



# installation, start-up, and operating instructions

## UPFLOW GAS-FIRED INDUCED-COMBUSTION FURNACES

### 393AAV Series A

Cancels: II 393A-70-1

II 393A-70-2  
9-98

**NOTE:** Read the entire instruction manual before starting the installation.

This symbol → indicates a change since the last issue.

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### SAFETY CONSIDERATIONS

Installing and servicing heating equipment can be hazardous due to gas and electrical components. Only trained and qualified personnel should install, repair, or service heating equipment.

Untrained personnel can perform basic maintenance functions such as cleaning and replacing air filters. All other operations must be performed by trained service personnel. When working on heating equipment, observe precautions in the literature, on tags, and on labels attached to or shipped with the unit and other safety precautions that may apply.



### REGISTERED QUALITY SYSTEM

Follow all safety codes. In the United States, follow all safety codes including the National Fuel Gas Code (NFGC) NFPA 54-1996/ANSI Z223.1-1996 and the Installation Standards, Warm Air Heating and Air Conditioning Systems (NFPA 90B) ANSI/NFPA 90B. In Canada, refer to the current edition of the National Standard of Canada CAN/CGA-B149.1- and .2-M95 Natural Gas and Propane Installation Codes (NSCNGPIC). Wear safety glasses and work gloves. Have fire extinguisher available during start-up and adjustment procedures and service calls.

Recognize safety information. This is the safety-alert symbol . When you see this symbol on the furnace and in instructions or manuals, be alert to the potential for personal injury.

Understand the signal words DANGER, WARNING, and CAUTION. These words are used with the safety-alert symbol. DANGER identifies the most serious hazards which **will** result in severe personal injury or death. WARNING signifies a hazard which **could** result in personal injury or death. CAUTION is used to identify unsafe practices which **would** result in minor personal injury or product and property damage.

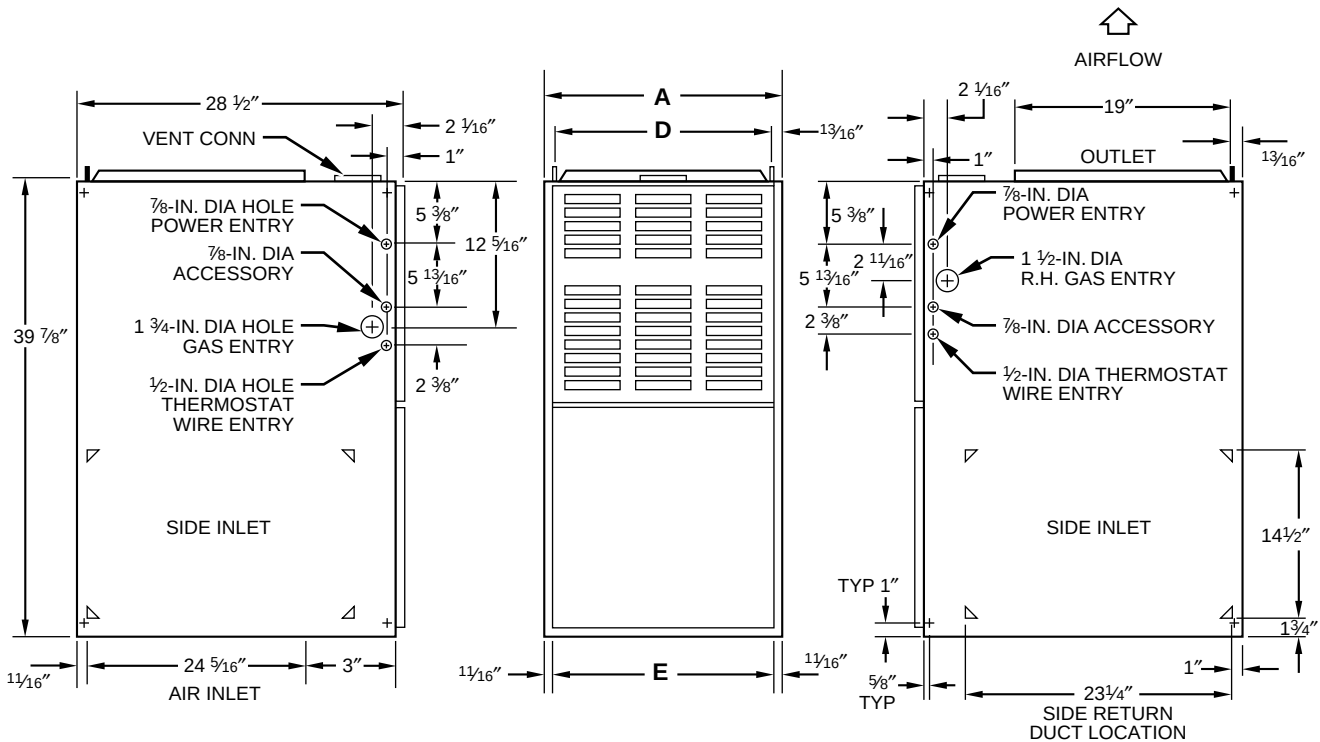
These instructions cover minimum requirements and conform to existing national standards and safety codes. In some instances, these instructions exceed certain local codes and ordinances, especially those that may not have kept up with changing residential construction practices. We require these instructions as a minimum for a safe installation.

