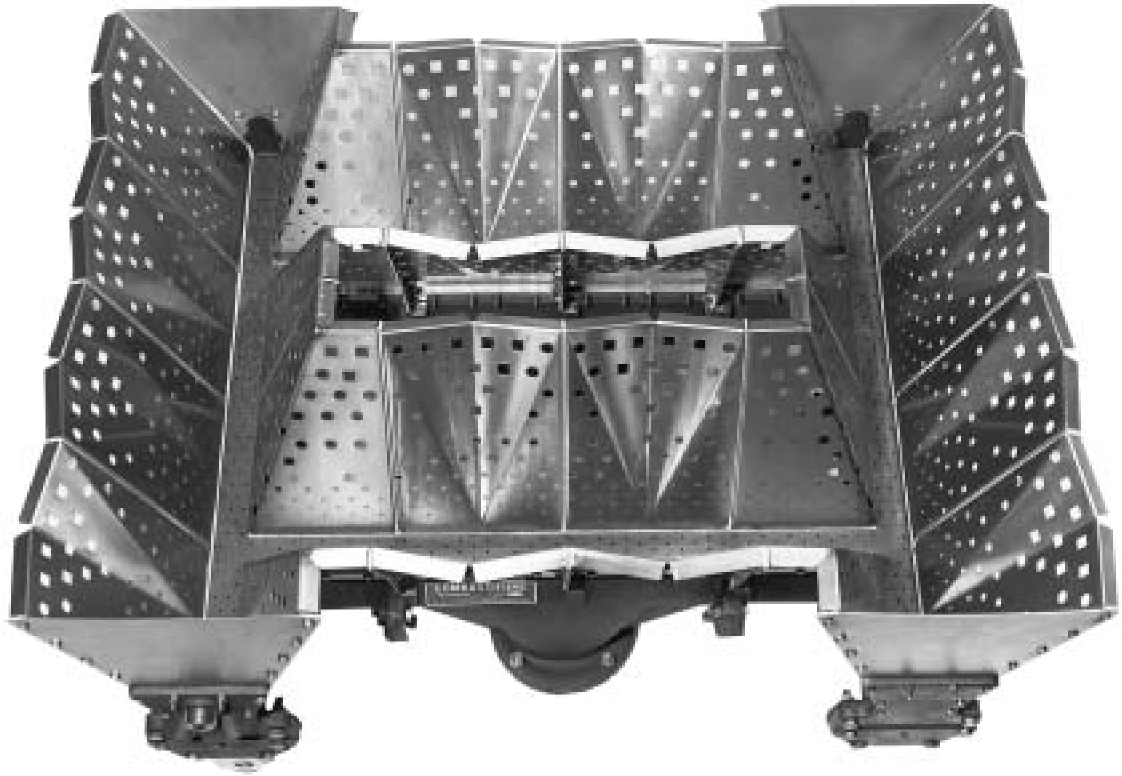
COMBUSTIFUME® Line Burners



8 ft. Series CF5D COMBUSTIFUME® Burner assembly

- **For direct-fired fume incineration** and higher temperature process air heating applications
- **Modular burner design** provides burner assembly configurations and total heat release for maximum application flexibility
- **COMBUSTIFUME® Burner provides stable, efficient, raw gas operations** in air streams with oxygen levels as low as 16% (by volume), or with inlet temperatures up to 1050°F (566°C)
- **Burns clean and odor-free with low levels of NOx production**
- **When air stream oxygen content is low,** primary combustion air may be added through the COMBUSTIFUME® Burner system to produce combustion of most clean gaseous fuels
- **Fume incineration costs are minimized** by direct firing COMBUSTIFUME® Burner in the effluent air stream
- **12 different varieties of COMBUSTIFUME® Line Burners available,** each optimized in materials and/or performance factors to match your specific application requirements

Covered by U.S. Patents #25,626; #3,297,259 and #4,573,907; Canada #786,136 and #786,137; Great Britain #943,733

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Design and Application Details

Principle of Operation

COMBUSTIFUME® Line Burners are designed for heating high temperature process air in motion and consist of a rust-resistant ductile iron or aluminum bronze body (which serves as the raw gas or air/fuel manifold), drilled to discharge the fuel/gas mixture between diverging stainless steel or Hastelloy-X mixing plates.

The entire burner assembly is mounted inside your duct directly in the air stream being heated. The air stream passes across the burner and through the mixing plates and is used as additional combustion air, particularly at the higher firing rates. Carefully controlled mixing plate aeration patterns give progressive mixing, superior cross-ignition and flame retention across the entire burner assembly length.

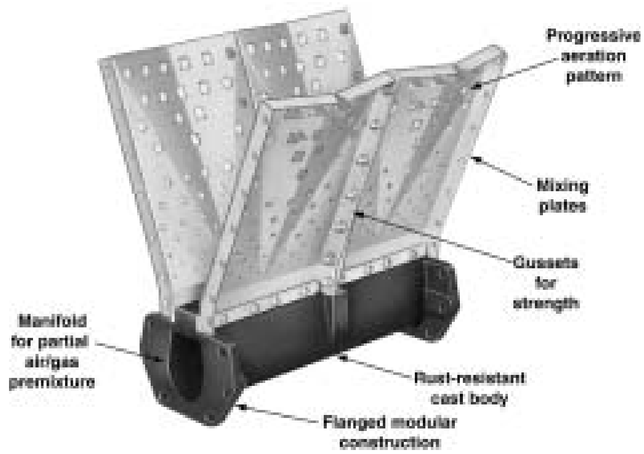
Air velocities and the resulting duct static pressure drop are the key to successful operation. They are established by the use of a customer-installed profile plate within the duct. A minimum profile width of 6" is required surrounding all COMBUSTIFUME® Burner assemblies.

Optimum burner performance and maximum service life demand that air stream velocities be uniform across the entire burner assembly.

Normal capacities vary widely with application. Fuel used and design velocities affect turndown. Modular design permits shape and total heat release to match application needs.

Performance data varies depending upon temperature of air upstream and downstream of burner assembly, the percent of oxygen (by volume) in the passing air stream, and the allowable duct static pressure drop (which relates to velocity of air across the COMBUSTIFUME® Burner).

Several varieties of COMBUSTIFUME® Burners are offered. Each type is optimized for a specific type of application. All varieties can be used when a partial air/gas premixture is required and are intended for use in heating process air-in-motion where high temperatures and/or lower air stream oxygen content are involved.



- **CF4D COMBUSTIFUME® Burners** have ductile iron bodies and #310 stainless steel mixing plates. Four different versions are available, either for raw gas burner applications, or for those requiring a partial air/gas premixture system and/or outlet temperatures up to 1500°F (816°C).
- **CF5D COMBUSTIFUME® Burners** complement their ductile iron bodies with Hastelloy-X mixing plates as above for applications with up to 1700°F (927°C) outlet temperature requirements.
- **CF5B COMBUSTIFUME® Burners** have an aluminum bronze body casting with Hastelloy-X mixing plates for use with applications requiring up to 1700°F (927°C) outlet temperatures with incoming temperatures up to 1050°F (566°C).

Typical applications include:

Adhesive tape curing	Brake lining ovens
Coffee roasters	Coil-coating lines
Core ovens	Cupola furnace stacks
Fat rendering	Fiberglass curing
Lithographing ovens	Meat smokehouses
Metal-coating ovens	Operating room exhaust
Packing house effluents	Paint-baking ovens
Paint removal facilities	Plastic curing ovens
Printing presses	Roofing paper machine hoods
Solvent degreasing	Textile dryers
Turbine exhaust reheat	Varnish burn-off
Varnish kettles	Vinyl sponge curing
Wire enameling	

Design Considerations

To properly select the appropriate type COMBUSTIFUME® Line Burner to meet your specific application requirements, these four factors must first be determined:

1. **Percent (by volume) of oxygen** remaining in air stream to be heated
2. **Allowable duct static pressure drop**, which is a direct relationship to the velocity of air across the burner and/or profile plate
3. **Air stream temperatures** approaching and downstream of the COMBUSTIFUME® Burner
4. **Type of fuel** to be fired through the burner

Oxygen content and temperature of effluent/air stream dictates how and which COMBUSTIFUME® Line Burner must be applied. Flammability of a raw gas burner is affected by oxygen content, air stream temperature and moisture content. Since a typical application for COMBUSTIFUME® Burners would involve an air stream temperature of 700°F or higher, air streams with measured oxygen levels above 16% (by volume) will normally support combustion by a raw gas burner and not require additional primary combustion air. However, if measured oxygen content in air stream is less than 16% or air stream temperature is less than 500°F, a percentage of partial premixed gas/air may be required to supplement the lower oxygen levels in your system for a complete combustion reaction to occur. Please refer to the Air Stream Flammability Chart on this page for the exact oxygen requirements of effluent/air streams.

Elevated air stream temperatures approaching a COMBUSTIFUME® Burner can be as high as 1050°F (566°C). This naturally causes changes in air density and net air velocities, and results in an effect on COMBUSTIFUME® Burner performance.

The combination effect of lower inlet temperature and lower oxygen levels will normally require a partial percentage of premixture be added through the COMBUSTIFUME® Burner system.

This combination effect (or air stream flammability) is graphically illustrated in the chart at right.

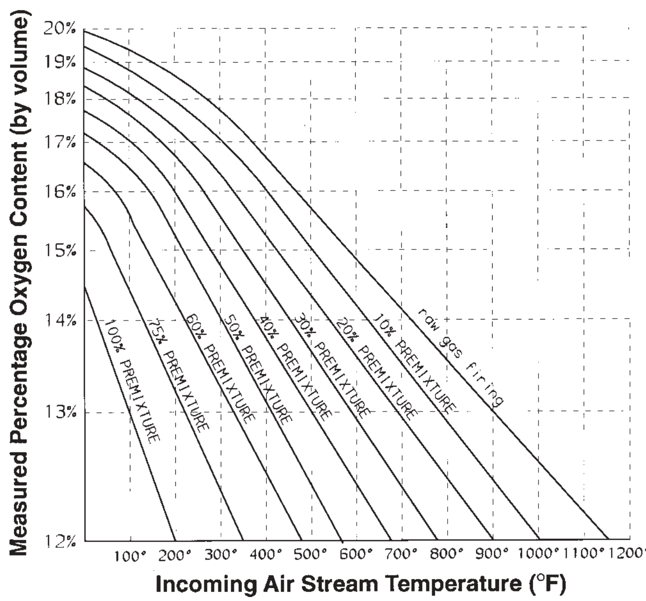
Since oxygen content within the air stream is critical to the flammability range of a COMBUSTIFUME® Burner, it also directly affects the maximum capacity (Btu/hr per lineal foot) of the burner assembly.

Any combination of temperatures and oxygen levels falling **above** the raw gas firing diagonal line should support combustion with a raw gas COMBUSTIFUME® Burner system.

Any combination of incoming temperature and measured percent of oxygen falling **below** the diagonal line will normally require the designated percentage of premixing through a COMBUSTIFUME® Burner system.

> Notice: When primary combustion air is supplemented in the system, a corresponding work load increase must be factored into the gross heating requirement to heat the fresh combustion air being introduced.

Air Stream Flammability Chart



Performance Selection Data

General

Air stream velocity and resulting pressure drop affect performance of COMBUSTIFUME® Burner systems. This velocity across and through your burner's mixing plates must be kept uniform and within desired limits by use of a (customer fabricated) silhouette profile plate through which the burner fires. A minimum 6" profile plate should be installed surrounding the interior duct walls at the leading edge of your burner's mixing plates.

Optimum design operating velocity ranges are shown in preceding pages. The most accurate readings for velocities (in SFPM) are as measured with a velometer (or pitot tube) directly in the duct at the plane of the profile plate and leading edge of your burner's mixing plates.

Since COMBUSTIFUME® Burner systems are installed in such widely diversified applications, it is often difficult to get into the chamber/duct and profile plate area to obtain the velocity pressure readings described above. For this reason, a close approximation of operating velocities may be made with a measurement of **duct static pressure drop**. Preferably, a static pressure test point one duct diameter in distance **upstream** from the profile plate and one duct diameter length **downstream** will give an approximation of operating velocity across the burner.

These static pressure drops relate to velocity (in SFPM) as shown in Table 1 below.

CAUTION: Do not try to take a differential static pressure reading from a test port at or near an elbow in the duct or chamber due to potentially erroneous readings caused by turbulence set up within the duct at such points. Measure in a straight duct with at least one duct diameter in length before and after the profile opening.

For lower temperature rise applications, determine profile opening area by adding burner displacement area (ft²/section) from page 5705 to net free area of your duct:

$$\text{Net free area of duct (ft}^2\text{)} = \frac{\text{Fan volume (SCFM)}}{\text{Velocity (SFPM)}}$$

NOTE: Various duct size/profile area relationships may give slightly different field site data than is shown in static pressure chart below.

Table 1: Velocity (SFPM) relative to static pressure drop ("wc)

Approximate air stream velocity at burner profile plate (SFPM)	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**
Duct static pressure drop through profile opening ("wc) [1]	0.1	0.2	0.4	0.6	0.9	1.2	1.6

[1] Based on profile/burner plane K factor of 0.8. May vary with your specific duct size/profile area relationship

Design and Application Details

COMBUSTIFUME® Line Burner Design Parameters

COMBUSTIFUME® Burner Type	Maximum Temperature Limits	Maximum Discharge Temperature	Maximum Static Pressure Drop
CF4D	1000°F (538°C)	1500°F (816°C)	2" wc
CF5D			2.5" wc
CF5D		1700°F (927°C)	2" wc
CF5B	1050°F (566°C)		

Minimum capacity is 150,000 Btu/hr per lineal foot of COMBUSTIFUME® Line Burner for "raw gas" burner systems.

