnace exhaust.

Another important use for nozzle-mix is the use of oxygen-boosting and also use of oxy-fuel (no air).

The following diagram explains the design inherent in all nozzle-mix burners. The design concept is simple, but the actual engineering design, and the many variations in configuration and materials are very complex.

![NOZZLE MIX BURNER](image)

I have made my own nozzle mix burners and ceramic recuperators, as detailed in The Independent Glassblower, Issues No. 6 and 7. Since they are entirely ceramic, 1200 degree F air is no problem.

Charles Correll (see AD section) manufactures a nozzle mix burner with recuperators of his own
design. Many glass studios use the Correll system.

Commercial manufacturers offer nozzle mix burners designed for specific applications. Many of these use metal parts in or on the burner, which may limit the hot air temperature to 1000 degrees F. Some of the commercial burners are engineered for oxygen injection, which requires a different design than the burners engineered for hot air.

TO BE CONTINUED

Dear David,

I think that I shall never see
Examples of my husband's glee
Like those displayed four times a year
When your publication ends up here.

He hides away, and his final word
Is that he's not to be disturbed.
I hear soft chuckles, and "Yea! That's for sure",
Plus "Right!", "Perfect!", and "That's exactly
how they were!"

Since his copies end with #34
I've enclosed a check for one year more,
With thanks for all the info. and pleasure-
You've supplied them both in equal measure!

Many thanks,
Cathy Wright-Eichholz Huntington Woods, MI

Dear Cathy,

Thank you! You just made my day. This is time consuming to do, but I will try to keep "the presses rolling". DG

IRIDIZING GLASS

Art Allison

Dear Independent Glassblower,
RE: Iridizing

ALL colors (Gold, Blue, Cyan, Magenta & Variations) can be achieved by using Stannous Chloride dissolved in 50/50 Muratic acid (HCl) and Alcohol, sprayed on hot glass.

The "TRICK" is operator control!
As you have written, many tests are necessary. I achieve the best results spraying on a REDUCED surface of a Silver Bearing Glass.
Reduced Lead Bearing Glass, also adds an exciting twist to the iridized surface.