### ELECTROSTATIC DISCHARGE (ESD) PRECAUTIONS PROCEDURE



**CAUTION:** Electrostatic discharge can affect electronic components. Take precautions during furnace installation and servicing to protect the furnace electronic control. Precautions will prevent electrostatic discharges from personnel and hand tools which are held during the procedure. These precautions will help to avoid exposing the control to electrostatic discharge by putting the furnace, the control, and the person at the same electrostatic potential.

1. Disconnect all power to the furnace. DO NOT TOUCH THE CONTROL OR ANY WIRE CONNECTED TO THE CONTROL PRIOR TO DISCHARGING YOUR BODY'S ELECTROSTATIC CHARGE TO GROUND.



- NOTES:**
- Two additional 7/8-in. dia holes are located in the top plate.
  - Minimum return-air openings at furnace, based on metal duct. If flex duct is used, see flex duct manufacturer's recommendations for equivalent diameters.
  - Minimum return-air opening at furnace:
    - For 800 CFM—16-in. round or 14 1/2 x 12-in. rectangle.
    - For 1200 CFM—20-in. round or 14 1/2 x 19 1/2-in. rectangle.
    - For 1600 CFM—22-in. round or 14 1/2 x 23 1/4-in. rectangle.
    - For airflow requirements above 1800 CFM, see Air Delivery table in Product Data literature for specific use of single side inlets. The use of both side inlets, a combination of 1 side and the bottom, or the bottom only will ensure adequate return air openings for airflow requirements above 1800 CFM.

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**Fig. 1—Dimensional Drawing**  
**TABLE 1—DIMENSIONS (IN.)**

| UNIT SIZE | A       | D       | E        | VENT CONN | SHIP. WT (LB) |
|-----------|---------|---------|----------|-----------|---------------|
| 024070    | 14-3/16 | 12-9/16 | 12-11/16 | 4         | 132           |
| 036070    | 14-3/16 | 12-9/16 | 12-11/16 | 4         | 134           |
| 042091    | 17-1/2  | 15-7/8  | 16       | 4         | 150           |
| 048111    | 21      | 19-3/8  | 19-1/2   | 4         | 166           |
| 060135    | 24-1/2  | 22-7/8  | 23       | 5         | 194           |
| 060155    | 24-1/2  | 22-7/8  | 23       | 5         | 204           |

- Firmly touch a clean, unpainted, metal surface of the furnace chassis which is close to the control. Tools held in a person's hand during grounding will be satisfactorily discharged.
- After touching the chassis you may proceed to service the control or connecting wires as long as you do nothing that recharges your body with static electricity (for example; DO NOT move or shuffle your feet, DO NOT touch ungrounded objects, etc.).
- If you touch ungrounded objects (recharge your body with static electricity), firmly touch furnace again before touching control or wires.
- Use this procedure for installed and uninstalled (ungrounded) furnaces.
- Before removing a new control from its container, discharge your body's electrostatic charge to ground to protect the control from damage. If the control is to be installed in a furnace, follow items 1 through 5 before bringing the control or yourself into contact with the furnace. Put all used AND new controls into containers before touching ungrounded objects.

