Chapter 2

Introduction to Burners

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Introduction to burners

To understand burners, one must understand a bit about combustion. Combustion is the rapid chemical combination of a substance with oxygen resulting in the production of heat and light. For something to burn, three things are needed:

1. **Fuel**
2. **Oxygen**
3. **Heat**

Home heating fuel will not burn as a liquid. To burn, the fuel must be converted into a vapor. The burner atomizes the fuel, vaporizes it, mixes it with air, and heats the mixture above its ignition point.

High pressure atomizing

Today's burners are called high-pressure burners because they use a fuel unit (also known as a fuel pump) to pressurize the fuel to 100 pounds per square inch (PSI) or more.

This pressure forces the fuel through a nozzle designed to reduce (atomize) the fuel into small droplets that are vaporized in the combustion area. High voltage is delivered to the electrodes causing a spark close to the nozzle. The spark supplies the heat for ignition. A fan supplies the air required for combustion, Figure 2-1.

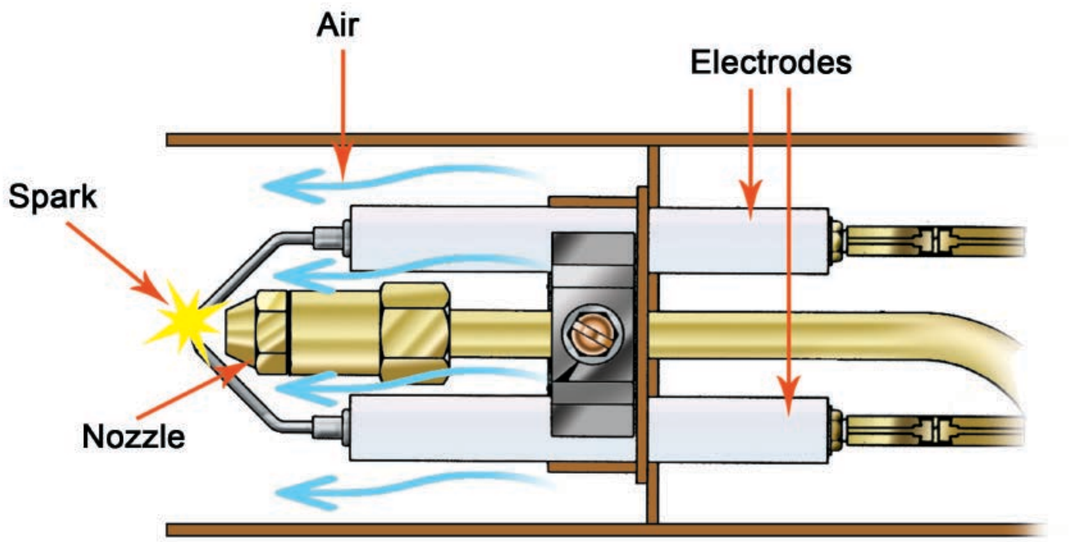

Figure 2-1: Combustion process

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Flame retention burners

The current design for burners is called flame retention. Figure 2-2 shows pictures of modern flame retention burners.

Figure 2-2: Flame retention burners

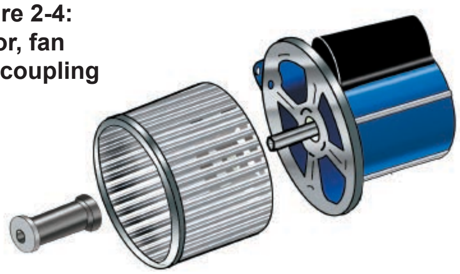
Construction of Flame Retention Burners

High-pressure burners consist of a motor, fan (C), fuel unit (A), ignition transformer or ignitor (E), nozzle assembly (B & D), and a housing to which all of these parts are attached, as illustrated in Figure 2-3, opposite page.