Differential gas pressure (the difference between gas pressure inside COMBUSTIFUME® Burner manifold and the combustion chamber static pressure) **required in burner at maximum firing rates is shown in table below.**

For raw gas firing in air streams where oxygen level exceeds 16% (for 24 hole drilling pattern)

Maximum Capacity 1000's Btu/hr per lineal ft.		500	600	700	800	900	1000
Differential Gas Pressures (inches wc)	**Natural**	2	2.9	4	5.2	6.6	8
	Propane	0.8	1.2	1.6	2.1	2.6	3.3

Effluent air streams with oxygen levels of 12% to 16% may be heated with COMBUSTIFUME® Burner supplied with a partial premixture of air and natural or propane gas.

A complete burner system to handle these difficult applications would include a COMBUSTIFUME® Burner assembly, Series "HG" Mixing Tube, MICRO-RATIO® Control Valve and a combustion air blower as shown below. Your Maxon representative can help you select from the broad range of options available.

Thermal expansion due to the high operating temperature of incineration units requires special care in manifold and combustion chamber design. Flexible connections between manifold and burner assembly inlets are recommended, and provision should be made in burner support to allow for growth with temperature.

Flame supervision by UV scanner is preferred, and must be used whenever effluent inlet temperatures exceed 600°F (316°C). Cooling or purge air to the scanner connection is recommended. Flame rods can be mounted through pilot assembly, but are limited to 600°F (316°C) effluent inlet temperature.

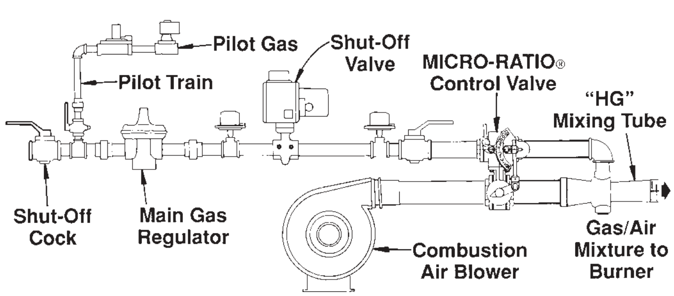
Observation and access are both important to a successful installation. Ability to view the flame from downstream of burner (particularly pilot location) greatly simplifies start-up and operating procedures, while access to upstream side of burner facilitates eventual maintenance.

Displacement area per section

For purposes of calculating operating air velocities and resulting static pressure drops across the burner assembly and profile plate, use the following equivalent displacements:

Each 6" straight section:	0.35 ft^2
Each 12" straight & 12B section:	0.7 ft^2
Each 12" x 6" tee section:	0.75 ft^2
Each 12" x 12" cross & BX section:	0.85 ft^2
Each 36" B H section:	1.5 ft^2

"HG" Mixing Tube System **for partial premixed COMBUSTIFUME® Burner system**



Maxon assumes no responsibility for the use or misuse of the piping layouts shown. Specific piping and wiring diagrams should always be submitted to the appropriate agencies for approval on each application.

Performance Selection Data

Series "HG" Mixing Tubes with partially premixed COMBUSTIFUME® Burner system in 12 – 16% oxygen level air stream applications

General Selection Procedure:

1. Determine available oxygen level in air stream to be heated.
2. Enter Table 1 under column with specific oxygen level for parameters of your application. Available oxygen level dictates combustion air and extra heat requirements for additional primary air flows.
3. Calculate gross heat requirement.
4. Determine burner footage and inlet feed requirements.
5. Select "HG" Mixing Tube size from Table 2 based upon the volume of combustion air required.

Table 1: Design Parameters

Percent of oxygen in effluent:	**12 to 12.9**	**13 to 13.9**	**14 to 15.9**
Required increase in gross heat release (Btu/hr)	10%	7.5%	5%
Maximum heat release per lineal foot of burner (Btu/hr)	700,000		1,000,000
Minimum heat release (Btu/hr) per lineal foot of burner	75,000		
Combustion air required through Series "HG" Mixing Tube (SCFM per lineal foot of burner)	47	41	34
Differential air pressure required (inches wc) as measured between burner inlet and duct/chamber static pressure	8	6.4	5.5

Example:

- Required heat release of 7,000,000 Btu/hr
- For system measured with 13.5% oxygen in air stream

From Table 1 (13 to 13.9%, middle column)

A. Gross heat required
7,000,000 x 1.075 = 7,525,000 Btu/hr

B. $\frac{7{,}525{,}000 \text{ Btu}}{700{,}000 \text{ Btu/ft}}$ = 10.75 ft. = 11 ft. of burner

C. $\frac{11 \text{ ft.}}{6 \text{ ft/inlet}}$ = 2 inlets

D. 11 ft. x 41 SCFM/ft = 451 SCFM primary air with differential pressure = 6.4" wc

From Table 2 (400 to 1167 SCFM)

E. Select 6" HG Mixing Tube with
12 each 29/64" gas orifices per Table 3

F. Select MICRO-RATIO® Control Valve
– for 451 SCFM air = (27060 SCFH)
– for 7525 SCFH natural gas

Table 2: Series "HG" Mixing Tube Selection

"HG" Mixing Tube Size	**SCFM combustion air volume required at maximum through "HG" Mixing Tube**
2"	0 to 190
3"	90 to 260
4"	175 to 500
6"	400 to 1167
8"	880 to 2500

Table 3: Gas Orifice Drillings for Series "HG" Mixing Tubes
NOTE: Drillings below based on 2 PSIG inlet gas pressure (measured at "HG" Mixing Tube gas inlet)

Size of "HG" Mixing Tube (number of gas orifices in parentheses)	**For partially premixed systems**			
	Combustion Air Pressure measured at air inlet of "HG" Mixing Tube	**Gas Orifice Drillings** for Series "66" AIRFLO® and COMBUSTIFUME® Burners		
		for Natural Gas	**for Propane Gas**	**for Butane Gas**
2" HG (4)	6 & 8 osi	21/64"	I	F
3" HG (6)		21/64"	I	F
4" HG (8)		7/16"	T	R
6" HG (12)		29/64"	3/8"	T
8" HG (12)		35/64"	29/64"	7/16"

Performance Selection Data

Raw gas firing of COMBUSTIFUME® Burners in air streams with 16+% oxygen levels

Profiling for higher temperature applications

When calculating profile dimensions for COMBUSTIFUME® Burner systems in applications with higher inlet air temperatures, greater temperature rises, and/or variable air stream volumes, the air with elevated temperatures and densities must be considered.

Sample Calculations

A sample procedure for designing a raw gas COMBUSTIFUME® Burner system for a thermal fuel incinerator (with 16+% oxygen level) is provided below.

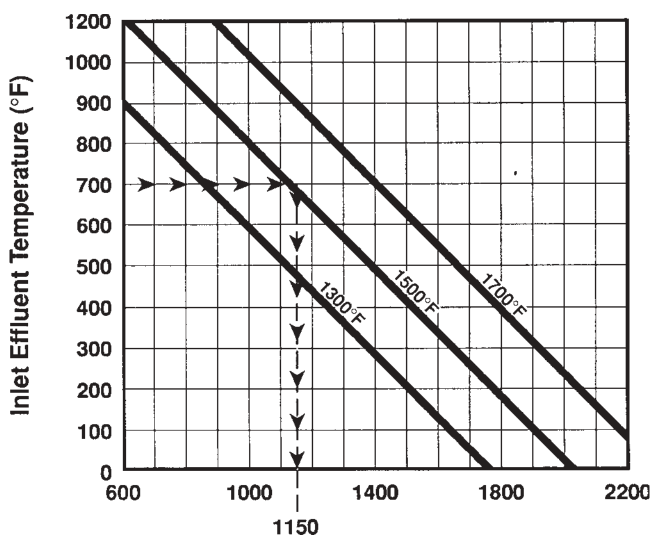
General Selection Procedure

1. **Determine available oxygen level in air stream to be heated.**
   For a raw gas application, we will use 16+% oxygen level.
2. **Determine the SCFM of air through the incinerator. Include any variations in this flow.**
   For our calculations, we will use a constant volume air fan of 5000 SCFM.
3. **Determine inlet temperature of effluent to COMBUSTIFUME® Burner.**
   We will use inlet temperature of 700°F.
4. **Determine outlet or discharge temperatures from the incinerator.**
   For our example, we will design for 1500°F.
5. **Determine the volume of any combustible hydrocarbons in the effluent air stream.**
   We will use 20 gallons of evaporated solvent per hour @ 110,000 Btu/gallon.
6. **Determine available gas pressure and its anticipated pressure drop through the control system's piping and valves.**
   For this example, we will use 5 PSIG natural gas supply pressure available; 3" wc pressure drop through control system; +3" wc static pressure in combustion chamber; 8" wc differential gas pressure required to burner and 14" wc gas pressure required from main gas regulator (at maximum burner firing rate).
7. **Calculate maximum total heat required**

Btu/hr = SCFM x "K"
(from step 2) (from chart below)

Multiply SCFM of air by multiplier (K), which combines hypothetical available heat at 1500°F and a 1.08 composite air heating factor to give the value in Btu required being "gross heating value" of fuel. Since multiplier (K) varies with inlet and discharge air temperature, the various factors are graphically shown below:

For 1300°F, 1500°F and 1700°F discharge temperatures



$$\text{Evolvement of "K"} = \left(\frac{\text{CFH gas}}{\text{SCFM air}}\right) \times 1000$$

Enter chart at 700°F inlet temperature line (from step 3); follow across to intersect the 1500°F discharge temperature sloped line, then drop straight down to read the "K" multiplier factor of 1150.

Therefore, maximum heat input required:

Btu/hr = 5000 SCFM x 1150 = 5,750,000

Performance Selection Data

Design procedure and calculation example *(continued)*

8. **Determine the COMBUSTIFUME® Burner footage**

   Divide the maximum Btu/hr (calculated in step 7) by 1,000,000 Btu/hr per lineal foot. Round-up to the nearest whole foot (if necessary).

$$\text{Required Burner Footage} = \frac{\text{5,750,000 Btu/hr (from step 7)}}{\text{1,000,000 Btu/lineal foot}}$$

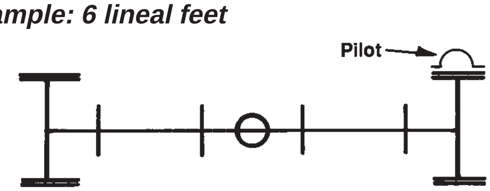
Required burner footage = 5.7 lineal feet

= (round-off to 6 lineal ft.)

9. **Lay out a proposed burner assembly using these general guidelines:**
   - A. Use as few tee sections as possible to conform to general shape of the combustion chamber.
   - B. Minimize use of cross or back inlet cross sections for general fume incineration applications, since they do not provide the same degree of exposure to the flame achieved by straight or tee sections.
   - C. If multiple burner rows are used, they should be placed on 12" centers to avoid need for between-the-row profile plate baffles.
   - D. **Do not** exceed 3,500,000 Btu/hr capacity for any **2" diameter end inlet flange.**
   - E. **2" diameter back inlet flange and INCINO-PAK® inlet feed section** should feed no more than 7,000,000 Btu/hr capacity.
   - F. **3" diameter back inlet flange** on "12B" section can feed up to a maximum of 10,000,000 Btu/hr, or 8,300,000 Btu with any 36BH section.
   - G. Keep burner assembly balanced and as symmetrical as possible around all inlet feeds.

   NOTE: Several possible burner arrangements could be devised. For this example, we will propose the burner layout illustrated below:

Example: 6 lineal feet



10. **Determine total burner displacement area** by adding the displacement area of all the individual sections (see page 5705)

    Area displaced by this assembly:

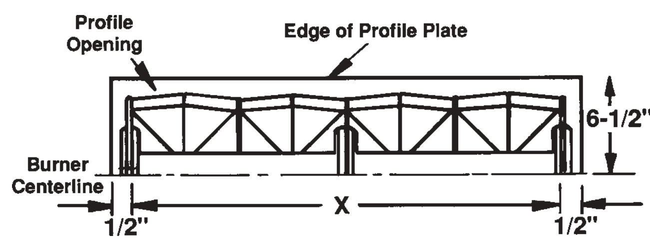
    (2) 12" x 6" tee sections @ 0.75 = 1.50 ft²

    (3) 12" straight sections @ 0.7 = 2.10 ft²

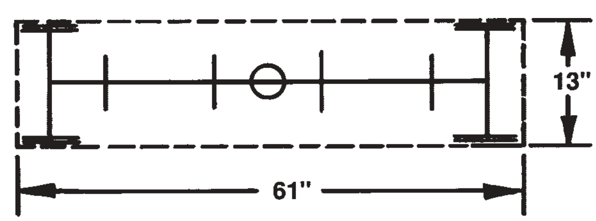
    Total Area = 3.60 ft²

11. **Determine dimensions of profile plate opening using these general guidelines:**
    - A. Profile opening should be 1" longer than nominal length of burner assembly (dimension X + 1" in the sketch below)
    - B. Edge of profile plate should be 6-1/2" from centerline of any "outside row" of castings

"Typical Configuration" Example:



Example: 6 lineal feet assembly



12. **Calculate gross area of profile plate opening**

$$\text{Sq. ft. area} = \frac{\text{inches length x inches width}}{\text{144 sq. in. / sq. ft.}}$$

If we assume a gross profile area of 13" x 61"

Gross area of opening in profile plate

$$= \frac{13'' \times 61''}{144\ in^2/ft^2} = 5.51 \text{ sq. ft.}$$

Performance Selection Data

Design procedure and calculation example *(continued)*

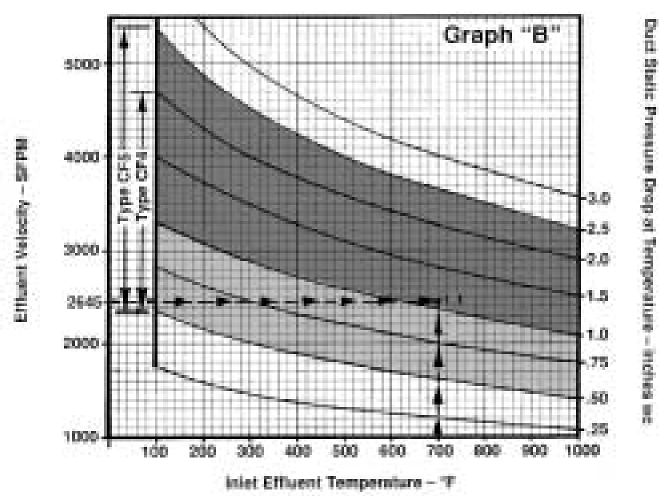
13. **Calculate the velocity of flow of the effluent over the burner and through profile opening**

$$\text{Velocity (SFPM)} = \frac{\text{SCFM (from step 2)}}{\text{Profile Area (from step 12)} - \text{Burner Displacement (from step 10)}}$$

Velocity of Effluent:

$$\text{SFPM} = \frac{5000\ \text{SCFM}}{5.51\ ft^2 - 3.62\ ft^2} = 2645\ \text{SFPM}$$

14. **Check the duct static pressure drop across the burner assembly and profile plate**
In Graph “B” below, check to see whether the velocity determined in step 13 and the inlet effluent temperature (step 3) result in a pressure drop within the shaded (acceptable) area.
Conditions in the shaded area are permissible.