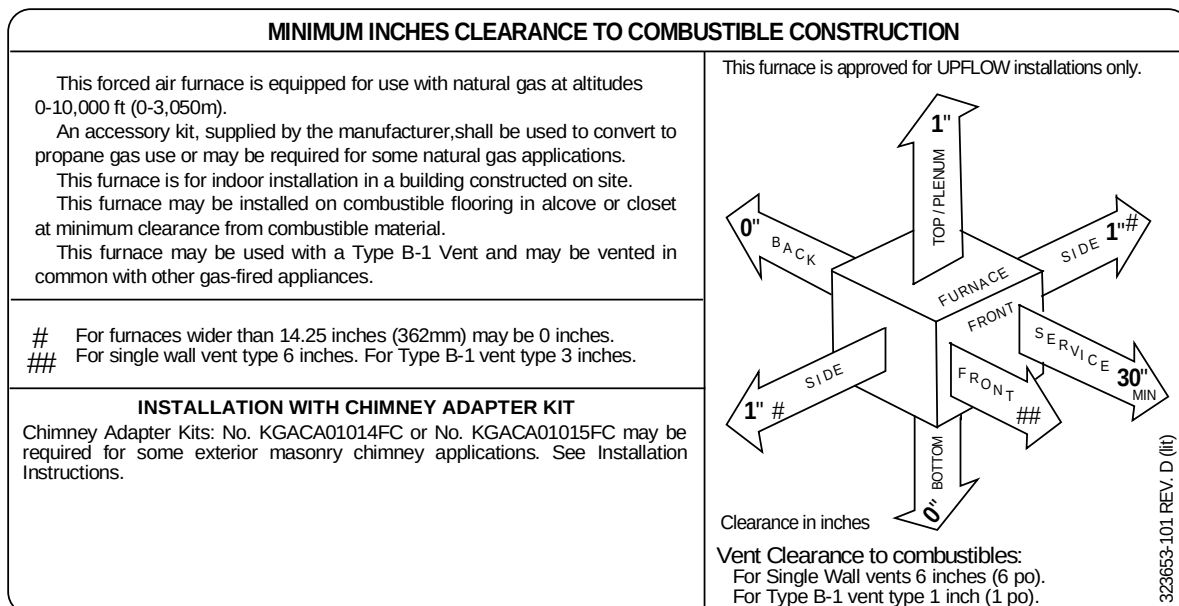
- An ESD service kit (available from commercial sources) may also be used to prevent ESD damage.

## → INTRODUCTION

The Model 393AAV, Series A Furnace is available in sizes 66,000 through 154,000 Btuh input capacities.

The design of the upflow gas-fired furnace is A.G.A./C.G.A. certified for natural and propane gas and for installation on combustible flooring, in alcoves, attics, basements, closets, or utility rooms. The furnace is factory-shipped for use with natural gas. A factory accessory gas conversion kit, as listed on the furnace rating plate is required to convert furnace for use with propane gas. The design of this furnace line is **not** A.G.A./C.G.A. certified for installation in mobile homes, recreation vehicles, or outdoors.

Before installing the furnace in the United States, refer to the current edition of the NFGC/NFPA 54/Z223.1 and the NFPA 90B. For further information, the NFGC/NFPA 54/Z223.1 and NFPA 90B are available from National Fire Protection Association Inc., Batterymarch Park, Quincy, MA 02269; or American Gas Association, 1515 Wilson Boulevard, Arlington, VA 22209.