Motor

The electric motor drives a fan and a fuel unit. The motor is mounted to the housing of the burner with bolts. Removing these bolts allows easy removal of the motor and access to the fan which is attached

Figure 2-4: Motor, fan and coupling



to the motor shaft. In the event of motor failure, a new motor must be installed with the same rotation, frame size, and revolutions per minute (RPM). Figure 2-4 shows a motor, fan and coupling. The coupling attaches to the motor shaft on one end and the fuel unit shaft on the other.

Multiblade fan & air shutter

A fan wheel, Figure 2-5, within the burner housing is driven directly by the motor shaft and provides the necessary air to support combustion. An adjustable air shutter on the burner housing controls the volume of air moved by the fan.

Figure 2-5: Burner fan or blower wheel

The fans beveled blades must be kept free of dirt and lint. The slightest amount of dirt will reduce the amount of air delivered.

A fan with a bent or broken blade will be out of balance. This can cause a vibration and put an extra strain on the motor bearings. When replacing the burner fan, use the exact model specified by the manufacturer.

Fuel unit

The fuel unit is driven by the motor. Its shaft is attached to the motor shaft by the burner coupling. The fuel unit consists of three main parts:

1. **Strainer:** to remove foreign matter from the fuel before it enters the pump gears.
2. **Gears:** to lift the fuel from the tank and deliver it to the regulating valve.
3. **Regulating valve:** to build up and maintain the proper operating pressure.

Ignition transformer or solid-state ignitor

Burners have either an ignition transformer or solid-state ignitor that “steps up” line voltage of 120 volts to more than 10,000 volts to generate a high voltage spark providing the heat necessary to vaporize and ignite the fuel.