Optimum pressure should be in the 1 - 1.5" range.

– **If the pressure drop is too high,** the profile opening must be increased.

– **If the pressure drop is too low,** the profile opening must be reduced.

NOTE: Chart is based on tight profiling. If sizeable gap is maintained around burner, pressure drop will be less than indicated in Graph “B”.

Pressure drop across burner and profile plate (refer to Graph “B”)

(2645 SFPM @ 700°F) = 1.1" wc drop

It would be better to change the opening to 12-1/2" x 60", which would increase pressure drop as follows:

$$\text{Area} = \frac{12.5'' \times 60''}{144\ in^2/ft^2} = 5.21\ ft^2$$

$$\text{SFPM} = \frac{5000}{5.21 - 3.62} = 3200$$

Pressure drop = 1.9" wc

15. **Check the minimum Btu/hr per lineal foot required**

$$\text{Btu/hr per foot} = \frac{\text{Maximum heat (from step 1)} - \text{Btu/hr available from solvent (from step 5)}}{\text{Footage of burner (from step 8)}}$$

$$\text{Minimum Btu/hr per ft.} = \frac{5{,}750{,}000 - (20\ \text{gal.} \times 110{,}000)}{6\ \text{ft.}}$$

$= 591{,}667$

If above figure falls below 150,000 Btu/hr per ft., burner footage must be reduced and/or a compromise of other design parameters must be made. Our example is well above the 150,000 limit, so the turndown range of a standard COMBUSTIFUME® Burner system should be adequate.

16. **Select the proper type COMBUSTIFUME® Burner from these general guidelines:**

Type of COMBUSTIFUME® Burner: With inlet effluent temperature of 700°F, discharge temperature of 1500°F, and a pressure drop of approximately 1.9" wc for burner assembly selected:

COMBUSTIFUME® Burner Type	Maximum Inlet Temperature	Maximum Discharge Temperature	Maximum Static Pressure Drop
CF4D	1000°F (538°C)	1500°F (816°C)	2" wc
CF5D			2.5" wc
CF5D		1700°F (927°C)	2"
CF5B	1050°F (566°C)		

Use Type CF4D COMBUSTIFUME® Burner

Capacity/Selection Data

Based on capacity information given in this catalog section, and within the constraints of duct size and air volume flows, a COMBUSTIFUME® Burner assembly is designed utilizing these available sections shown on the following pages.

When ordering a burner assembly made up from these available module components, be sure to provide an assembly sketch of the complete burner (as viewed from the back, or upstream, side), including locations of all accessories and/or individual component sections.

All open ends of burner assembly must be closed off with one of the end closures or pilot assemblies shown on the following pages. Any end plate ports not used must be plugged.

Air stream velocity and resulting static pressure drop affect performance and are achieved by means of a silhouette profile plate within the duct.

A minimum profile plate width of 6" is required surrounding all COMBUSTIFUME® Burner assemblies.

Burner inlet feed piping must be adequate to provide a well-distributed flow of air/gas throughout the burner assembly. Burner assembly layout should be symmetrical and balanced with relation to inlet feed sections.

Do not exceed the capacity feed limitations shown in the table below.

Raw gas firing capacity limitations for inlet feed sections

<table>
<tr><th colspan="2">COMBUSTIFUME® Burner</th><th rowspan="2">Maximum Btu/hr per inlet</th></tr>
<tr><th>Inlet Pipe Size (NPT)</th><th>Burner Section</th></tr>
<tr><td rowspan="3">2"</td><td>End inlet flange set</td><td>3,500,000</td></tr>
<tr><td>12" straight (12B)</td><td rowspan="2">7,000,000</td></tr>
<tr><td>INCINO-PAK® (12B & 36B)</td></tr>
<tr><td rowspan="3">3"</td><td>36" back inlet (BH)</td><td>8,300,000</td></tr>
<tr><td>12" straight (12B)</td><td rowspan="2">10,000,000</td></tr>
<tr><td rowspan="2">12" x 12" cross (XB)</td></tr>
<tr><td>4"</td><td>12,000,000</td></tr>
</table>

Inlet flanges bolt directly to burner body casting and accept threaded NPT piping. Chart above shows maximum lineal feet of COMBUSTIFUME® Burner that may be fed by a given inlet flange.

COMBUSTIFUME® Line Burner Designation

The designation of each COMBUSTIFUME® Burner section identifies specifics about that section.

Example: **12" x 12" bk inlet section CF 5 – BX – D – 24**

Section Description

CF = COMBUSTIFUME® Burner
IP-CF = INCINO-PAK® Burner

Mixing Plate Material
4 = #310 stainless steel
5 = Hastelloy-X

Section Code
6 = 6" straight section
12 = 12" straight section
T = 12" x 6" tee section
X = 12" x 12" cross section
12B = 12" back inlet straight section
BX = 12" x 12" back inlet cross section
BH = 36" back inlet "H" section

Body Material
D = ductile iron body
B = aluminum bronze body

Number of (#30) drilled holes per lineal foot
24 = 24 holes (0.3113 in²/ft) discharge area
48 = 48 holes (0.6226 in²/ft) discharge area [1]
96 = 96 holes (1.2451 in²/ft) discharge area [1]
120 = 120 holes (1.5564 in²/ft) discharge area [1]

[1] These drill patterns available for special applications such as low Btu/fuels and partial premixing system

Performance Selection Data

INCINO-PAK® Burner Inlet Feed Sections

INCINO-PAK® Burner sections are special configurations of 12" or 36" back inlet feed sections. They provide “outside-the-duct” access to the raw gas pilot, ignitor, and flame safeguard components, eliminating lateral duct wall connections.

INCINO-PAK® Burner sections are designed to feed COMBUSTIFUME® Burner elements in end-fired incinerators or preheaters with cylindrical combustion chambers, or when burner is fired at an elbow in the ductwork.

INCINO-PAK® Burner sections can be used alone (with appropriate end plates and accessories added), or as an inlet feed section in a larger COMBUSTIFUME® Line Burner assembly.

All INCINO-PAK® Burner sections contain a 2" (NPT) gas inlet connection which may be used to feed up to a maximum capacity of 7,000,000 Btu/hr.

Heat release and gas pressure requirements match those of the other COMBUSTIFUME® sections. The **raw gas pilot** capacity is 25,000 Btu/hr.

WARNING: Pilot gas should be interrupted once main flame is established. UV sight tube must be sealed against any scanner cooling air used.

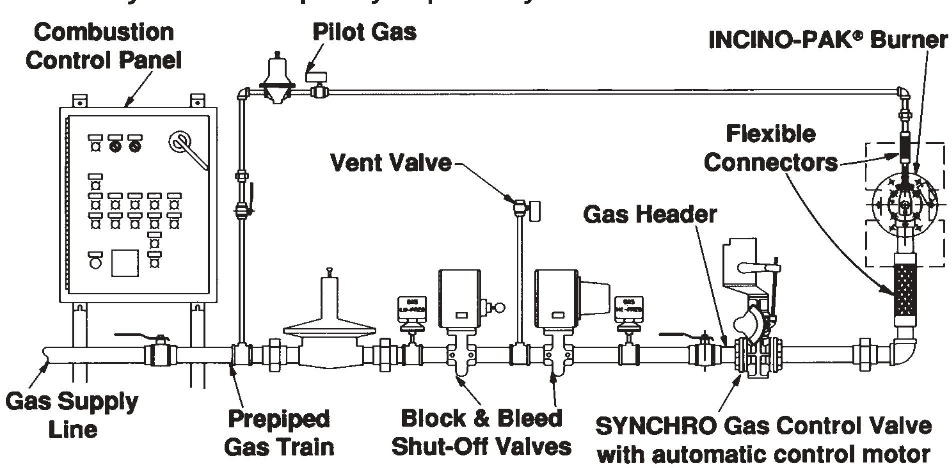
36" back inlet “H” INCINO-PAK® Burner section shown with (4) COMBUSTIFUME® Burner end plates; includes spark ignitor, pilot gas adjustable orifice cock, raw gas pilot, and arranged for mounting of customer’s UV scanner

Three manifold lengths are offered in both the 12B and 36B back inlet INCINO-PAK® Burner sections:
Series 600 = 600 millimeter (23.8") length
Series 800 = 800 millimeter (31.5") length
Series 1100 = 1100 millimeter (43.3") length

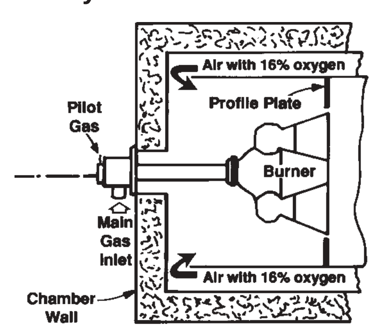
This **“manifold length”** reflects the distance between the outside duct mounting wall and the centerline of the COMBUSTIFUME® Burner casting. See catalog page 5712 for specific dimensions.

Each INCINO-PAK® Burner section includes a spark electrode, adjustable pilot gas orifice, body gasket, and provision for your UV scanner.

Typical block & bleed piping layout for raw gas INCINO-PAK® Burner system as frequently required by insurance authorities



Typical installation in cylindrical incinerator

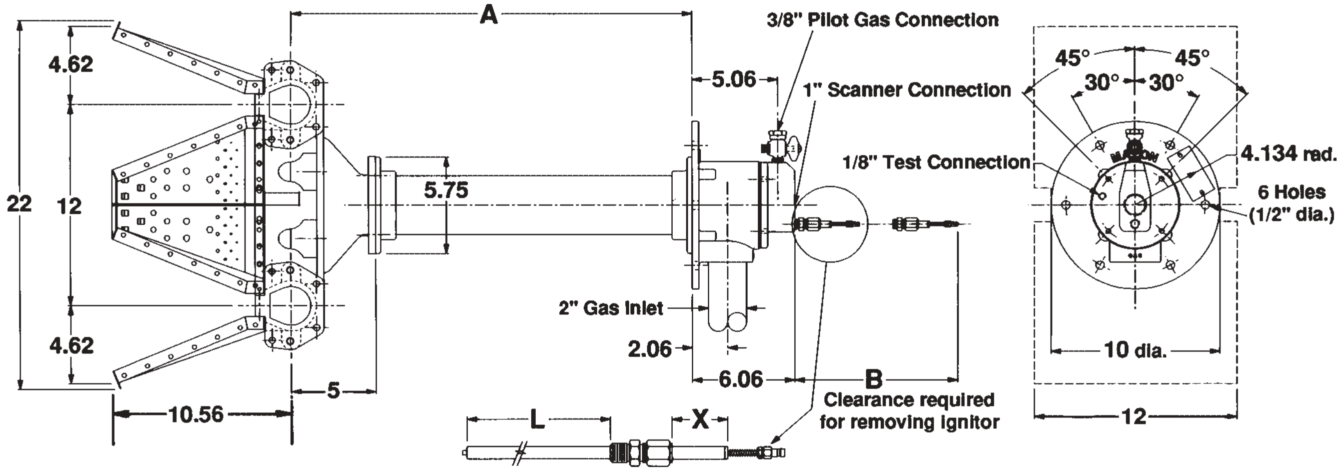


Maxon assumes no responsibility for the use or misuse of the piping layout shown. Specific piping and wiring diagrams should always be submitted to the approproate agencies for approval on each application.