→ Fig. 2—Clearances to Combustibles

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Before installing the furnace in Canada, refer to the current edition of the NSCNGPIC. Contact Standards Department of International Approval Services of Canada, 178 Rexdale Boulevard, Etobicoke, Ontario, Canada M9W 1R3.

Installation must comply with regulations of serving gas supplier and local building, heating, plumbing or other codes in effect in the area in which installation is made. In absence of local codes, installation must conform with NFGC.

Canadian installations must be made in accordance with NSCNG-PIC and all authorities having jurisdiction.

These instructions cover minimum requirements for a safe installation and conform to existing national standards and safety codes. In some instances, these instructions exceed certain local codes and ordinances, especially those that may not have kept pace with changing residential construction practices. We require these instructions as a minimum for a safe installation.

⚠

**CAUTION:** Application of this furnace should be indoors with special attention given to vent sizing and material, gas input rate, air temperature rise, and unit sizing. Improper installation or misapplication of the furnace can require excessive servicing or cause premature component failure.

This furnace is designed for a minimum continuous return-air temperature of 60°F db or an intermittent operation down to 55°F db such as when used with a night setback thermostat. Return-air temperature must not exceed a maximum of 85°F db.

⚠

**WARNING:** Improper installation, adjustment, alteration, service, maintenance, or use can cause carbon monoxide poisoning, explosion, fire, electrical shock, or other conditions which may cause personal injury or property damage. Consult a qualified installer, service agency, local gas supplier, or your distributor or branch for information or assistance. The qualified installer or agency must use only factory-authorized and listed kits or accessories when modifying this product. Failure to follow this warning can cause electrical shock, fire, personal injury, or death.

For accessory installation details, refer to the applicable instruction literature.

**NOTE:** Remove all shipping brackets and materials before operating the furnace.

## I. LOCATION

### A. General

⚠

**CAUTION:** Do not install furnace in a corrosive or contaminated atmosphere. Make sure all combustion and circulating air requirements are met, in addition to all local codes and ordinances.

⚠

**CAUTION:** Do not use this furnace during construction when adhesives, sealers, and/or new carpets are being installed. If the furnace is required during construction, use clean outside air for combustion and ventilation. Compounds of chlorine and fluorine when burned with combustion air form acids which cause corrosion of the heat exchangers and metal vent system. Some of these compounds are found in paneling and dry wall adhesives, paints, thinners, masonry cleaning materials, and many other solvents commonly used in the construction process. Excessive exposure to contaminated combustion air will result in safety and performance related problems.

This furnace must be installed so the electrical components are protected from water. This furnace shall not be installed directly on carpeting, tile, or any combustible material other than wood flooring.

Locate furnace as close to the chimney/vent and as near the center of the air distribution system as possible. The furnace should be installed as level as possible.

Provide ample space for servicing and cleaning. Always comply with the minimum fire protection clearances shown on the unit rating plate.

### B. Location Relative to Cooling Equipment

The cooling coil must be installed parallel with or on the downstream side of the unit to avoid condensation in the heat exchangers. When installed parallel with a furnace, dampers or other means used to control the flow of air must prevent chilled air from entering the unit. If the dampers are manually operated, they must be equipped with means to prevent operation of either unit unless the damper is in the full-heat or full-cool position.

## C. Hazardous Locations

When the furnace is installed in a residential garage, it must be installed so that the burners and ignition source are located at least 18 in. above the floor. The furnace should be protected from physical damage by vehicles. When a furnace is installed in public garages, airplane hangars, or other buildings having hazardous atmospheres, the unit must be installed in accordance with the recommended good practice requirements of the National Fire Protection Association, Inc.

## II. AIR FOR COMBUSTION AND VENTILATION

Provisions for adequate combustion and ventilation air must be provided in accordance with Section 5.3 of the NFGC, Air for Combustion and Ventilation in the U.S.A., Section 7 of the NSCNGPIC in Canada, or applicable provisions of the local building codes, and all authorities having jurisdiction.

