Canadian Gas Technician Learning Module 10

Burners and Combustion Systems

Learning Objectives

Upon completion of this chapter, students will be able to:

01

Burner Systems

Explain the operation of atmospheric and power burner systems

02

Ignition Types

Identify different ignition system types and their operation

03

Flame Sensing

Understand flame sensing methods and troubleshoot sensor problems

04

Orifice Sizing

Calculate and select proper burner orifice sizes

05

Air Adjustment

Adjust primary air for optimal combustion

06

Combustion Analysis

Perform combustion analysis and interpret results

07

Air Requirements

Calculate combustion air requirements per CSA B149.1

08

Problem Solving

Identify and correct common combustion problems

09

Port Loading

Understand burner port loading and flame characteristics

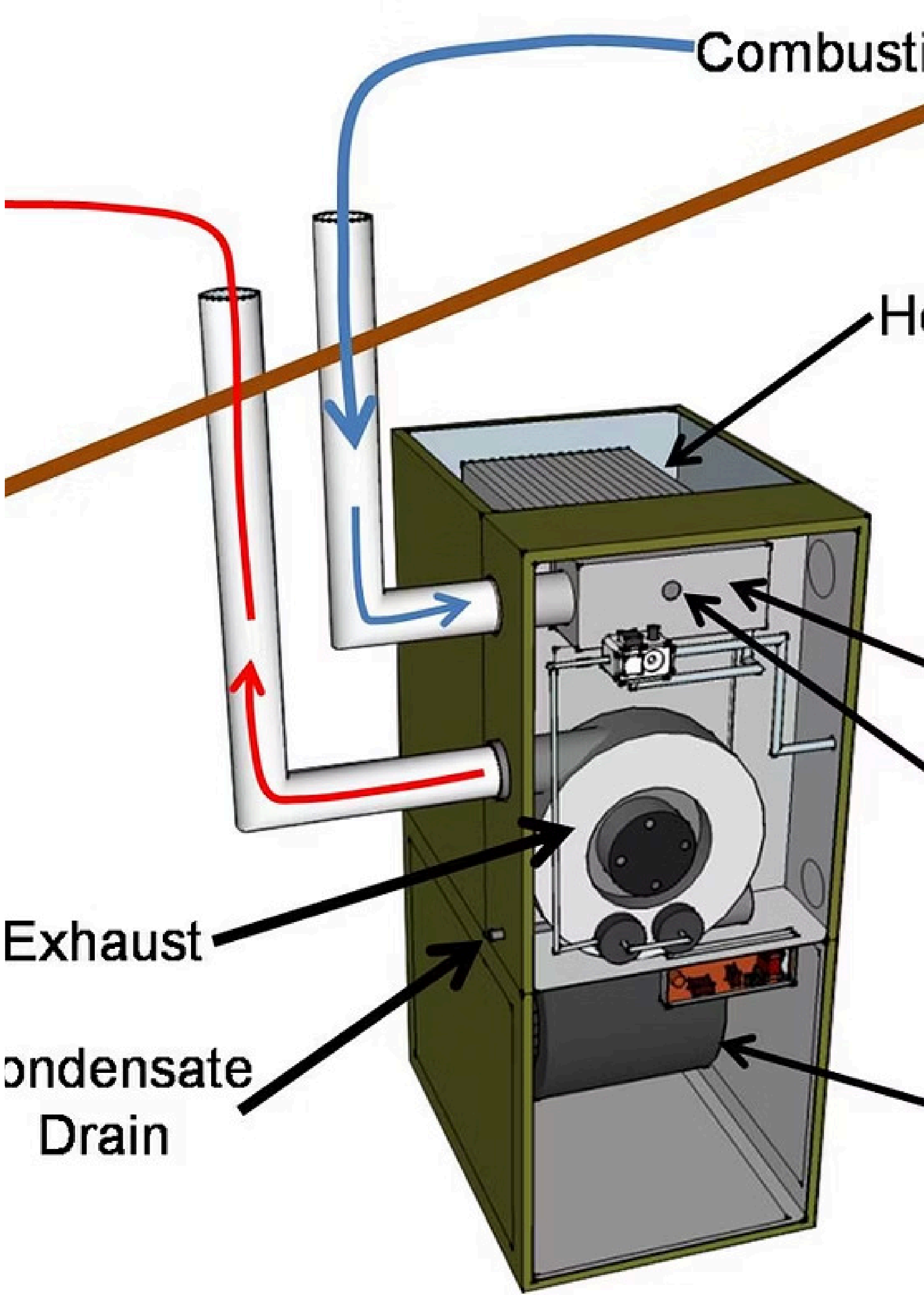
10

Pressure Relationships

Apply pressure and flow relationships to burner operation

10.1 Atmospheric Burners

Atmospheric burners are the most common type in residential gas appliances, using natural draft and venturi principles.



Basic Operation Principles

Venturi Effect:

The core principle of atmospheric burners:

Gas Flow

Gas flows through orifice at pressure (typically 3.5" W.C. natural gas, 10" W.C. propane)

Velocity

High-velocity gas jet creates low-pressure area

Air Entrainment

Low pressure draws in primary air through air shutter

Mixing

Gas and primary air mix in venturi throat and mixing tube

Delivery

Mixed gas-air exits burner ports

Secondary Air

Additional air drawn from surrounding area during combustion

Components

Gas Orifice (Spud)

- Precisely sized hole
- Controls gas flow rate
- Threads into manifold or burner
- Sized for gas type and input