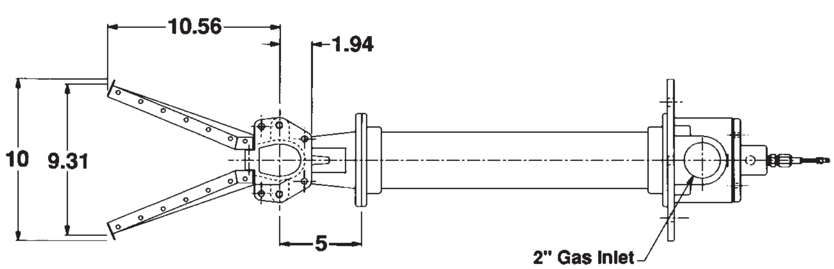
Dimensions (in inches)

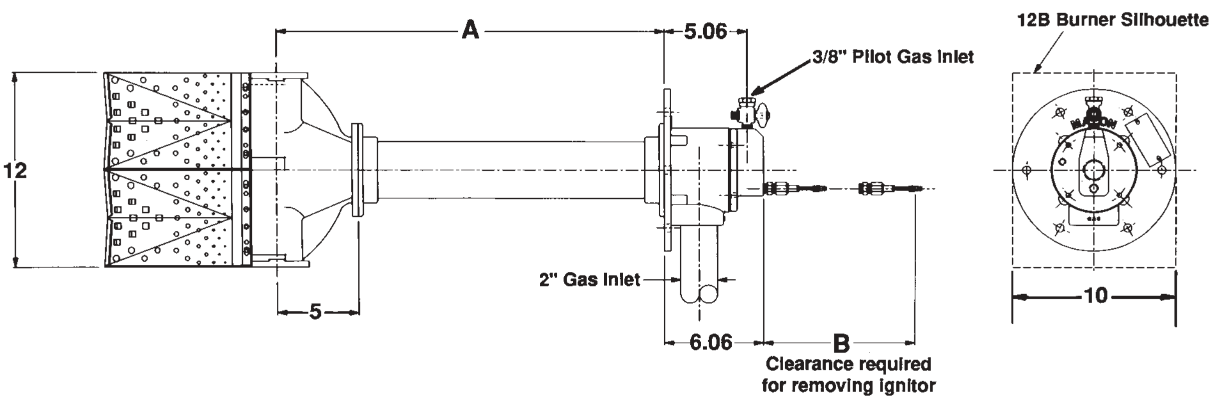
INCINO-PAK® Burner Back Inlet Sections

36" back inlet “H” section



12" back inlet “12B” section





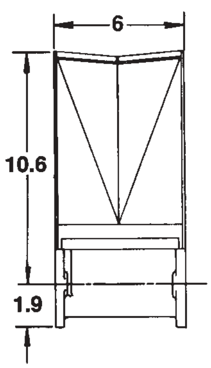
Series	A	B	L	X
600	23.81	37.25	31.65	1.5
800	31.5	45.25	39.34	1.75
1100	43.31	56.25	51.15	1

Pipe threads on this page conform to NPT (ANSI Standard B2.1)

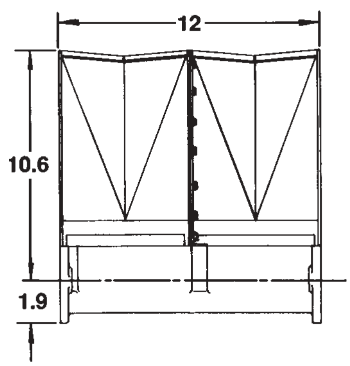
Envelope Dimensions (in inches)

Modular Burner Sections

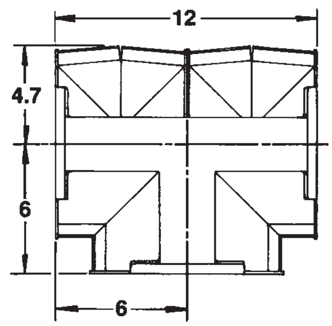
6" straight section



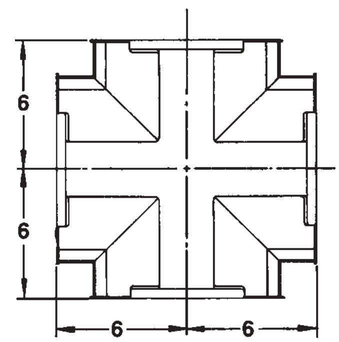
12" straight section



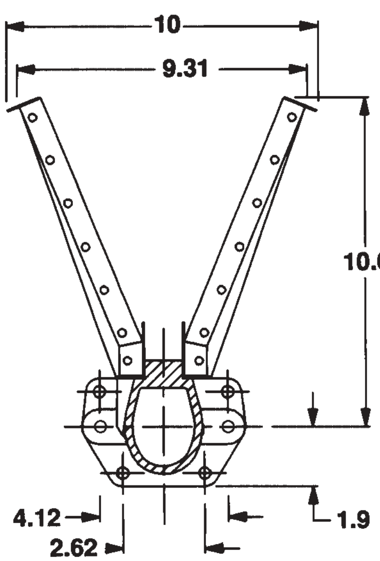
12" x 6" tee section



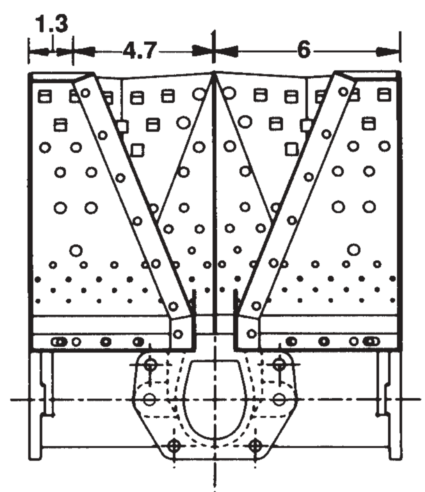
12" x 12" cross section



Typical End Views



Straight Sections

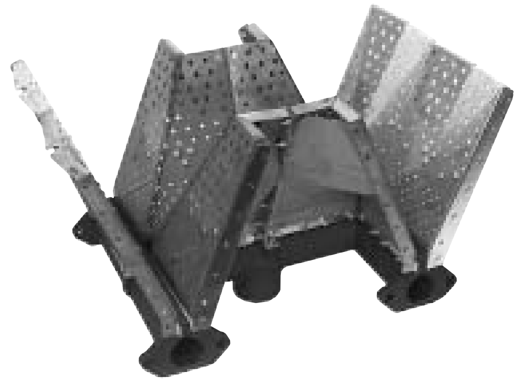


Tee and Cross Sections

Envelope Dimensions (in inches)

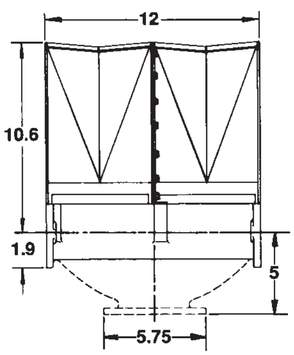
Modular Inlet Feed Burner Sections

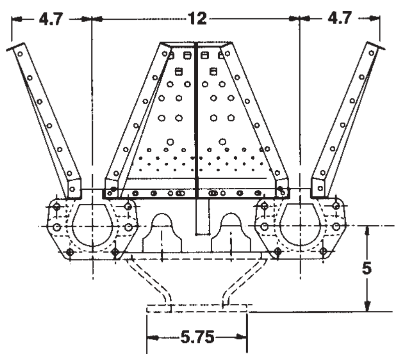
12" back inlet section

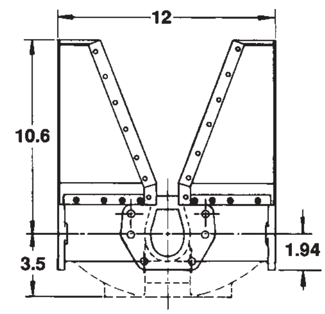


36" back inlet section

12" x 12"
back inlet cross







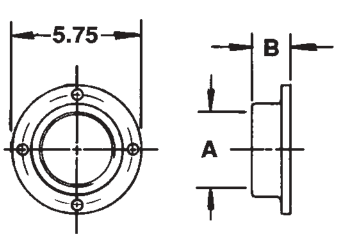
NOTE: 12B, 36B and XB back inlet sections must be ordered with one of the back inlet flange sets shown below.

Back Inlet Flanges

Flange Sets for 12" & 36" Back Inlet Sections

2"
LFB

3"
LFB

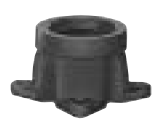


A (size)	B
2	0.88
3	1.25

Inlet flanges bolt directly to burner casting and accept either standard NPT or standard ISO threaded piping of indicated size.

NOTE: Refer to page 5710 for specific inlet feed capacity limitations.

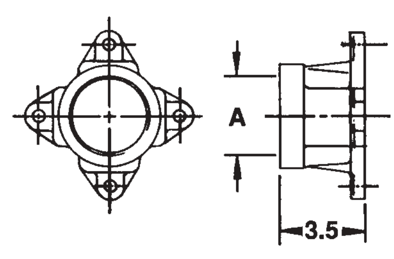
Flange Sets for 12" x 12" Back Inlet Cross Sections



3"

4"

A (size)
3
4



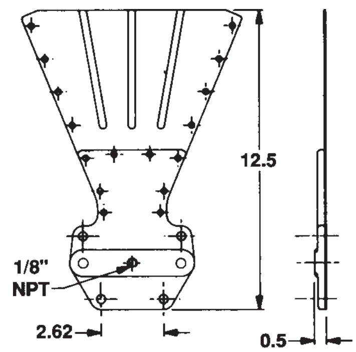
Envelope Dimensions (in inches)

End Closures and End Inlet Flange Sets

All open ends of a burner assembly must be closed off with one of these end closures, or with a pilot end plate or pilot assembly as shown below and on page 5716.

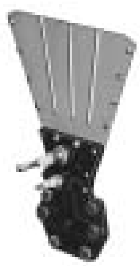
Plain end plate set

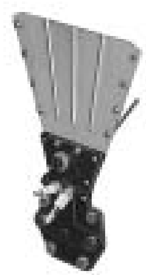
Plain end plate closure includes 1/8" NPT test connection



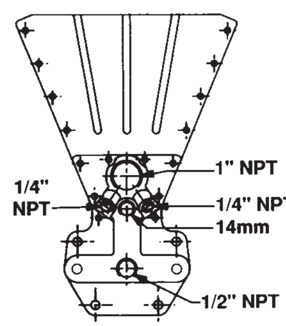
Pilot end plate set

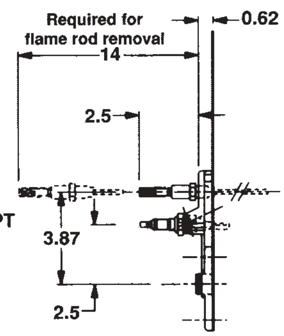
UV scanner can be mounted through straight-in flame rod location. 1" tap is bushed to 1/4" for flame rod.





Alternate flame rod position

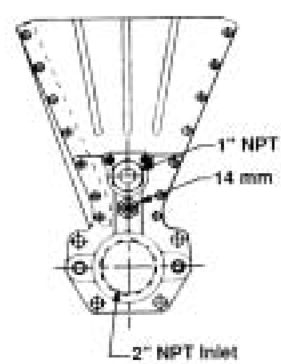


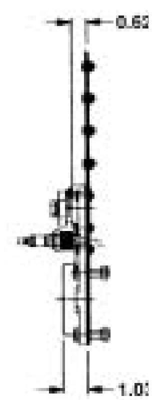


Flame rods (if used) must be ordered separately with all pilot end plate sets.

Inlet pilot set

UV scanner can be mounted through straight-in flame rod location. 1" tap is bushed to 1/4" for flame rod.





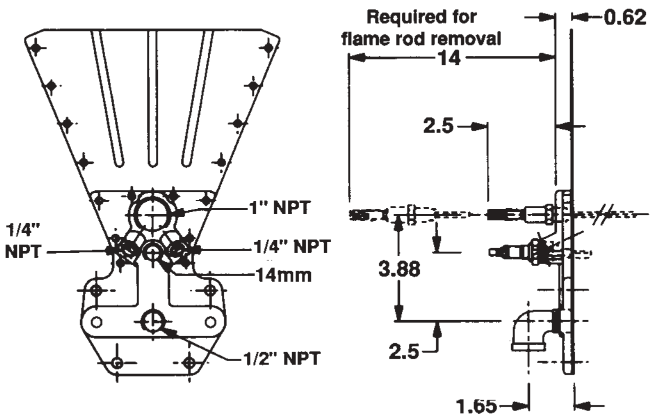
NOTE: See catalog page 5710 for specific inlet feed capacity limitations.

Envelope Dimensions (in inches)

Pilot Assemblies

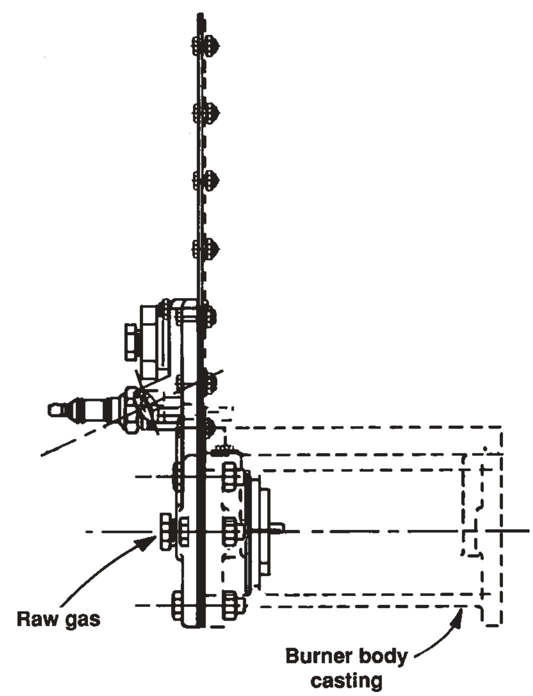
Built-in pilot arrangements

Direct mounted version includes 14mm spark ignitor. Order electrode separately for externally mounted version. Order flame rod (if used) separately.

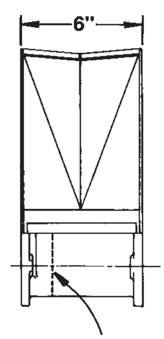


NOTE: Built-in pilot assemblies must mount **only** where COMBUSTIFUME® Burner sections provide for the segmented gas chamber within the burner body casting. See sketches below relative to possible locations for built-in pilot assemblies.

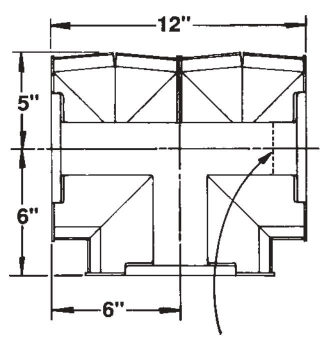
Built-in pilot detail



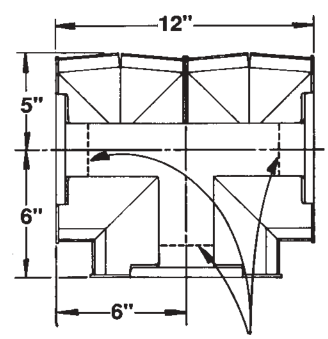
Optional external mounting assemblies shown on page 5718



All 6" straight sections, whether gray iron, ductile iron, or aluminum bronze, can accept built-in pilots on **one** end.



Aluminum bronze 12" x 6" tee section can accept built-in pilot only on **right end** of straight 12" side (when viewed from back side of the assembly).