**CAUTION:** Air for combustion must not be contaminated by halogen compounds, which include fluoride, chloride, bromide, and iodide. These elements are found in aerosol sprays, detergents, bleaches, cleaning solvents, salts, air fresheners, and other household products.

All fuel-burning equipment must be supplied with air for combustion of the fuel. Sufficient air **MUST** be provided to ensure there will not be a negative pressure in the equipment room or space. In addition, a positive seal **MUST** be made between the furnace cabinet and the return-air duct to prevent pulling air from the burner area, draft hood relief opening (when applicable), and blocked vent safeguard opening.

**CAUTION:** The operation of exhaust fans, kitchen ventilation fans, clothes dryers, or fireplaces could create a **NEGATIVE PRESSURE CONDITION** at the furnace. Make-up air **MUST BE PROVIDED** for the ventilation devices, in addition to that required by the furnace.

The requirements for combustion and ventilation air depend upon whether the furnace is located in an unconfined or confined space.

### A. Unconfined Space

An unconfined space has at least 50 cubic ft for each 1000 Btuh of input for all the appliances (such as furnaces, clothes dryer, water heaters, etc.) in the space.

For Example:

| 393AAV FURNACE<br>INPUT BTUH | MINIMUM SQ FT WITH<br>7-1/2 FT CEILING |
|------------------------------|----------------------------------------|
| 66,000                       | 440                                    |
| 88,000                       | 587                                    |
| 110,000                      | 733                                    |
| 132,000                      | 880                                    |
| 154,000                      | 1026                                   |

If the unconfined space is of unusually tight construction, air for combustion and ventilation **MUST** come from either the outdoors or spaces freely communicating with the outdoors. Combustion and ventilation openings must be sized the same as for a confined space as defined below. Return air must not be taken from the room unless an equal or greater amount of air is supplied to the room.

### → B. Confined Space

A confined space is defined as a space whose volume is less than 50 cu ft per 1000 Btuh of total input ratings of all appliances installed in that space. A confined space **MUST** have provisions for supplying air for combustion, ventilation, and dilution of flue gases using 1 of the following methods. (See Fig. 4 and Table 2.)

**NOTE:** In determining free area of an opening, the blocking effect of louvers, grilles, and screens must be considered. If free area of louver or grille design is unknown, assume that wood louvers have a 20 percent free area and metal louvers or grilles have a 60 percent free area. Screens, when used, must not be smaller than 1/4-in. mesh. Louvers and grilles must be constructed so they cannot be closed.

The size of the openings depends upon whether air comes from outside of the structure or an unconfined space inside the structure.

1. All air from inside the structure requires 2 openings (for structures not usually tight):
  - a. Each opening **MUST** have at least 1 sq in. of free area per 1000 Btuh of total input for all equipment within the confined space, but not less than 100 sq in. per opening. (See Fig. 4 and Table 2.) The minimum dimension of air openings shall not be less than 3 in.
  - b. If building is constructed unusually tight, a permanent opening directly communicating with the outdoors shall be provided. See item 2 below.
  - c. If furnace is installed on a raised platform to provide a return-air plenum, and return air is taken directly from hallway or space adjacent to furnace, all air for combustion must come from outdoors.
2. Air from outside the structure requires 1 of the following methods:
  - a. If combustion air is taken from outdoors through 2 vertical ducts, the openings and ducts **MUST** have at least 1 sq in. of free area per 4000 Btuh of total input for all equipment within the confined space. (See Fig. 4 and Table 2.)
  - b. If combustion air is taken from outdoors through 2 horizontal ducts, the openings and ducts **MUST** have at least 1 sq in. of free area per 2000 Btuh of total input for all equipment within the confined space. (See Fig. 4 and Table 2.)
  - c. If combustion air is taken from outdoors through a single opening or duct (horizontal or vertical) commencing within 12 in. of the top of the confined space, opening and duct **MUST** have at least 1 sq in. of free area per 3000 Btuh of the total input for all equipment within the confined space and not less than the sum of the areas of all vent connectors in the confined space. (See Fig. 4 and Table 2.) Equipment clearances to the structure shall be at least 1 in. from the sides and back and 6 in. from the front of the appliances.