Air Shutter

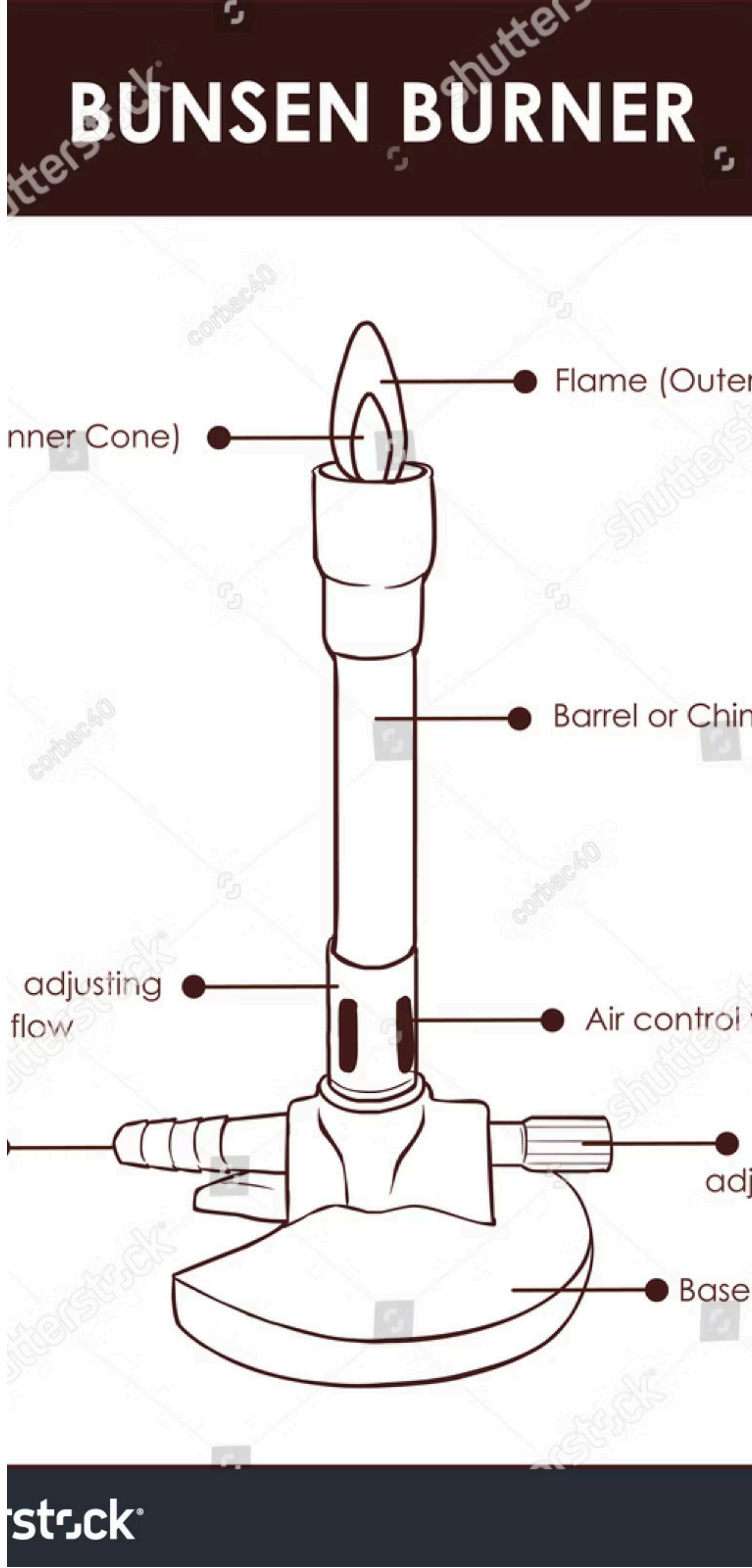
- Adjustable opening
- Controls primary air entry
- Slide, rotating band, or fixed
- Sets air-fuel ratio

Venturi (Mixing Tube)

- Converging-diverging passage
- Creates low pressure for air entrainment
- Mixes gas and air
- Delivers mixture to burner

Burner Head

- Port configuration
- Distributes flame
- Various designs (ribbon, inshot, slotted, etc.)
- Material: cast iron, steel, stainless steel



Critical Concept

Primary and Secondary Air

Primary Air

Definition:

- Air mixed with gas BEFORE combustion
- Drawn through air shutter
- Typically 40-60% of total air needed

Control:

- Air shutter adjustment
- Affects flame characteristics
- Critical for proper combustion

Too Little Primary Air

Flame Appearance

Yellow, lazy flame

Combustion Quality

Incomplete combustion

Safety Hazard

Soot and carbon monoxide production

Performance

Lower efficiency

Potential Issue

Possible flame lifting

Too Much Primary Air

Flame Appearance

Short, sharp blue flame

Combustion Sound

Hard, noisy combustion (roaring)

Flame Stability

Flame lifting or blowing off ports

Safety Risk

Flashback possible

Efficiency Loss

Heat loss through excess air

Correct Primary Air

Stable blue flame

Soft, quiet combustion

Inner cone distinct

Slight yellow tips acceptable (minimal)

No lifting or flashback

Secondary Air

Definition:

- Air drawn into flame from surrounding area
- Completes combustion
- Approximately 40-60% of total air

Control:

- No direct control mechanism
- Must be available from room/combustion air supply
- Limited by combustion air provisions

Importance:

- Completes combustion
- Prevents CO formation
- Essential for safe operation
- Reason combustion air openings required

Section 10.1

Burner Types and Designs

Understanding different burner configurations is essential for proper service and troubleshooting.

Atmospheric (In-Shot) Burners

Description:

- Most common residential furnace burner
- Gas-air mixture "shoots" horizontally into heat exchanger
- Venturi throat at burner inlet
- Flame projects forward into heat exchanger tubes or clamshell

Construction:

- Cast iron or stamped steel
- Mixing tube with air shutter
- Burner head with port configuration
- Orifice threads into manifold

Atmospheric Burner Operation

01

Venturi Effect

Gas jet creates venturi effect

02

Air Entry

Primary air enters through shutter

03

Mixing

Mixed gas-air travels through mixing tube

04

Exit

Exits ports and ignites

05

Projection

Flame projects into heat exchanger

Port Configurations:

- Single row of ports
- Double row (ribbon style)
- Slotted ports
- Various patterns for flame distribution

In-Shot Burner Characteristics

Advantages:

- Simple and reliable
- Quiet operation
- Easy to service
- Good heat transfer
- Proven design

Applications:

- Residential forced-air furnaces (most common)
- Some commercial furnaces
- Standard efficiency equipment

Service Considerations:

- Air shutter adjustment critical
- Burner alignment important
- Must maintain proper spacing to heat exchanger
- Clean ports if clogged

Upshot (Vertical) Burners

Description:

- Flame projects vertically upward
- Burner positioned below heat exchanger
- Gas-air mixture shoots upward into heat exchanger
- Common in older furnaces and some boilers

Construction:

- Similar to in-shot but vertical orientation
- Mixing tube vertical or angled
- Burner ports face upward
- Cast iron or steel construction

Upshot Burner Operation

Mixing

Venturi mixes gas and air

Travel

Mixture travels up through burner

Exit

Exits upward-facing ports

Combustion

Flame rises into heat exchanger above

Heat Exchanger Configuration:

- Clamshell heat exchanger typical
- Sectional cast iron (boilers)
- Heat exchanger surrounds flame

Upshot Burner Characteristics

Advantages:

- Natural flame direction (upward)
- Good for gravity systems
- Simple design
- Effective heat transfer

Disadvantages:

- Larger footprint
- Less common in modern equipment
- More difficult to service (access)

Applications:

- Older residential furnaces
- Gravity furnaces (obsolete)
- Cast iron boilers
- Some commercial equipment

Ribbon Burners

Description:

- Long, narrow burner
- Multiple ports in continuous row(s)
- Creates "ribbon" of flame
- Port arrangement provides wide flame pattern

Construction:

- Stamped steel body
- Hundreds of small drilled or stamped ports
- One or two rows of ports
- Length matches heat exchanger width

Port Configuration:

- Ports: 1/16" to 1/8" diameter typically
- Spacing: 1/4" to 1/2" center-to-center
- Single or double row
- Very uniform distribution

Ribbon Burner Characteristics

Operation:

- Gas-air mixture enters one end
- Distributes along length of burner
- Burns at many small ports
- Wide, even flame pattern
- Excellent heat distribution

Advantages:

- Very uniform heat distribution
- Efficient combustion
- Good flame stability
- Quiet operation
- Minimal flame impingement risk

Disadvantages:

- Port plugging possible (dust, debris)
- Requires proper manifold pressure
- Cleaning tedious (many small ports)

Applications:

- Modern high-efficiency furnaces
- Premix burners
- Commercial cooking equipment
- Industrial heaters

Service Considerations:

- Check all ports for plugging
- Clean with wire brush or compressed air
- Verify even flame across entire length
- Check for port erosion

Slotted Port Burners

Description:

- Slots instead of round holes
- Common in water heaters
- Wide flame pattern from each slot
- Simple and economical

Construction:

- Stamped or cast metal
- Rectangular or elongated slots
- Typically 3-8 slots per burner
- Slots: 1/4" to 3/4" long

Operation:

- Gas-air mixture enters from below or side
- Exits through slots
- Each slot produces wide flame
- Flames overlap for coverage

Slotted Port Characteristics

Flame Characteristics:

- Wider, flatter flames than round ports
- Good stability
- Less prone to lifting
- Forgiving of slight adjustment errors

Advantages:

- Less prone to clogging than small ports
- Easy to clean
- Stable flames
- Forgiving design
- Lower cost

Disadvantages:

- Less uniform than many small ports
- Potential for flame impingement if misaligned
- Limited to lower input applications

Applications:

- Residential water heaters (very common)
- Small commercial water heaters
- Pool heaters
- Some space heaters

Service Considerations:

- Easy to clean
- Check for burner alignment
- Verify proper spacing to baffle/flame arrestor
- Look for flame impingement

Drilled Port Burners

Description:

- Precision-drilled round holes
- Cast iron or heavy steel construction
- Very stable and durable
- Used in boilers and commercial equipment

Construction:

- Cast iron body (typical)
- Precision-drilled ports
- Port size: 1/8" to 1/4" typical
- Spacing designed for specific application
- Heavy, durable construction

Port Patterns:

- Linear rows
- Circular patterns
- Custom patterns for application
- Engineered for specific heat exchanger

Drilled Port Characteristics

Operation:

- Gas-air mixture supplied to burner
- Exits each drilled port
- Individual flame at each port
- Very stable combustion
- Predictable performance

Advantages:

- Very durable (cast iron)
- Long service life
- Precise flame control
- Excellent stability
- Resists warping

Disadvantages:

- Heavy
- Expensive
- Difficult to modify
- Requires proper support

Applications:

- Cast iron boilers (very common)
- Commercial boilers
- Industrial heaters
- High-quality residential boilers
- Long-life applications

Service Considerations:

- Check for cracks (cast iron)
- Clean ports with wire brush
- Verify proper seating/gasketing
- Check for port erosion
- Inspect for flame impingement

Multi-Port (Perforated) Burners

Description:

- Many small holes (perforations)
- Often 100+ ports per burner
- Produces multiple small flames
- Very uniform heat distribution

Construction:

- Sheet metal with stamped or drilled holes
- Burner may be flat, cylindrical, or shaped
- Port size: 1/32" to 1/16" very small
- High port density

Applications:

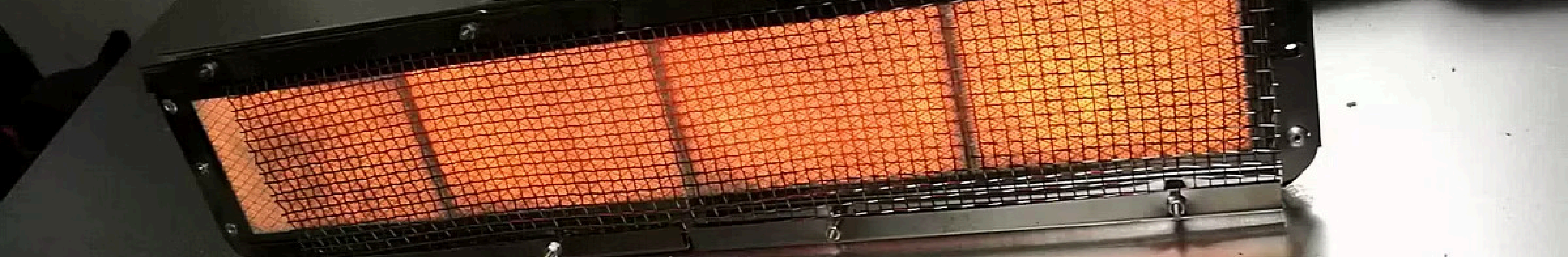
- Infrared heaters
- High-efficiency appliances
- Radiant burners
- Commercial cooking (some)
- Specialized industrial applications