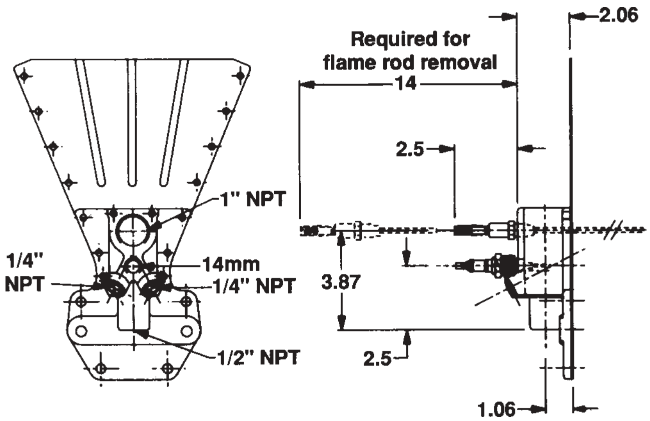


Ductile iron 12" x 6" tee sections can have built-in pilot assembly mounted on **any** end.
NOTE: Gray iron tee sections do not accept built-in pilot assemblies.

Envelope Dimensions (in inches)
Pilot Assemblies

AIRFLO-PAK pilot arrangements

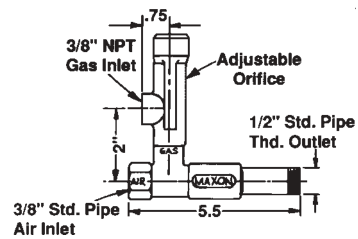
Direct mounted version includes 14mm spark ignitor. Order electrode separately for **externally mounted** version. Order flame rod (if used) and pilot mixer separately.



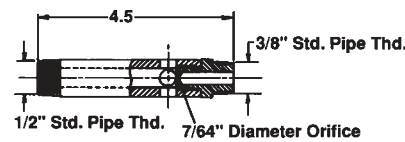
Optional air/gas pilot mixers

for all COMBUSTIFUME® Burner AIRFLO-PAK pilot assemblies

Pressure type with adjustable orifice

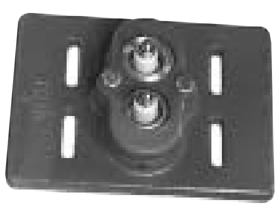


Atmospheric type with fixed orifice



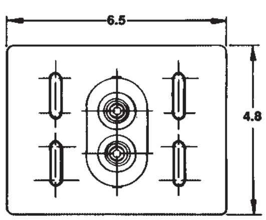
External Mounting Plate Assemblies

External mounting plate details – A plate is included with all assemblies shown on page 5718

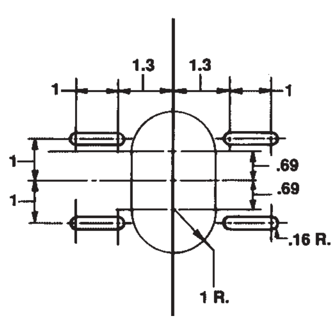


Mounting Plate with two (2) feed-through insulators for internal mounting of spark ignitor and flame rod. Same size external mounting plate used in all assemblies shown on page 5718.

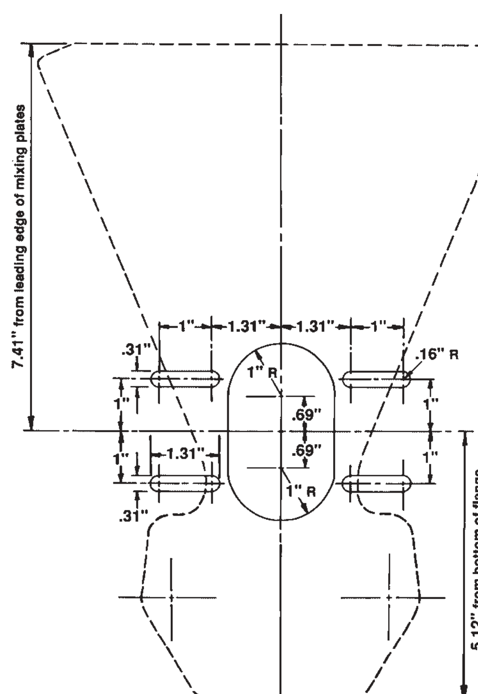
External mounting plate dimensions



Through-wall opening required



Positioning mounting plate in relation to AIRFLO® Burner pilot location

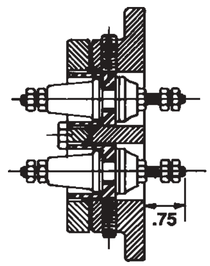


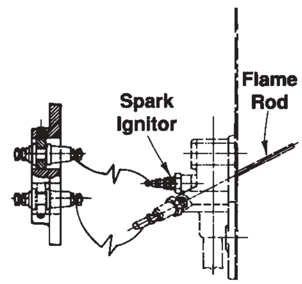
Dimensions (in inches)

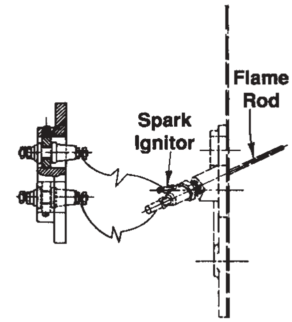
External Mounting Plate Assemblies

Description		As used with AIRFLO-PAK pilot assemblies	As used with built-in pilot assemblies

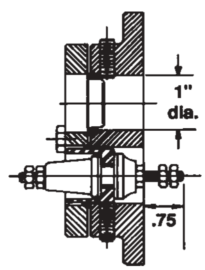
External mounting plate assembly for <u>internal</u> spark ignitor & <u>internal</u> flame rod

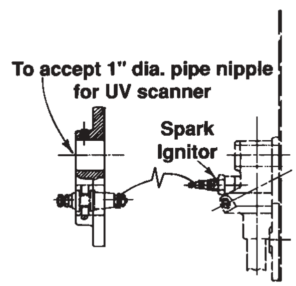


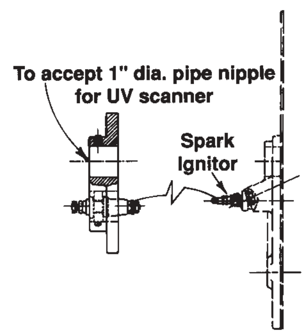




External mounting plate assembly for <u>external</u> UV scanner & <u>internal</u> spark ignitor



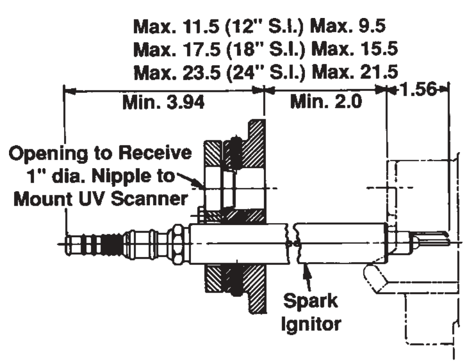


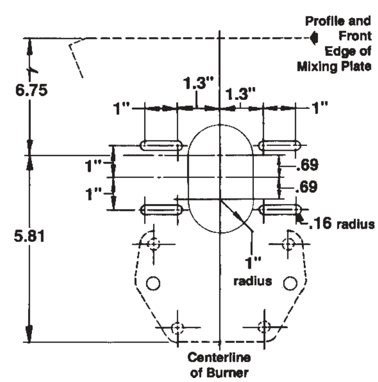


Description	

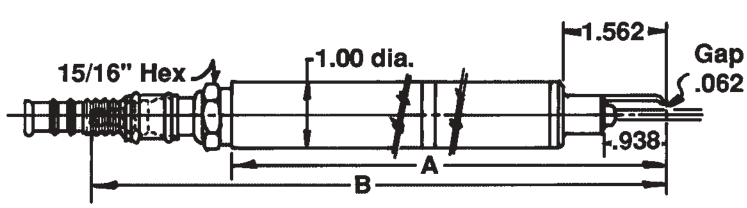
External mounting plate assembly for <u>external</u> spark electrode & <u>external</u> UV scanner

NOTE: Order optional spark electrode sub-assembly separately





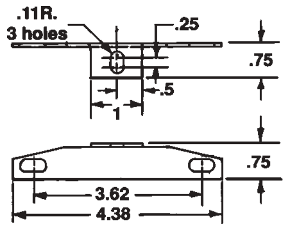
Optional external (shrouded) spark electrode for above



External electrode	12"	18"	24"	36"
Dimension "A"	12	18	24	34.437
Dimension "B"	13.781	19.781	25.781	36.170

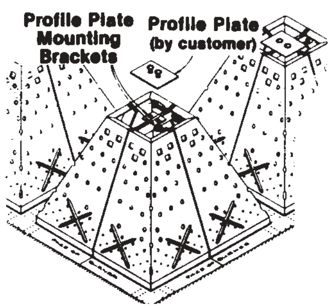
Accessory Dimensions (in inches)

Profile Plate Bracket

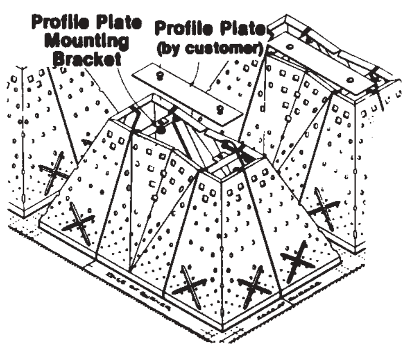


Provides support for profile within closed burner loop. On some applications, it may be necessary to restrict air flow between adjacent burner rows to achieve design operating velocities. This is done by installing customer-fabricated profile plates on profile mounting bracket(s). See **sketch 1** below for use on square openings (formed by adjacent cross-sections of burner). **Sketch 2** applies to rectangular opening.

1



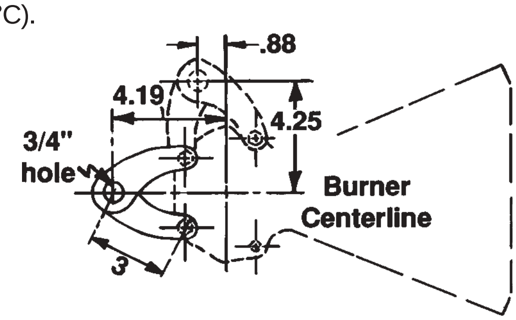
2



Universal support bracket

Normally used in pairs as shown below. Mount to burner assembly at any joint between sections.

Two versions available: zinc plated carbon steel for maximum inlet temperature up to 750°F (399°C) or #304SS for maximum inlet temperature up to 1600°F (871°C).

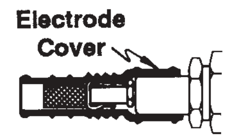


Division plate

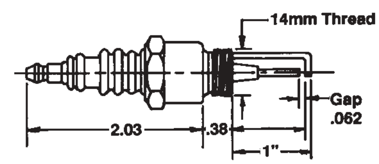
Provides isolation of burner feed(s) where desirable.

Optional electrode cover

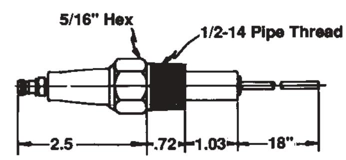
Protects porcelain insulator and electrical connection from dirt and moisture. May be used for ambient temperatures up to 450°F (232°C).



14mm Spark Ignitor

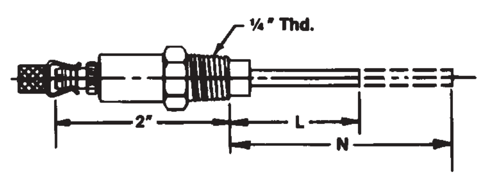


Spark Electrode



Flame rod identification

For those COMBUSTIFUME® Burners using flame rods, most applications are covered by one of three sizes (specific number depends on nominal length “N” of rod extension). These may need cut to dimension “L” specified in tables on page 9908A before use in your particular application.

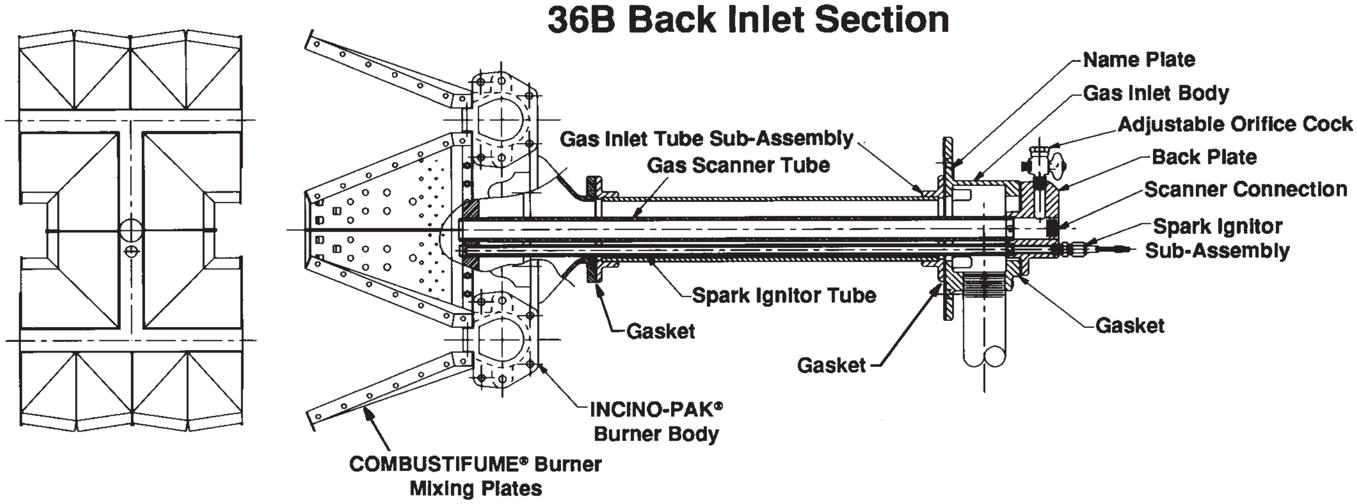


N
7-1/2"
12"
24"