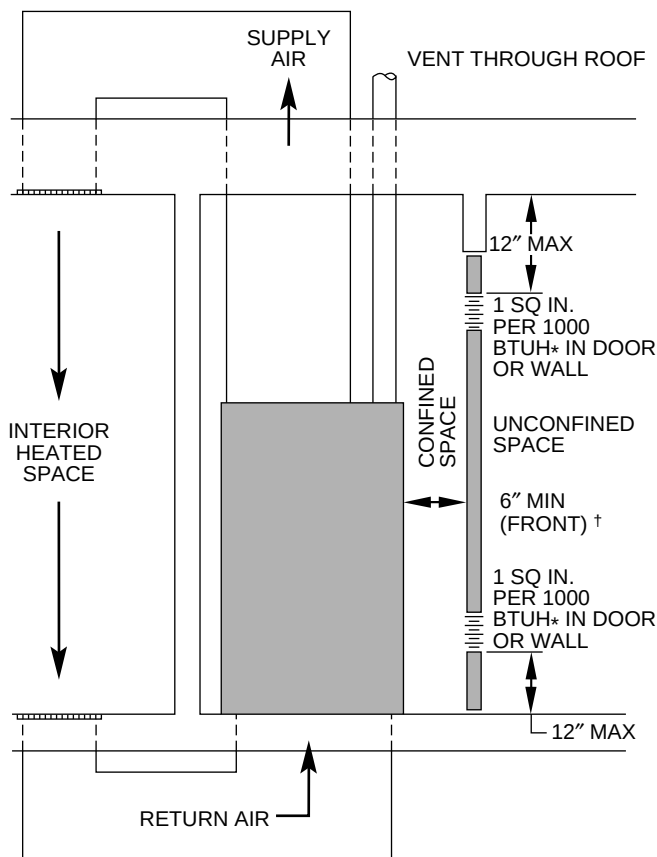
When ducts are used, they must be of the same cross-sectional area as the free area of the openings to which they connect. The minimum dimension of ducts must not be less than 3 in. (See Fig. 4.)

**WARNING:** Do not install the furnace on its back or sides. Safety control operation will be adversely affected. Never connect return-air ducts to the back of the furnace. A failure to follow this warning can cause a fire, personal injury, or death.

## → AIR DUCTS

### I. GENERAL REQUIREMENTS

The duct system should be designed and sized according to accepted national standards such as those published by: Air Conditioning Contractors Association (ACCA), Sheet Metal and Air Conditioning Contractors National Association (SMACNA) or