Characteristics:

- Many small flames or radiant surface
- Very uniform heating
- Excellent mixing
- Low emissions potential
- Quiet operation

Service:

- Prone to plugging (very small ports)
- Difficult to clean (many ports)
- May require replacement if damaged
- Critical to maintain proper pressure



Radiant Burners

Description:

- Flame heats ceramic or metal surface
- Surface radiates infrared heat
- No visible flame (sometimes)
- Efficient radiant heating

Construction:

- Perforated burner or porous ceramic
- Gas-air mixture burns at or in surface
- Surface glows orange/red
- Reflector directs heat

Radiant Burner Types

Ceramic Radiant

- Porous ceramic tile or panel
- Gas burns within ceramic matrix
- Surface glows bright orange
- Infrared radiation

Metal Mesh/Screen

- Fine metal screen
- Flame stabilizes on screen surface
- Screen glows
- Radiant heat

Operation:

- Gas-air mixture supplied
- Combustion at surface
- Surface heats to 1500-1800°F
- Radiates infrared energy
- No convective heat transfer

Radiant Burner Characteristics

Advantages:

- Efficient radiant heating
- Quiet operation
- No visible flame (safer perception)
- Targeted heating
- Good for outdoor/open areas

Disadvantages:

- Fragile (ceramic types)
- Expensive
- Requires precise control
- Can be damaged by impact

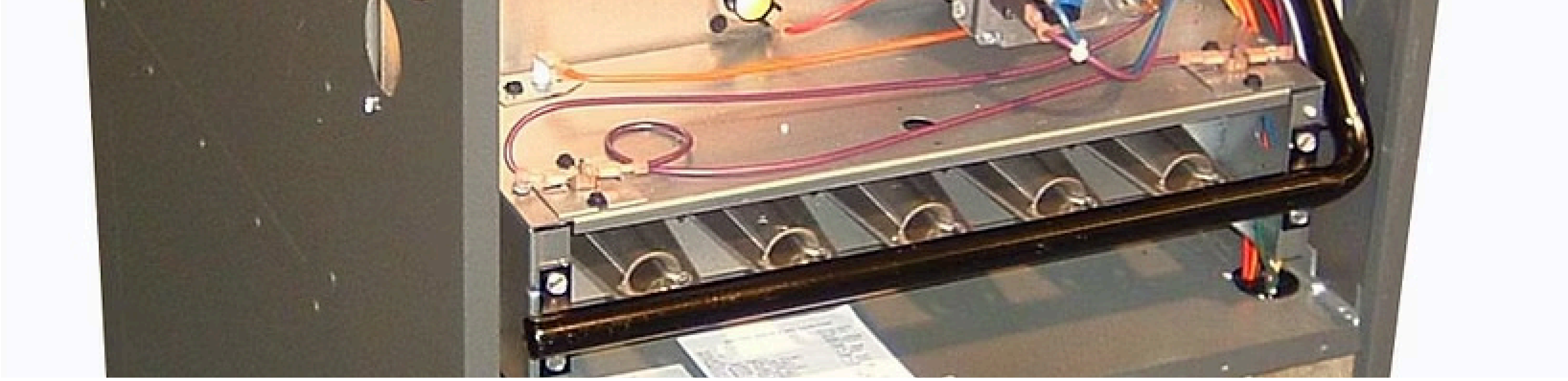
Applications:

- Outdoor patio heaters
- Industrial process heating
- Commercial space heating (high bay)
- Infrared comfort heating
- Paint drying, curing

Advanced Technology

Power Burners (Fan-Assisted)

Uses fan to supply combustion air - positive or negative pressure - more complex but higher performance - common in modern equipment



Power Burner Types

Forced Draft

- Fan pushes air through burner
- Positive pressure in combustion chamber
- Fan upstream of burner

Induced Draft

- Fan pulls air through burner
- Negative pressure in combustion chamber
- Fan downstream (after heat exchanger)

Premix

- Gas and air completely mixed before burner
- Fan mixes and delivers to burner head
- Very efficient
- Lower emissions

Construction:

- Burner head with ports or mesh
- Fan (centrifugal or vane-axial)
- Gas valve with air mixing section
- Electronic controls
- Pressure switches

Power Burner Characteristics

Advantages:

- Better combustion control
- Higher efficiency
- Can handle longer vents
- More compact
- Less sensitive to building pressure
- Can modulate

Disadvantages:

- More complex
- Higher cost
- Requires electricity
- Fan failure = no heat
- More maintenance

Applications:

- High-efficiency furnaces (90%+ AFUE)
- Condensing boilers
- Modulating equipment
- Commercial equipment
- Sealed combustion appliances

Sealed Combustion Burners

Description:

- Combustion chamber sealed from room
- All combustion air from outdoors
- Often power burner design
- Direct vent configuration

Construction:

- Sealed combustion chamber
- Concentric vent (air in, flue out)
- Fan-powered typically
- Gaskets seal chamber

Operation:

- Fan draws outdoor air
- Mixes with gas
- Burns in sealed chamber
- Flue gases exhaust outside
- No room air involved

Sealed Combustion Characteristics

Advantages:

- No combustion air from conditioned space
- No spillage possibility
- Works in tight buildings
- Can install in confined spaces
- Improved efficiency (not heating outdoor air)

Disadvantages:

- More expensive
- Complex installation
- Requires specific venting
- Sensitive to wind effects

Applications:

- Modern high-efficiency equipment
- Tight building installations
- Bedroom closet installations (with restrictions)
- Commercial applications

Conversion Burners

Description:

- Aftermarket burners
- Convert oil to gas (historical)
- Convert atmosphere to power (rare)
- Retrofit applications

Notes:

- Becoming obsolete
- Usually better to replace entire appliance
- Complex certification issues
- Limited applications today

Specialty Burners

Bunsen Burner Style

- Laboratory and process applications
- Adjustable air and gas
- Single flame
- Not common in HVAC

Surface Combustion

- Industrial applications
- Combustion at or within porous material
- Process heating
- Specialized equipment

Duct Burners

- Installed in ductwork
- Supplemental heating
- Commercial buildings
- Make-up air heating

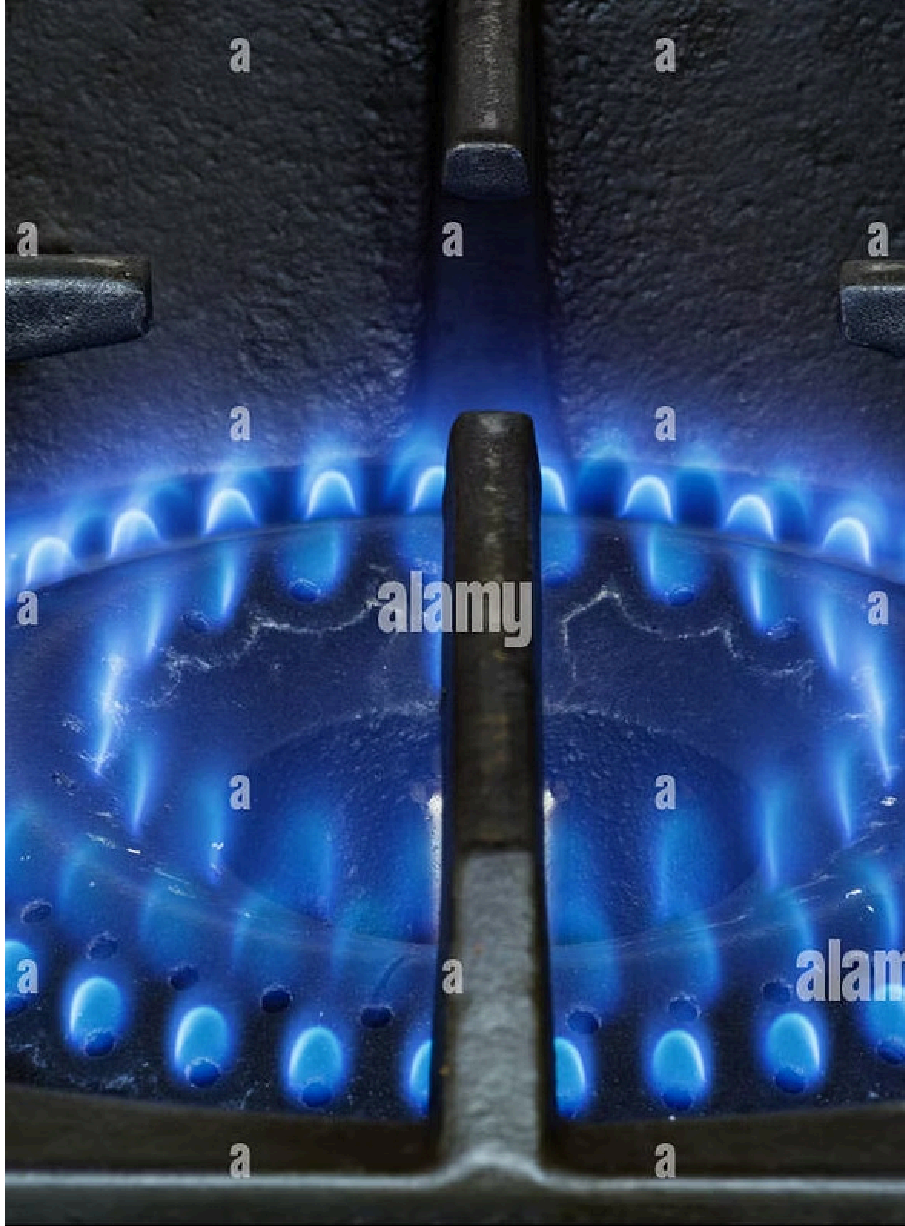
Flame Characteristics

Proper Natural Gas Flame:

- Clear blue color
- Distinct inner cone (light blue)
- Outer mantle (darker blue/purple)
- Stable, not lifting or floating
- Soft, quiet combustion
- Minimal yellow tipping at outer edge

Proper Propane Flame:

- Blue flame with slight luminosity
- May show more yellow tipping than natural gas (acceptable if minimal)
- Stable and quiet
- Distinct inner cone



Flame Zones

Inner Cone (Primary Combustion Zone)

- Light blue
- Hottest part: 1,980°C (3,600°F) for methane
- Primary air combustion
- Distinct boundary

Outer Mantle (Secondary Combustion Zone)

- Darker blue/purple
- Secondary air completes combustion
- Slightly cooler than inner cone
- May show slight yellow at tips

Problem Flames

Yellow or Orange Flame

- Insufficient air
- Incomplete combustion
- Soot formation
- CO production
- Requires adjustment

Lifting Flame

- Flame lifts off ports
- Excessive primary air or gas velocity
- Can cause ignition failure
- Noisy operation
- Reduce primary air or check orifice size

Floating Flame

- Flame hovers above burner
- Not stable on ports
- Usually too much primary air
- Dangerous can extinguish

Critical Flame Problems

Flashback

- Flame burns inside burner
- Too much primary air
- Gas velocity too low
- Very dangerous
- Shut down immediately
- Reduce primary air

Impingement

- Flame contacts surfaces
- Heat exchanger too close
- Misaligned burner
- Causes incomplete combustion
- Yellow flame and CO

10.2 Power Burners

Power burners use fans to force combustion, providing better control and higher efficiency.