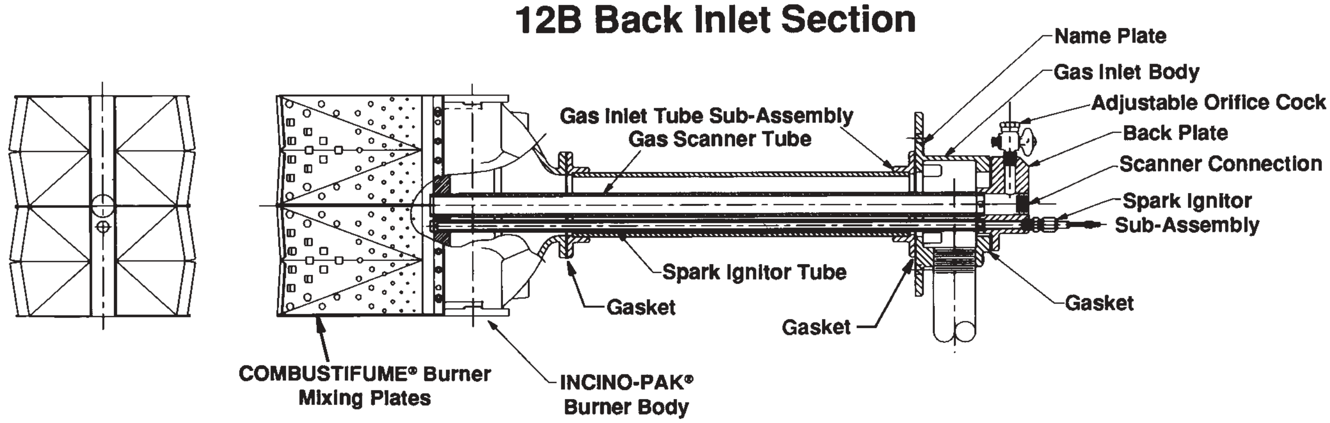
Component Identification

INCINO-PAK® Burner Back Inlet Feed Section

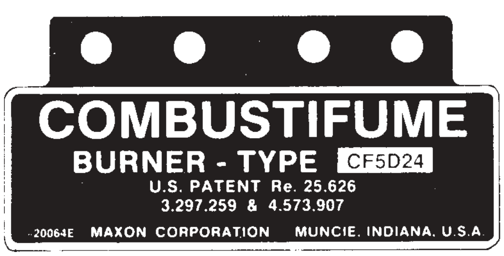
36B Back Inlet Section



12B Back Inlet Section



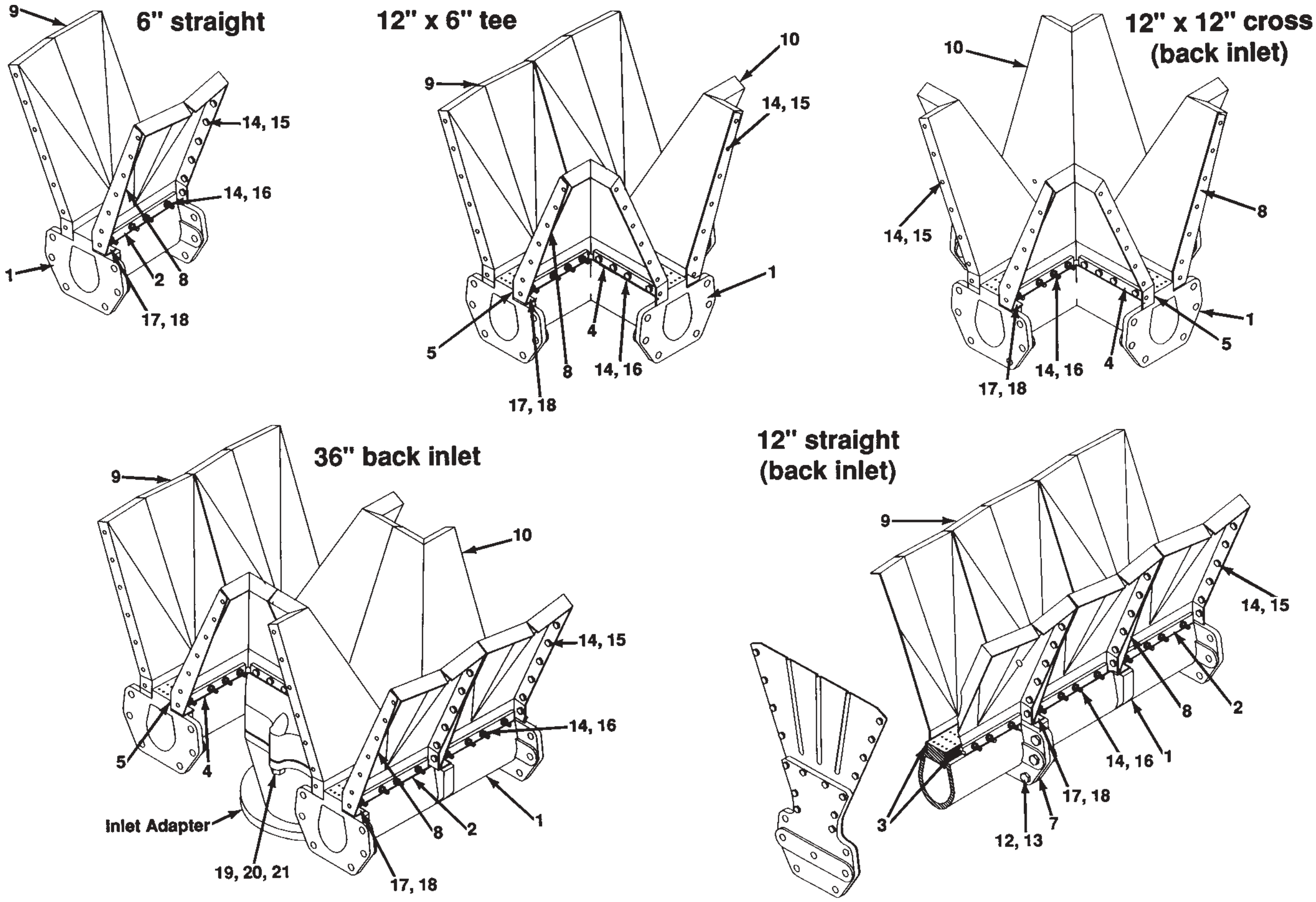
Nameplate located on COMBUSTIFUME® Burner body



Nameplate located on INCINO-PAK® Burner gas inlet body

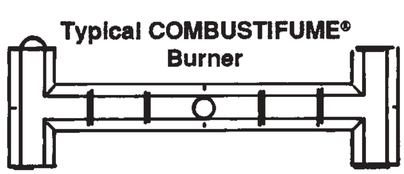
Component Identification

COMBUSTIFUME® Line Burners



To order replacement parts:

1. **Identify specific COMBUSTIFUME® series/type** from burner assembly information plate pictured on page 5720.
2. **Provide sketch of burner arrangement**, as viewed from back (or casting side) of assembly. For example:



3. **Specify quantity of each replacement item required** from table at right.

Item Number	Part Description
1	Burner body
2	Back up bar (straight)
3	Gasket, body (straight)
4	Back up bar (inside)
5	Gasket, inside
6	Back up bar (outside)
7	Burner body gasket (between joints)
8	Support bracket gasket 18 GA
9	6" mixing plate
10	Corner mixing plate
12	M10 - 1.5 x 45 hex head cap screw
13	M10 - 1.5 finished hex nut
14	#10 -24 FLEX-LOK hex nut
15	#10 -24 x 1/2" indented hex head machine screw
16	#10 -24 x 2-1/4" indented hex head machine screw
17	Washer
18	#10 -24 x 3/8" indented hex head machine screw
19	M10 - 1.5 hex nut finished
20	M10 - 1.5 x 35 hex head cap screw
21	1/4" -20 x 3/4" hex head cap screw

Notes

Installation Instructions

General

These mounting instructions for COMBUSTIFUME® Burners are in addition to the **general AIRFLO® Line Burner installation instructions** published on Maxon catalog pages 5000-S-1 through 5000-S-10.

Specific instructions are also offered for other Maxon component items:
– **Shut-Off Valves** (pages 6000-S-1 through S-14)
– **Flow Control Valves** (pages 7000-S-1 through S-4)
– **Mixing Tubes** (pages 3200-S-1 through S-6)

Read complete instructions before proceeding, and familiarize yourself with all the system's equipment components. Verify that your equipment has been installed in accordance with the original manufacturer's current instructions.

Clean fuel lines are essential to prevent blockage of pipe train components or burner gas ports. All dirt, scale and pipe dope should be blown out of any new gas line before actually connecting to the burner system.

Main gas shut-off cock should be upstream of both main gas regulator and pilot line take-off. Use it to shut off fuel to both pilot and main burner during shutdown periods of more than a few hours. **Maxon Control Valves, such as the Series "CV" and MICRO-RATIO® Valves, are not intended for tight shut-off.**

Main gas regulator is essential to maintain a uniform system supply pressure. A separate regulator should be provided in the branch leading to each burner system if more than one is served by a common main. Size regulator for full system capacity at required pressure, including pipe train losses and any positive chamber pressure. Follow the instructions attached to the regulator during installation.

Pilot take-off should be upstream of main gas regulator but downstream of main gas cock. It should normally include its own pilot gas regulator (selected to meet pilot flow and pressure needs), a solenoid valve and shut-off cock. An adjustable gas orifice at the pilot inlet simplifies adjustment.

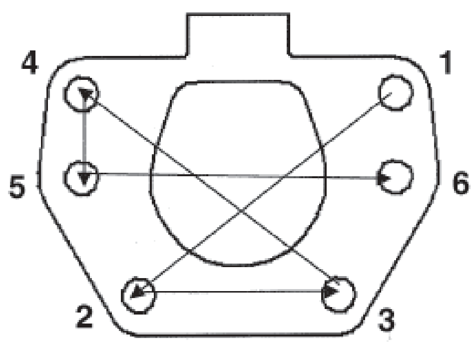
Appropriate pilots should be provided which are compatible with the type of burner and control system being used.

Fuel shut-off valves (when properly connected to a safety control system) shut the fuel supply off with a loss of electrical power. **Manual reset valves** require operator attendance each time the system is started up (or restarted after a shut-down). **Motorized shut-off valves** permit automatic start/restart when used with appropriate control system.

Test connections are essential for burner adjustment. At a minimum, they should be provided downstream of any mixing tube and at each burner inlet. Test connections should never be installed in elbows or pipe tees. **Test connections must be plugged except when readings are being taken.**

Bolt Torque Tightening

1. Apply Never-Seez (anti-seize and lubricating compound) to the threads of the bolts to improve the pre-loading of the gasket.
2. Tighten the bolts to 1/2 the specified value (see table below), starting at position 1 and working to position 6.
3. Tighten the bolts to the full torque value, starting at position 1 and working to position 6.
4. Tighten the bolts again to the full value starting at position 1 and working to position 6.



Torque Values

Bolt Size	Bolt Material	Torque Value	Units
M10	Plated steel	186	in lbs
M10	Stainless steel	248	in lbs
M10	High Alloy	45	ft lbs

Installation Instructions

INCINO-PAK® Burner Sections

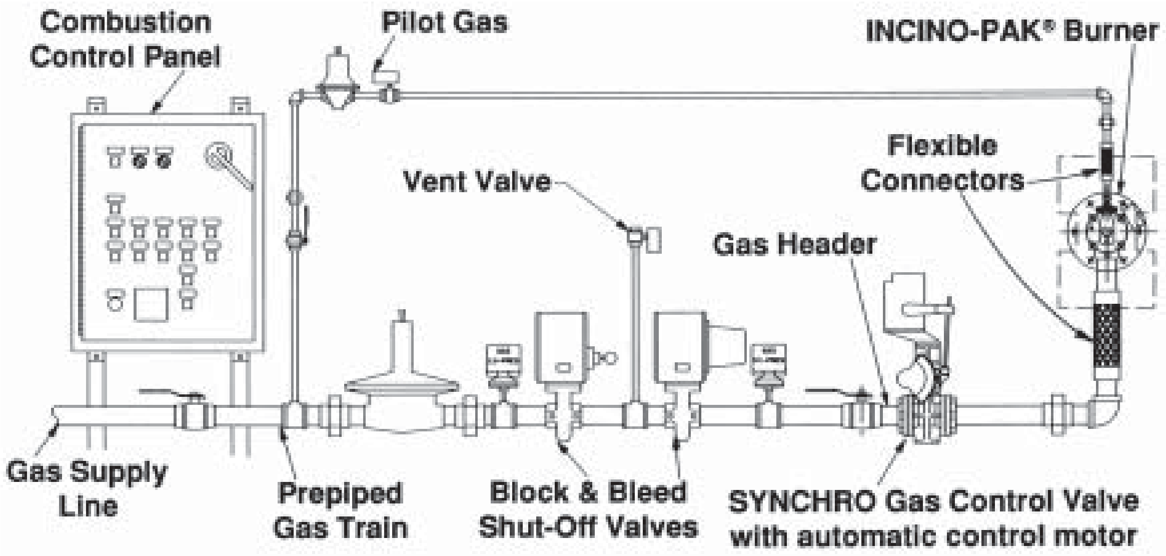
INCINO-PAK® Burner sections are special configurations of 12" and 36" back inlet feed sections designed to provide “outside-the-duct” access to the pilot, ignitor and flame safeguard components.

These sections are used in end-fired incinerators or preheaters, or when burner is fired at an elbow in the ductwork. As such, the mounting and installation of INCINO-PAK® Burner sections differs slightly from the other Maxon AIRFLO® Burners.

INCINO-PAK® Burner sections mount through the duct/chamber wall and extend the AIRFLO® Burner body and mixing plates out into the air stream. They must still be profiled in the duct, since velocity must be maintained just like all Maxon AIRFLO® Burners.

The externally mounted burner body housing remains on the outside of the duct/chamber.