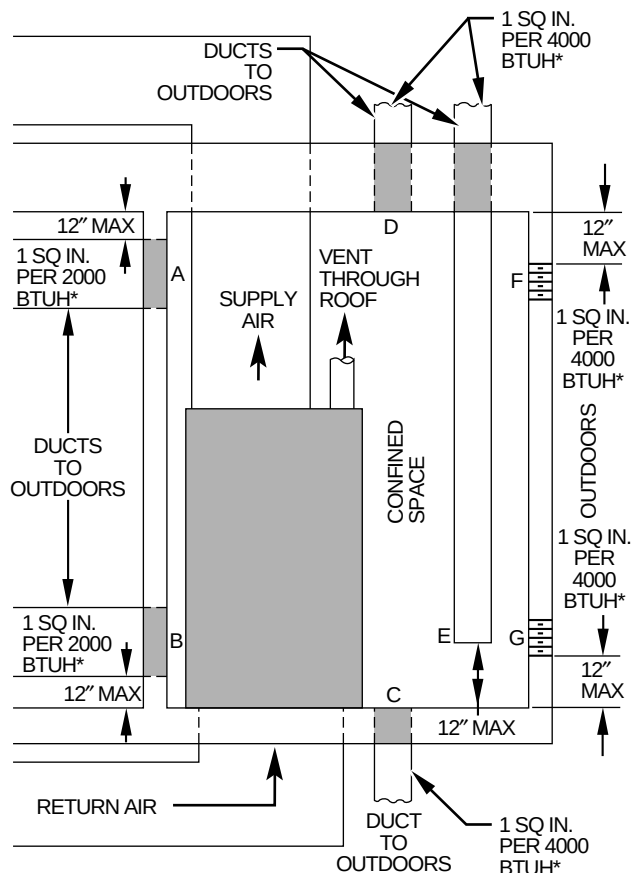


\* Minimum opening size is 100 sq in. with minimum dimensions of 3 in.

† Minimum of 3 in. when type-B1 vent is used.

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**Fig. 3—Confined Space: Air for Combustion and Ventilation from an Unconfined Space**



\*Minimum dimensions of 3 in.

**NOTE:** Use any of the following combinations of openings:  
A & B C & D D & E F & G

A89013

**Fig. 4—Confined Space: Air for Combustion and Ventilation from Outdoors**

**TABLE 2—FREE AREA OF COMBUSTION AIR OPENING**

| 393AAV<br>FURNACE<br>HIGH-FIRE<br>INPUT<br>(BTUH) | AIR FROM UNCON-<br>FINED SPACE      | OUTDOOR AIR THROUGH<br>VERTICAL DUCTS        |                            | OUTDOOR AIR THROUGH<br>HORIZONTAL DUCTS      |                            | OUTDOOR AIR THROUGH<br>SINGLE DUCT           |                            |
|---------------------------------------------------|-------------------------------------|----------------------------------------------|----------------------------|----------------------------------------------|----------------------------|----------------------------------------------|----------------------------|
|                                                   | Free Area<br>of Opening<br>(Sq In.) | Free Area of<br>Opening and Duct<br>(Sq In.) | Round<br>Pipe<br>(In. Dia) | Free Area of<br>Opening and Duct<br>(Sq In.) | Round<br>Pipe<br>(In. Dia) | Free Area of<br>Opening and Duct<br>(Sq In.) | Round<br>Pipe<br>(In. Dia) |
| 66,000                                            | 100                                 | 16.5                                         | 5                          | 33.0                                         | 7                          | 22.00                                        | 6                          |
| 88,000                                            | 100                                 | 22.0                                         | 6                          | 44.0                                         | 8                          | 29.33                                        | 7                          |
| 110,000                                           | 115                                 | 27.5                                         | 6                          | 55.0                                         | 9                          | 36.67                                        | 7                          |
| 132,000                                           | 138                                 | 33.0                                         | 7                          | 66.0                                         | 10                         | 44.00                                        | 8                          |
| 154,000                                           | 154                                 | 38.5                                         | 8                          | 77.0                                         | 10                         | 51.33                                        | 9                          |

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). Or consult factory *The Air Systems Design Guidelines* reference tables available from your local distributor. The duct system should be sized to handle the required system design CFM at the design static pressure.

When a furnace is installed so that the supply ducts carry air to areas outside the space containing the furnace, the return air must also be handled by a duct(s) sealed to the furnace casing and terminating outside the space containing the furnace.

Secure ductwork with proper fasteners for type of ductwork used. Seal supply- and return-duct connections to furnace with code approved tape or duct sealer.

Flexible connections should be used between ductwork and furnace to prevent transmission of vibration. Ductwork passing through unconditioned space should be insulated to enhance system performance. When air conditioning is used, a vapor barrier is recommended.

Maintain a 1-in. clearance from combustible materials to supply air ductwork for a distance of 36 in. horizontally from the furnace. See NFPA 90B or local code for further requirements.