Power Burner Operation

Basic Principle:

- Fan forces air into combustion chamber
- Gas injected into air stream
- Premixed before combustion
- More precise air-fuel control

Advantages:

- Better mixing
- More complete combustion
- Higher efficiency
- More compact
- Independent of room conditions
- Can handle longer vent runs

Types:

Forced Draft

Fan blows air through burner - positive pressure in combustion chamber - fan before burner

Induced Draft

Fan draws air through burner - negative pressure in combustion chamber - fan after heat exchanger - more common in residential

Premix

Gas and air fully mixed before combustion - very efficient - lower emissions - complex controls

Modulating Burners

Operation:

- Vary firing rate to match load
- Gas valve and fan modulate together
- Maintain optimal air-fuel ratio
- High efficiency

Advantages:

- Precise temperature control
- Fewer cycles
- Higher seasonal efficiency
- Better comfort

Control:

- Electronic controls monitor demand
- Adjust gas valve position
- Adjust fan speed
- Maintain proper ratio

Applications:

- High-efficiency furnaces
- Modulating boilers
- Premium residential equipment
- Commercial applications

Two-Stage Burners

Operation:

- Two firing rates: high and low
- Typically 65-70% low, 100% high
- Better than single-stage
- Simpler than modulating

Control:

- Thermostat or control board determines stage
- Cold call = high fire
- Moderate call = low fire
- Gas valve switches between outputs

Benefits:

- Reduced cycling
- Better efficiency
- Improved comfort
- Lower cost than modulating

10.3 Burner Orifices

Orifices control gas flow rate and are critical for proper appliance operation.

Gas Orifice Capacity Chart

GAS USE IN BTUS PER HOUR AGAINST A GIVEN ORIFICE SI

Decimal Equivalent	Natural Gas				
Gas Pressure >	3.0	3.5	4.0	4.5	7.0
	Gas Use in Btus/Hr				
.0760	13577	14665	15678	16629	20740
.0781	14338	15487	16556	17560	21902
.0785	14485	15646	16726	17741	22127
.0810	15423	16658	17809	18889	23558
.0820	15806	17072	18251	19358	24144
.0860	17385	18778	20075	21293	26557
.0890	18620	20111	21500	22804	28442
.0935	20550	22197	23729	25168	31391
.0938	20682	22339	23882	25330	31592
.0960	21664	23399	25015	26532	33092
.0980	22576	24384	26068	27649	34485
.0995	23272	25137	26872	28502	35549
.1015	24217	26157	27963	29660	36992
.1040	25425	27462	29358	31139	38837
.1065	26662	28798	30786	32654	40726
.1094	28133	30388	32486	34456	42975
.1100	28443	30722	32843	34835	43447
.1110	28962	31283	33443	35472	44241
.1130	30015	32420	34659	36761	45849
.1160	31630	34165	36524	38739	48316
.1200	33849	36562	39068	41457	51706
.1250	36729	39672	42411	44984	56104
.1285	38815	41924	44819	47538	59290
.1360	43478	46961	50204	53249	66413
.1405	46402	50120	53581	56831	70881
.1406	46469	50192	53657	56912	70982
.1440	48743	52649	56284	59698	74456
.1470	50795	54865	58653	62211	77591
.1495	52538	56747	60665	64345	80253

Orifice Function

Purpose:

- Meter gas flow
- Create specific input rate
- Match appliance requirements
- Convert pressure to flow

How Orifices Work:

- Gas under pressure enters orifice
- Small opening restricts flow
- Flow rate depends on:

Orifice size (diameter)

Gas pressure

Specific gravity of gas

Orifice Sizing

Factors Affecting Size:

Gas Type

- Natural gas: larger orifices
- Propane: smaller orifices (60% of natural gas size typically)
- Different heating values require different flows

Pressure

- Natural gas manifold: typically 3.5" W.C.
- Propane manifold: typically 10" W.C.
- Higher pressure = smaller orifice for same flow

Input Required

- Higher input = larger orifice
- Flow in CFH needed
- Calculate from BTU input

Specific Gravity

- Heavier gas = slower flow
- Lighter gas = faster flow
- Corrections needed if SG differs from standard

Drill Number Sizing

Drill Number System:

- Standardized drill sizes
- Numbered #1 through #80 (plus wire gauges)
- Higher number = smaller diameter
- Fractional sizes also used

Common Ranges:

- Natural gas: #35 to #50 typical residential
- Propane: #50 to #60 typical residential
- Varies by appliance and input

Example:

- #43 drill = 0.089" diameter
- #54 drill = 0.055" diameter

Measurement:

- Orifice drill size often stamped on orifice
- Can measure with drill bit gauge
- Precision critical (0.001" changes flow significantly)

Altitude Compensation

At Higher Elevations:

- Less oxygen available
- Must reduce gas flow
- Smaller orifices required
- Or reduce pressure

Typical Adjustment:

- 4% reduction per 1,000 feet above rated elevation
- Accomplished by smaller orifices or lower pressure
- Follow manufacturer de-rating instructions

Example:

- Sea level orifice: #43
- 5,000 ft elevation
- May require #45 or #46 (smaller)
- Or reduce manifold pressure

Orifice Installation

Procedure:

01

Turn off gas supply

02

Release pressure downstream

03

Remove old orifice (wrench on hex)

04

Inspect threads

05

Install new orifice (hand tight then 1/4-1/2 turn)

06

Don't overtighten (brass threads)

07

Pressure test

08

Leak test with soap solution

09

Set manifold pressure

10

Verify input rate

Common Mistakes:

- Wrong orifice size
- Cross-threading
- Overtightening (cracks orifice or manifold)
- Not leak testing
- Forgetting pilot orifice

10.4 Ignition Systems

Modern appliances use various ignition methods to light burners safely and efficiently.