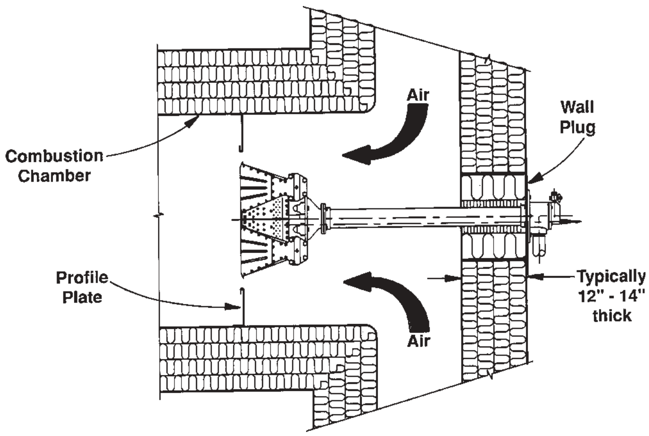
A typical INCINO-PAK® Burner system piping layout is illustrated in the drawing below:



Maxon assumes no responsibility for the use or misuse of the piping layout shown. Specific piping and wiring diagrams should always be submitted to the appropriate agencies for approval on each application.

Installation Instructions

INCINO-PAK® Burner Mounting

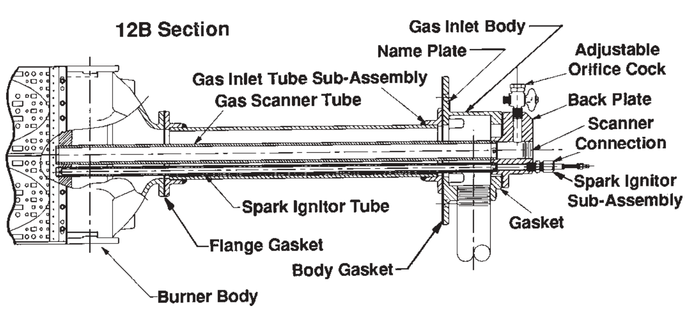


A typical method of through-wall mounting of INCINO-PAK® Burner is shown above. The INCINO-PAK® Burner's back housing is normally mounted and secured onto a separate "wall plug" that is large enough to allow the burner element to be inserted through the duct/chamber wall opening and center itself in the profile plate. The burner element's weight must be independently supported.

The "wall plug" is secured into the opening of the duct/chamber wall, positioning the burner element in the air stream, and providing a maintenance/inspection access port for the burner and combustion chamber.

The INCINO-PAK® Burner section can be used alone (with appropriate end plates, etc.) or as an inlet feed section in a larger COMBUSTIFUME® Burner assembly.

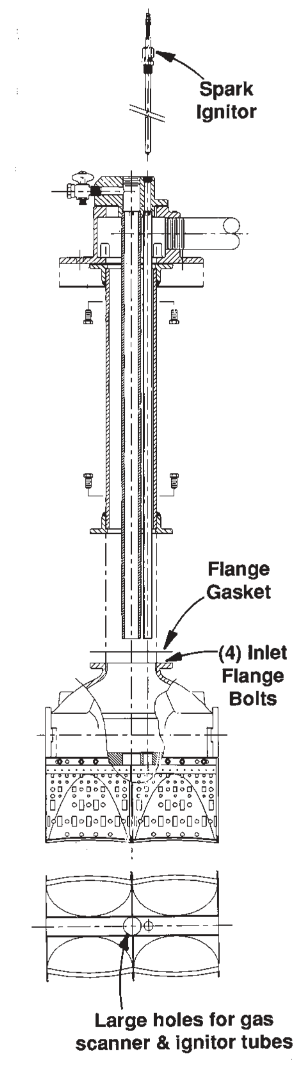
You must separate the INCINO-PAK® Burner body housing and gas scanner tube sub-assembly from the COMBUSTIFUME® Burner element, then re-assemble it after mounting in your duct/chamber.



CAUTION: Prior to attempting burner separation, completely remove the spark ignitor from the INCINO-PAK® Burner assembly. Replace ignitor only after INCINO-PAK® section is securely mounted.

Remove remaining (3) flange bolts from burner inlet flange. (Instruction packet is attached to this flange joint at time of manufacture.) Once the (4) body inlet flange bolts are removed, the burner element can be separated from the gas inlet tube sub-assembly by pulling gas inlet body out of burner element.

NOTICE: The gas scanner tube and spark ignitor tube must align themselves with the large holes in the burner body casting face.



This alignment and the inlet flange joint integrity must be maintained when burner is re-assembled.

Place large body flange gasket (shipped loose) onto gas inlet tube to seal body inlet flange and combustion chamber wall joint prior to mounting burner element and/or gas inlet burner body into position on your combustion chamber.

Provide a liberal coating of the high-temperature "Never-Seez" gasket paste (shipped loose) on both metal flange surfaces. Insert the 2" diameter inlet flange gasket (shipped loose) between these surfaces prior to re-assembling burner element and inlet tube sub-assembly.

NOTE: Wooden alignment dowels inserted through the large holes of the burner element face casting will help to remount and align the gas scanner tube and spark ignitor tube when re-assembling the burner assembly.

Raw Gas Burner Start-Up Instructions

Read complete instructions before proceeding, and familiarize yourself with all the system's equipment components. Verify that your equipment has been installed in accordance with the original manufacturer's current instructions.

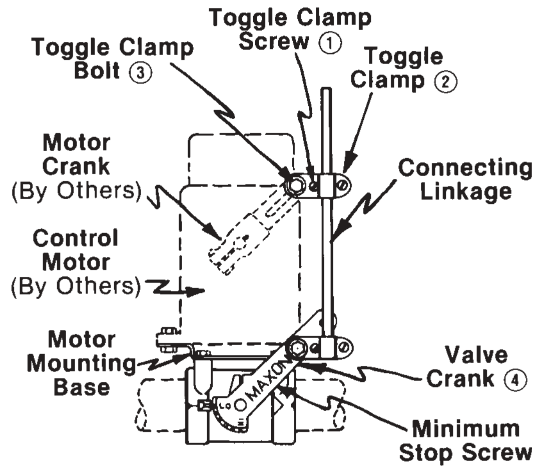
CAUTION: Initial adjustment and light-off should be undertaken only by trained and experienced personnel familiar with combustion systems, with control/safety circuitry and with knowledge of the overall installation. Instructions provided by the company and/or individuals responsible for the manufacture and/or overall installation of complete system incorporating Maxon burners take precedence over these provided by Maxon. If Maxon instructions conflict with any codes or regulations, contact Maxon Corporation before attempting start-up.

For initial burner start-up of raw gas burner system:

1. **Close all burner fuel valves or cocks**. Make preliminary adjustments to fuel gas regulators. Remove pilot and main gas regulators' adjusting screw covers. Turn adjusting screw down (clockwise) to approximately mid-position. Close pilot gas adjustable orifice screw by turning in clockwise until it stops. (Do not over-tighten.) Then back out the adjustable orifice (counter-clockwise) approximately 2-3 turns.
2. **Check all electric circuitry.** Verify that **all** control devices and interlocks are operable and functioning within their respective settings/ ranges. Be sure all air and gas manifolds are tight and that test ports are plugged if not being used.
3. **Check that all duct and chamber dampers are properly positioned** and locked into operating positions.

Initial start-up adjustment should only be accomplished during a "manual" burner control mode.

4. **Disconnect the automatic control motor's linkage from your MICRO-RATIO® Control Valve's operating crank arm (or from your Maxon Control Valve)** by loosening the control motor's connecting rod from the valve's toggle linkage. Manually set and secure control valve in its "minimum" position.



Typical Electric Control Motor with Series "CV" Control Valve

5. **Start all system-related fans and blowers.** Check for proper blower motor rotation and impeller direction. Verify that all control interlocks are working. Allow air handling equipment to run for adequate purge of your manifolds and combustion chamber plenums. With main gas shut off, manually advance MICRO-RATIO® Control Valve's operating crank to "high fire" position so that air only flows through burner and combustion chamber.

CAUTION: Do not by-pass control panel timers typically controlling sequential operations.

6. **To light and adjust gas pilot:** Pilot gas regulator should initially be set at approximately mid-point of its adjustment range. With pilot gas solenoid valve closed, open main fuel gas and pilot gas cock. Energize spark ignitor and open pilot gas solenoid. Observe pilot ignition through a sight port and/or by viewing micro-amp signal metered from flame safeguard relay circuit.

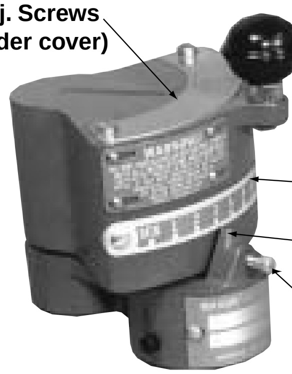
   Refine pilot setting for a hard blue flame (and/or strongest flame safeguard signal) by adjusting gas flow through pilot orifice and/or pilot regulator.
7. **Prepare to ignite main burner by adjusting main gas regulator** to approximately midpoint of its adjustment range. Linkage arrangement for the use of Series "CV" Gas Control Valve is illustrated above for a typical control motor. Arrange accordingly.

Raw Gas Burner Start-Up Instructions

8. **With control valve at "minimum", ignite main burner by opening main fuel shut-off valve.** Adjust main gas regulator to give the desired outlet pressure. Refine pilot adjustment if it has been affected. Adjust burner "minimum" by turning in on the minimum stop screw of the gas control valve until stable flame appears in the narrow zipper channel at the base of burner mixing plates.

   A good minimum fire should provide uniform flame across the entire burner face, contained within the zipper flame channel at the base of burner mixing plates. Any thin spots or gaps indicate uneven air velocity over the burner which must be corrected or a higher minimum fire established by continuing to turn in on the minimum stop screw.

   NOTE: If your Maxon COMBUSTIFUME® Burner was furnished with an adjustable gradient type Series "Q" or SYNCHRO Control Valve instead of a Series "CV" Valve, proceed to step 8A for specific instructions and differences in adjustment procedures.



   A. From step #5, the automatic control motor linkage has already been disconnected from your adjustable gradient type control valve and the valve is at its "minimum" position.
   B. Open fuel supply and begin adjustment of appropriate adjustable gradient valve by turning in minimum (or lowest numbered) screw until desired flame is achieved. (Main fuel regulator may need adjusted at this point.)
   C. Once your flame is established and refined at this position, and without advancing the screw carrier quadrant higher, screw all remaining screws down to at least the same level as your first adjusted screw.
      NOTE: A preliminary setting can be established with all the remaining adjusting screws. Generally, each succeeding screw needs to be screwed in approximately one full turn deeper than its preceding screw. A smooth "stair-step" gradient pre-set at this point from low to high will simplify the remaining adjustment steps.
   D. Without advancing the SYNCHRO Valve quadrant, screw down on second screw (one or two turns). Then slowly advance the SYNCHRO Valve quadrant to the #1 position. Refine flame appearance at this new position.
   E. Turn all higher-numbered screws in at least as far as the one last adjusted, then turn next one in as necessary to achieve desired flame while rotating valve mechanism to that position on indicator strip.
   F. Repeat for each remaining screw.
      NOTE: To avoid possible damage to cam strips, always turn all higher-numbered screws in as far as the one last adjusted.
   G. Refine adjustment as needed, always turning valve so that position indicator matches screw being adjusted. For more fuel, turn screw in (clockwise); for less fuel, turn screw out (counter-clockwise). If screws must be turned in flush with carrier casting, increase fuel pressure and re-adjust by starting at minimum over again.
   H. Cycle system off and on, and through all firing rates until satisfied with performance.
   I. Reconnect control motor linkage and check that operator does not "bind" and that all interlocks are performing properly.

9. **Adjust burner "high fire" by slowly rotating fuel control valve crank arm towards its maximum.** Observe flame characteristics carefully. Flame should remain a bright blue color with a length beyond the mixing plates as indicated in capacity/specification data. If flame becomes too long and yellow, gas pressure is too high and/or air velocity is too low.

Raw Gas Burner Start-Up Instructions

NOTE: Dust and/or chemicals entrained into passing air stream may affect physical color of flame. In this case, adjust burner for stable flame shape and geometry.

To measure gas pressure, connect water column (manometer) to the test connection in burner's end plate. **To determine air velocity**, use a velometer at the profile opening. Correct velocities by increasing or decreasing profile opening size.

If flame is too short, gas pressure may be too low and should be increased or velocities are too high and may need to be decreased. Note that air velocities should be measured only when the fan is handling air at the desired control temperature.

The desired maximum capacity may be achieved with less than full control valve opening. Mark with a pencil or scribe the point on valve crank arm where the desired maximum is obtained, then return crank arm to low position and shut system off.

10. **Referring to illustration on page 5700-S-4, reconnect control motor linkage** (with control motor in low or minimum position) by loosening toggle clamp screw ① and moving toggle clamp ② along the connecting linkage to a point where toggle clamp bolt ③ can be placed at the outermost position of control motor crank slot. Then tighten toggle clamp screw ①, thus fixing clamp to linkage.

    Allowing toggle clamp bolt ③ to slide in the crank arm slot, cycle control motor towards its maximum position and move fuel control valve crank ④ to the previously-determined maximum firing rate position. Tighten toggle clamp bolt ③, thus fixing clamp to motor crank.

    Cycle control motor back to minimum, watching carefully that it does not bind before reaching minimum.

    If it is stopped or if minimum is not reached, loosen toggle clamp screw ① and move toggle clamp along the connecting linkage so both motor and valve can assume their minimum positions. Then retighten toggle clamp screw ①. Refine adjustment by cycling several times between low and high control motor position while re-adjusting toggle clamp bolt ③ as necessary until control motor travels through its full cycle while moving control valve crank arm from its minimum only up to the desired maximum previously determined.

11. **Relight burner and cycle control system from low to high fire several times** to observe performance. Refine adjustments of pilot and main burner minimum if necessary.