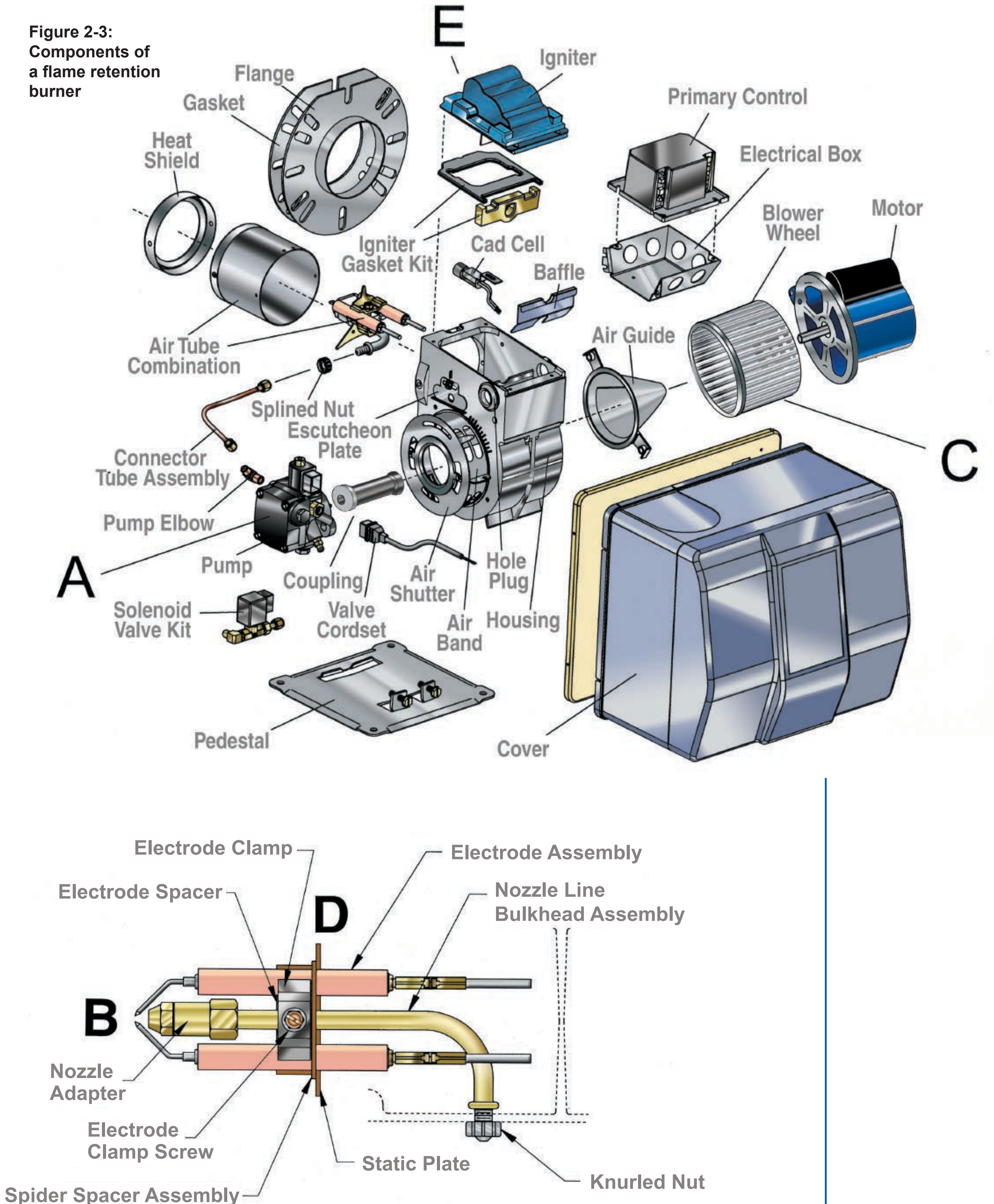


Figure 2-3: Components of a flame retention burner

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Air tube & nozzle assembly

The nozzle assembly, also called the firing assembly or nozzle line electrode assembly (NLEA), consists of the fuel feed pipe, the nozzle, nozzle adapter and electrodes. The entire assembly is located in the air tube of the burner. An opening in the burner housing permits access to and removal of the nozzle assembly.

Combustion heads

The combustion head creates a specific pattern of air at the end of the air tube. This forces air into the fuel spray providing oxygen, which allows the fuel to burn.

Elements needed for combustion

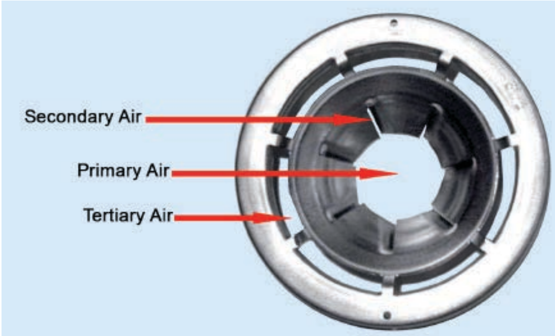
The three elements needed for combustion are fuel, air (oxygen), and heat (spark):

- The amount of fuel is based on the flow rate in gallons per hour (GPH) that the appliance requires. The size of the nozzle orifice and the pressure setting of the fuel unit determine the flow rate.
- Air is introduced into the air tube by the fan through the air intake which is usually controlled by adjustable shutters or bands. Setting these bands is the key final adjustment for proper combustion.
- Heat is supplied by a high voltage spark, generated by the ignitor, that "jumps" across the tips of the electrodes.

The flame retention head incorporates three basic air-directing elements: the center opening for primary air, the secondary slots, and the tertiary opening, Figure 2-6.

The center opening allows clearance for the fuel spray and the electrode spark to pass through the head without interference. The secondary slots radiate from the center opening towards the outside of the head. The tertiary opening follows the circumference of the combustion head. All three openings affect the way air is delivered to the fuel spray.

Figure 2-6: Fixed burner head air-directing elements



The **Primary Air** is the air that exits through the center opening in the flame retention ring where the fuel from the nozzle is sprayed. Primary air has the least desirable effect on combustion. Air will always take the path of least resistance, so the larger the center opening, the more the air will tend to pass through this opening and push the flame away from the face of the head. The smaller the center opening, the more air will be forced to seek its passageway through the other openings in the combustion head.