Standing Pilot

Operation:

- Small pilot flame burns continuously
- Ignites main burner when valve opens
- Thermocouple or thermopile proves flame
- Traditional system

Components:

Pilot Burner

- Small orifice (typically #55-#60 drill)
- Pilot flame directed at thermocouple
- Must remain lit continuously

Thermocouple

- Generates millivolts when heated
- Provides power to hold pilot safety valve open
- Typically 20-30 millivolts required
- See Chapter 10.5 for details

Pilot Safety Valve

- Electromagnet holds valve open
- Thermocouple powers magnet
- If pilot out, magnet releases, valve closes
- Prevents gas flow without flame

Standing Pilot Characteristics

Advantages:

- Simple and reliable
- No electricity required
- Proven technology
- Easy to relight

Disadvantages:

- Wastes gas (burns continuously)
- Heat loss
- Lower seasonal efficiency
- Not permitted on some high-efficiency equipment

Relighting Procedure:

1. Turn gas control to "OFF", wait 5 minutes
2. Turn to "PILOT"
3. Push and hold pilot button
4. Light pilot with igniter or match
5. Hold button 30-60 seconds
6. Release button pilot should stay lit
7. Turn to "ON" position
8. Set desired temperature

Intermittent Pilot Ignition (IPI)

Operation:

- Pilot lights electronically only when needed
- Spark ignites pilot
- Pilot ignites main burner
- Pilot extinguishes when main burner off
- Saves gas vs. standing pilot

Components:

Ignition Control Module

- Electronic controller
- Times ignition sequence
- Monitors flame
- Safety lockout if fails

Spark Generator

- Creates high-voltage spark (10,000+ volts)
- Ignites pilot
- Similar to car spark plug

Spark Electrode

- Positioned at pilot
- Gap to ground (typically 1/8")
- Creates arc to ignite pilot

Flame Sensor

- Flame rod (rectification)
- Or thermocouple
- Proves pilot lit before opening main valve

IPI Sequence and Characteristics

Sequence:

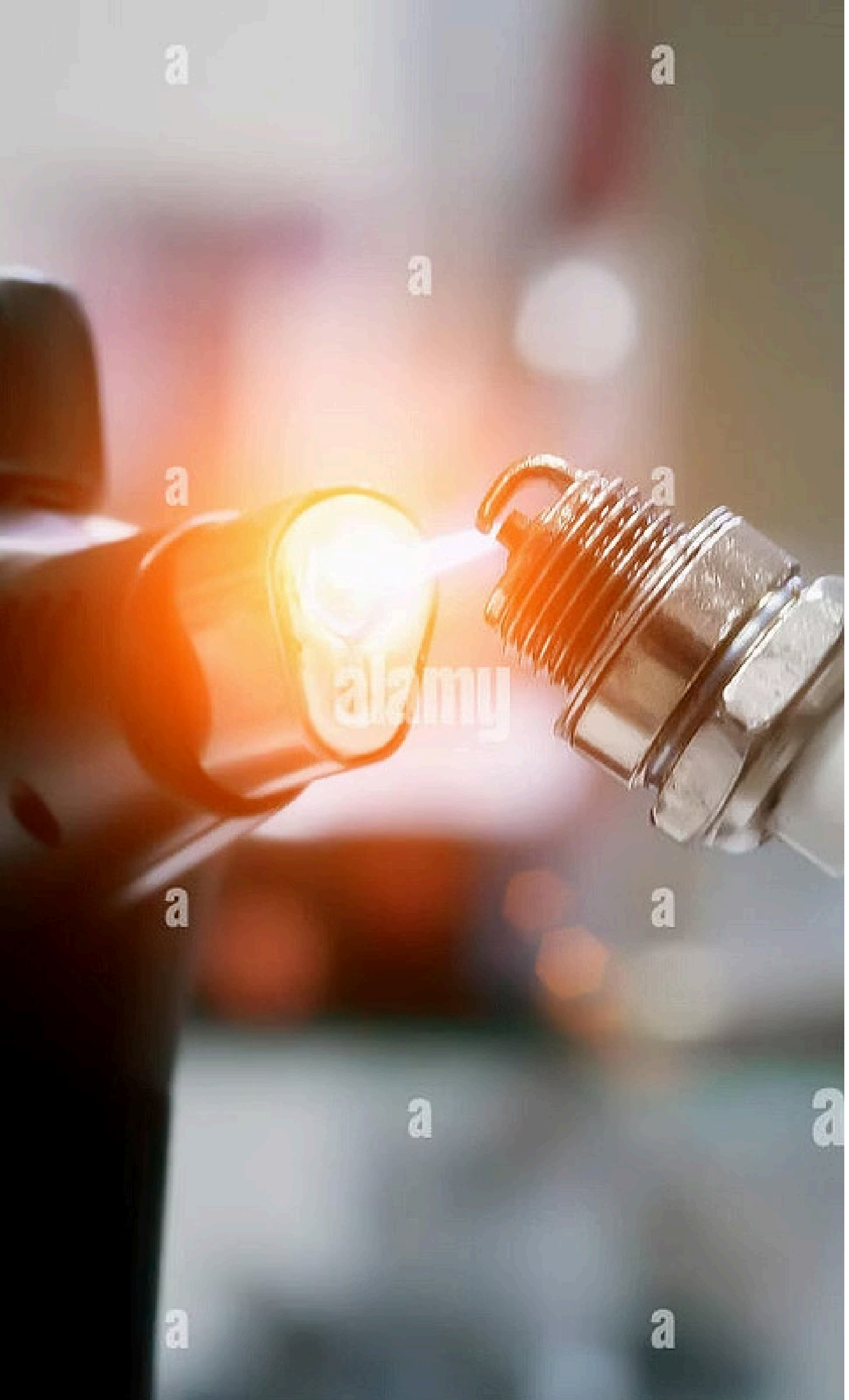
- **Call for heat**
- **Module energizes spark and gas valve (pilot)**
- **Pilot ignites (typically 5-7 seconds)**
- **Sensor proves pilot lit**
- **Main valve opens**
- **Main burner ignites from pilot**
- **Spark stops**
- **When satisfied, main valve closes, pilot extinguishes**

Advantages:

- Saves gas vs. standing pilot
- Automatic ignition
- No pilot outage problems
- Safer than standing pilot

Disadvantages:

- Requires electricity
- More complex than standing pilot
- Electronic components can fail
- More expensive



Direct Spark Ignition (DSI)

Operation:

- Spark directly ignites main burner
- No pilot flame
- Most efficient ignition
- Common in modern equipment

Components:

Ignition Control Module

- Electronic controller
- Provides high-voltage spark
- Monitors flame
- Safety timing and lockout

Spark Electrode(s)