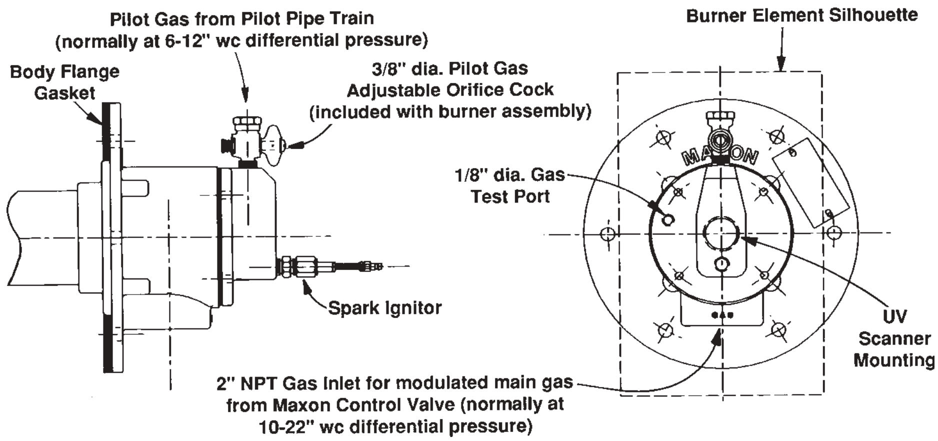
Warning: Test every UV flame sensor system for dangerous spark excitation from ignitors and other burners, as well as other possible sources of direct or reflected UV radiation.

12. **Check carefully that all interlocks and limits are in full operating condition and before system is placed into full service, instruct operator personnel on proper start-up, operation and shut-down of system**, establishing written instructions for reference.

Raw Gas Firing Start-Up Instructions for INCINO-PAK® Burner Sections

INCINO-PAK® Burner sections are started up in the same manner as other COMBUSTIFUME® Burners, except the designed manifolding for the raw gas brings all the components to the "outside" of the duct.

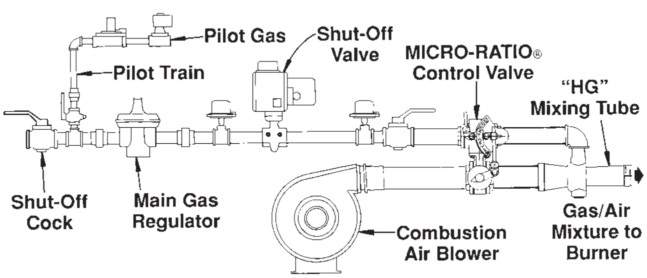
Your control valve is adjusted in the same manner with INCINO-PAK® Burners as described earlier for raw gas burner start-up instructions.



Partial-Premixed Burner Start-Up Instructions

COMBUSTIFUME® Line Burners may also be installed in oxygen-starved air streams. In those applications, a full or partial premixed air/gas mixture must be supplied to your COMBUSTIFUME® Burner to support proper combustion. With “partial-premixed” COMBUSTIFUME® Burner systems, a Series “HG” Mixing Tube with MICRO-RATIO® Control Valve is often used to premix gas and air prior to its introduction to the COMBUSTIFUME® Line Burner assembly.

A typical “HG” Mixing Tube system piping layout is illustrated below.



Maxon assumes no responsibility for the use or misuse of the piping layout shown. Specific piping and wiring diagrams should always be submitted to the appropriate agencies for approval on each application.

Combustion air blower provides the air (oxygen) supply to your combustion system and is essential to the mixing of fuel gas. It should be located in the coolest, cleanest position that you can find near the burner itself. It must not be exposed to direct radiant heat or positioned where it might draw in the inert gases or hot air rising from a furnace or oven. If problems exist, consider filters, relocation and/or ducting of an outside fresh air supply.

Minimize combustion air pressure drop between blower and mixing tube. Keep a minimum straight run of four pipe diameters into the mixer air inlet. Downstream piping from mixer to burner should be kept as short as possible.

Electrical service must match the voltage, phase and cycle of all electrical system components and be compatible with burner nameplate ratings. Insure that all normal control safeguards are satisfied. Combustion air blower should continue to run after shutdown to allow burner to cool.

Gas supply piping must be large enough to maintain the required fuel pressures cataloged for the particular burner size used with burner operating at full-rated capacity.

Natural gas pressure generally required (as measured at the mixer gas inlet) is 1 PSIG higher than air pressure for “HG” Mixing Tubes.

Anything more than minimal distance or piping turns may necessitate “oversizing” piping runs to keep pressure drops within acceptable ranges.

Inlet pipe leading to any burner should be at least four pipe diameters in length. If multiple burners are fed from a single gas train, care should be taken to minimize pressure drop and give maximum uniformity.

CAUTION: Do not install any shut-off device in the air/gas mixture line.

For initial burner start-up of partial-premixed burner system:

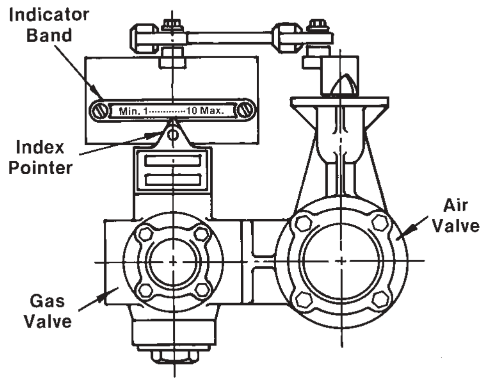
Start-up steps #1 through #5 are the same for partial-premix and raw gas burner systems. See page 5700-S-4 for first five start-up steps, then continue with step #6 below.

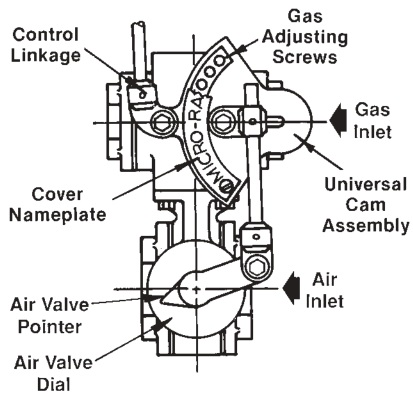
6. **Check minimum mixture pressure** at burners by turning the MICRO-RATIO® Control Valve to its minimum position and reading differential air pressure only at each burner with a water column manometer. Any reading below 0.25" wc differential (natural gas) requires re-adjustment as described below.

   Setting minimum mixture pressure with a MICRO-RATIO® Control Valve and Series “HG” Mixing Tube system:

   If minimum mixture pressure must be increased, open the MICRO-RATIO® air valve slowly (by turning toward higher-numbered positions) until the required differential air (mixture) pressure is reached, then mark air valve dial at the position opposite pointer. This point will become the <u>minimum</u> air setting for your MICRO-RATIO® Valve mixing tube system (see sketch on page 5700-S-8).

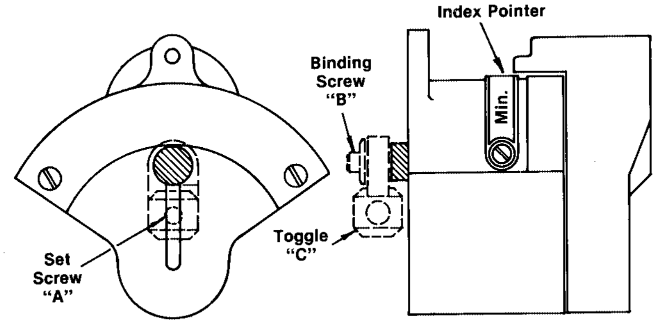
Partial-Premixed Burner Start-Up Instructions





Continue opening the MICRO-RATIO® air valve while watching the manometer connected into the burner's air/gas mixture manifold. Determine the point at which further opening of the air valve gives no appreciable increase in air pressure within the manifold/burner. Mark the air valve dial at this position opposite the air valve pointer. This point will become the maximum air setting for your MICRO-RATIO® Valve mixing tube system.

Having marked and/or recorded the MICRO-RATIO® Control Valve's air valve settings for both minimum and maximum firing positions, you may adjust the linkage and travel of the gas valve's stroke (see sketch below).



Loosen Allen set screw "A" and binding screw "B" in toggle "C". Move the toggle in universal cam assembly slot towards the center of rotation so that gas valve can rotate from its minimum to maximum position, while the air valve swings between the established (and marked) minimum and maximum settings.

Place air valve on pre-determined "minimum" position and rotate gas valve to its "minimum" setting position. Tighten down set screw "A" and binding screw "B" with both valves set at "minimum".

Establish set screw "A" as minimum-end adjustment point and binding screw "B" as maximum-end adjustment point. (Note: It doesn't matter which is maximum or minimum, as long as you identify and keep the same reference points for the next adjustment steps.)

Now rotate MICRO-RATIO® Valve to "maximum" position. The air valve maximum setting was previously determined. Loosen binding screw "B" and adjust pointer and linkage to correct just half the distance required to make the air valve pointer indicate the maximum air valve setting.

Partial-Premixed Burner Start-Up Instructions

Re-tighten binding screw "B" and return the MICRO-RATIO® Valve to the "minimum" air setting.

This time, loosen set screw "A" and again correct for just half the distance required to make the air valve pointer indicate the minimum air valve setting.

Re-tighten set screw "A" and again return the MICRO-RATIO® Valve to its maximum position.

Similarly, correct one half the distance with binding screw "B" for the maximum setting, etc.

Continue this adjustment procedure until the gas and air valves reach their minimum and maximum positions simultaneously. Normally, this is accomplished within seven adjustments.

7. **Remove cover plate** from screw carrier cam assembly and turn all adjusting screws counter-clockwise until flush with outer surface of casting (new equipment is shipped this way).
8. **Open main and pilot gas cocks** and light first burner pilot following instructions appropriate for that burner and pilot type. If multiple pilots are used, open individual cocks and adjust each in turn.

   To light and adjust gas pilot: Check to insure pilot combustion air supply is flowing to any pressure pilot mixer. Pilot gas regulator should initially be set at approximately midpoint of its adjustment range. With pilot gas solenoid closed, open main fuel gas and pilot gas cock. Energize spark ignitor and pilot gas solenoid. Observe pilot ignition through sight port of pilot assembly and/or by viewing micro-amp signal metered from flame safeguard relay circuit.

   Refine pilot setting for a hard blue flame (and/or strongest micro-amp signal) by adjusting gas flow through pilot orifice and/or pilot regulator.

   Shut off pilot gas cock to extinguish pilot fire. Re-open and confirm easy re-ignition several times. The flame safeguard relays should now power the main fuel shut-off valves.
9. **Light main burners at minimum** as follows:

   First, turn MICRO-RATIO® Valve to its minimum setting (which may be at position 1 or 2 after completing step 6), then open fuel shut-off valve and turn corresponding screw in (clockwise) until flame ignites at all burner nozzles. (This may take several turns of the screw.)

   NOTE: At this point, it is more important to get any kind of a flame as soon as possible. The flame geometry can be adjusted and refined as needed later.

   Continue turning in slowly until flame becomes noticeably rich (usually purple or green with a slight yellow tip). Then slowly back the screw out until the flame becomes bright blue.

   A good minimum fire should provide uniform flame across the entire burner face, contained within the zipper flame channel at the base of burner mixing plates. Any thin spots or gaps indicate uneven air velocity over the burner which must be corrected or a higher minimum fire established by continuing to turn in on the minimum stop screw.
10. Once your flame is established and refined at this position, and without advancing the screw carrier quadrant higher, screw all remaining screws down to at least the same level as your first adjusted screw.

    NOTE: A preliminary setting can be established with all the remaining adjusting screws. Generally, each succeeding screw needs to be screwed in approximately one full turn more (clockwise) than its preceding screw. A smooth "stair-step" gradient pre-set at this point from low to high will simplify the remaining adjustment steps.

CAUTION: If flame is extinguished, immediately return MICRO-RATIO® Control Valve to minimum position and shut off fuel (if flame safeguard has not already done so). Turn in slightly on adjusting screw at point where ignition was lost, then return valve to minimum position, re-establish pilot, open fuel valve and verify ignition.

11. Without advancing the valve quadrant, screw down clockwise on second screw (one or two turns). Then slowly advance the screw carrier quadrant to the #1 position. Adjust flame appearance at this new position.

    NOTE: If firing chamber is of refractory construction, allow your burner system to operate at this low setting for the necessary dry/cure-out time period recommended by the chamber or refractory manufacturer. Then continue adjustments of valve.

Partial-Premixed Burner Start-Up Instructions

12. Again, without moving valve, bring the third and all remaining adjusting screws down to the same level as the second screw.
    NOTE: If approximate pre-set gradient was made earlier, the remaining screws will already be at or below appropriate levels.
    Progressively work your way up through each adjusting screw position, developing a smooth progression slope from your first screw to the "maximum" position.
    As each is adjusted, you must turn the remaining unadjusted screws in at least that far to prevent possible damage to flexible cam strips inside the screw carrier cam assembly.
    Turning a screw in "clockwise" gives more gas at that setting; turning it out gives less.
    NOTE: To adjust the flame at any position, you must move the valve quadrant to the number you desire to adjust. This aligns the adjusting screw directly on top of the fuel valve plunger. A resulting adjustment of the screw is directly applied to the fuel valve plunger and its interconnected valve body linkage.
13. **Cycle burner from minimum to maximum** and refine adjustment, if necessary.
    For operation with interrupted pilot (as recommended), shut off pilots and cycle burner from minimum to maximum and back several times to verify the flame is maintained.

CAUTION: After completing previously listed steps, check all interlocking safety components and circuitry to prove that they are properly installed, correctly set, and fully operational. If in doubt, shut the system down, close main and pilot cocks, and contact responsible individual before proceeding further.

14. **Reconnect linkage to control motor**, plug all test connections, replace equipment cover caps and tighten linkage screws.
15. **Check out overall system operation** by cycling through light-off at minimum, interrupting pilot, and allowing temperature control system to cycle burner from minimum to maximum and return.
    Re-check all safety system interlocks for proper setting and operation.

WARNING: Test every UV installation for dangerous spark excitation from ignitors and other possible sources of direct or reflected UV radiation. Use only gas-tight scanner connections.

16. **Before system is placed into full service, instruct operator personnel** on proper start-up, operation and shut-down of system. Establish written instructions for their future reference.