The **Secondary Air** exits through the slots cut into the flame retention ring. The secondary slots are where the most important mixing of fuel and air occurs. The slot width regulates the velocity of the air passing through the slot. This is where the air acquires a spinning action. The air moves mostly in a rotary motion with little forward movement. Narrow slots will cause the air to spin faster and move forward less. This will cause the best mixing of fuel and air and create a compact, intense and efficient flame.

The secondary slots also aid in keeping the surface of the head clean and free

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of carbon. This air is spun by the flame retention ring and creates the flame retention effect. By spinning this secondary air, the flame is pulled back toward the flame retention ring.

The **Tertiary Air** is the air that exits around the outside of the flame retention ring or through the tertiary slots. For clean fuel combustion, every droplet of atomized fuel MUST be completely blanketed with air. Tertiary Air ensures that any droplets of atomized fuel escaping the fuel spray pattern will contact this air and burn. This ensures that there will be an envelope or curtain of air between flame and the walls of the combustion area.

Fixed & adjustable heads

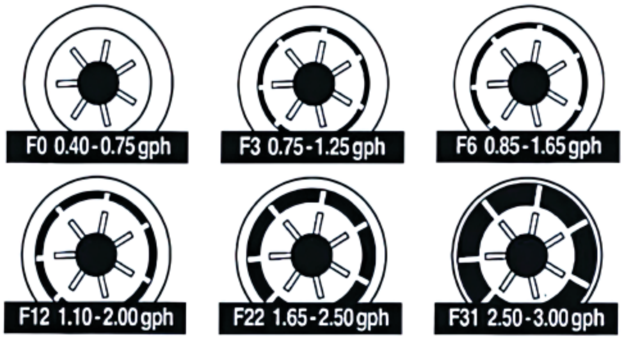
Flame retention heads fall into one of two categories: fixed or adjustable (sometimes called variable heads). The difference between them is the method by which they control the tertiary opening. The fixed head's tertiary opening is pre-set to a specific size for a specific firing rate range. There are a variety of one-piece heads available with fixed tertiary slots sized according to the firing rate for which it was designed. To change firing rates, the head must be changed.

With an adjustable head burner, the head is designed to move against or away from a ring, thus closing or opening the tertiary slot according to the firing rate requirements.

The adjustable head operation is based on the relationship between what is called the "throttle ring" and the "flame retention ring." The throttle ring is a ring at the end of the air tube that works in conjunction with the flame retention ring to create an air restriction and provide for the tertiary air effect. The adjustable head allows the technician to move the nozzle assembly forward or backward in order to change the tertiary opening to accommodate different firing rate requirements.

The fixed head, Figure 2-7, is simple and easy to use. However, each head is good only for a specific range of firing rates. When installing a new burner or changing a firing rate to optimize performance, the proper head for the specific firing rate must be installed.

Figure 2-7: Assortment of fixed heads



Static pressure

Static pressure is the means of producing and maintaining flow against resistance. Burners on the market today create much higher static pressures than units made in the 1980s and earlier.

Some of these burners create such high static pressures that they can force the products of combustion through the heat exchanger and out of the building without the use of a chimney. High static pressure burners have been developed to accommodate modern, flow resistive appliances (boilers, furnaces, and water heaters) and to assist with low or no draft conditions.

High static pressure is especially needed in most modern appliances which are designed with tighter, more efficient heat exchanger passages. This results in greater heat absorption by the heat exchanger and thus, higher efficiency.

Chapter 2: Additional Resources

NORA has compiled a library of additional technical resources for your continued education. Scan the QR code or go to the web address. Check back often, as NORA will continually add content as it becomes available.

You will find:
- Videos
- Technical Bulletins
- Instructions
- and More

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