- At main burner
- Creates spark directly to burner ports
- Gap critical (typically 1/8" to 3/16")
- One or multiple electrodes

Flame Sensor

- Flame rectification rod
- Separate from spark electrode (usually)
- Proves main burner lit
- Immediate sensing

DSI Sequence and Characteristics

Sequence:

01

Prepurge (induced draft fan runs)

02

Spark begins

03

Gas valve opens (pilot or main)

04

Flame ignites from spark

05

Flame sensor proves ignition

06

Spark stops

07

Normal operation

08

Safety lockout if no flame

Advantages:

- No pilot gas waste
- Fastest ignition
- Highest efficiency
- Fewer components than IPI

Disadvantages:

- Spark electrodes wear
- Gap maintenance required
- More sensitive to improper combustion
- Electronic failure potential

Hot Surface Ignition (HSI)

Operation:

- Silicon nitride or silicon carbide element heats electrically
- Glows bright orange (2,500°F)
- Ignites gas directly when valve opens
- No spark

Components:

Hot Surface Igniter

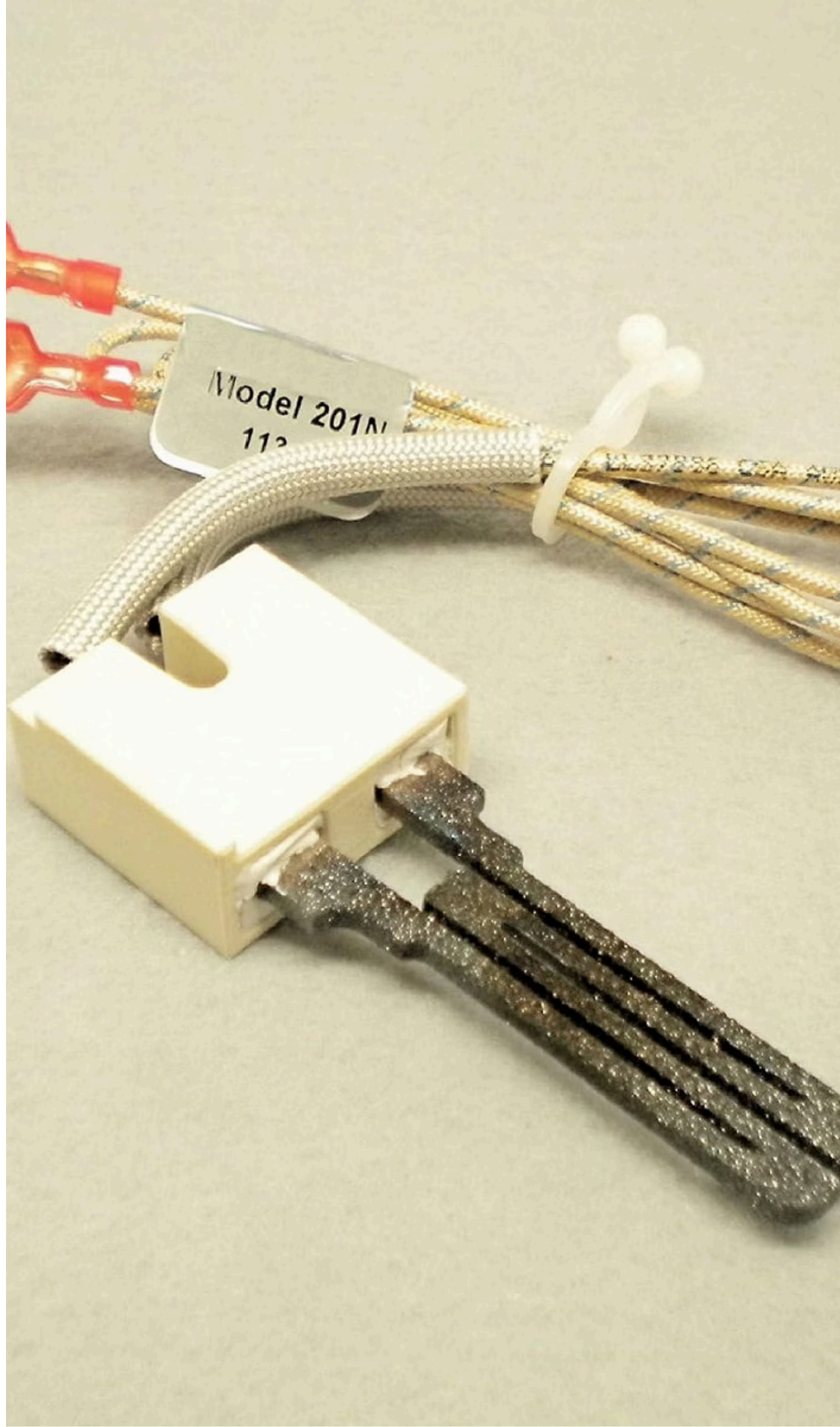
- Ceramic element
- Glows bright orange when energized
- Very fragile
- Positioned in gas path

Ignition Control

- Times warm-up period
- Opens valve when igniter hot
- Monitors flame
- Safety lockout

Flame Sensor

- Often igniter itself (senses current change)
- Or separate flame rod
- Proves ignition



HSI Sequence and Characteristics

Sequence:

01

Prepurge (if applicable)

02

Igniter energized (30-90 seconds warm-up)

03

Control confirms igniter hot

04

Gas valve opens

05

Gas ignites instantly from hot igniter

06

Flame sensor confirms

07

Igniter remains energized (most systems) or de-energizes

08

Normal operation

Advantages:

- Very reliable ignition
- No pilot gas waste
- No spark maintenance
- Quiet (no spark noise)
- Long service life (if not damaged)

Disadvantages:

- Fragile (easily broken if touched)
- Warm-up time delay
- Requires replacement when failed
- Cannot be repaired
- Higher current draw than spark

Handling HSI:

- NEVER touch ceramic element with bare hands (oils cause failure)
- Handle by ceramic base only
- Use gloves if must touch
- Very fragile breaks easily
- Replace if cracked

10.5 Flame Sensing

Flame sensing devices verify ignition and prove flame presence for safety.