## II. DUCTWORK ACOUSTICAL TREATMENT

Metal duct systems that do not have a 90 degree elbow and 10 ft of main duct to the first branch take-off may require internal acoustical lining. As an alternative, fibrous ductwork may be used if constructed and installed in accordance with the latest edition of SMACNA construction standard on fibrous glass ducts. Both acoustical lining and fibrous ductwork shall comply with NFPA 90B as tested by UL Standard 181 for Class 1 Rigid air ducts.

## III. SUPPLY AIR CONNECTIONS

### A. Upflow Furnaces

Connect supply-air duct to 3/4-in. flange on furnace supply-air outlet. The supply-air duct attachment must ONLY be connected

to furnace supply-/outlet-air duct flanges or air conditioning coil casing (when used). DO NOT cut main furnace casing to attach supply side air duct, humidifier, or other accessories. All accessories MUST be connected external to furnace main casing.

#### IV. RETURN AIR CONNECTIONS

##### A. Upflow Furnaces

The return-air duct must be connected to bottom, sides (left or right), or a combination of bottom and side(s) of main furnace casing as shown in Fig. 1. Bypass humidifier may be attached into unused side return air portion of the furnace casing. DO NOT connect any portion of return-air duct to back of furnace casing.

#### V. FILTER ARRANGEMENT

The factory-supplied filter(s) is shipped in the blower compartment. Determine location for the filter and relocate filter retaining wire if necessary. See Fig. 5 for side return application and Fig. 6 for bottom return application. See Table 3 to determine correct filter size for desired filter location. Table 3 indicates filter size, location, and quantity shipped with the furnace.

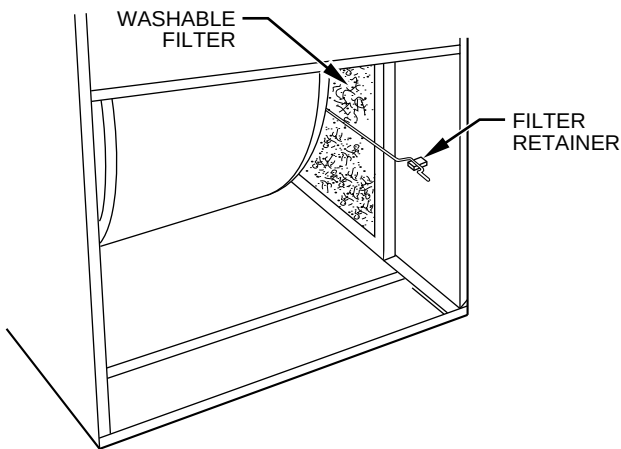


**Fig. 5—Side Filter Arrangement  
(Control Removed for Clarity)**

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For bottom air-return applications, filter may need to be folded to fit some furnace casing widths. A bottom closure panel is factory installed in the bottom of the furnace. When bottom return inlet is desired, remove and discard the bottom closure panel. Remove side clip(s) and install in hole. Two sets of hardware are needed for furnaces in 24-1/2-in. wide casings using 2 filters for bottom return. All hardware is provided for filter installation.

**NOTE:** Furnaces with a 17-1/2-in. wide casing require an additional procedure when locating the filter for bottom return-air application. Field fabricate a sheet metal filler strip 1 X 3 X 24-1/2 in. and install it along side of the filter as shown in Fig. 6. Drive 2 screws through the casing side and into the filler strip to secure it in place. Filter should rest on the top of the filler strip when installed.



**WARNING:** Never operate unit without a filter or with filter access door removed. Failure to follow this warning can cause fire, personal injury, or death.

#### VI. LEVELING LEGS (IF REQUIRED)

When the furnace is used with side inlet(s) and leveling legs are required, refer to Fig. 7, and install field-supplied, corrosion-resistant 5/16-in. machine bolts and nuts.

**NOTE:** The maximum length of the bolt should not exceed 1-1/2 in.

**17½-IN. WIDE CASINGS ONLY:**  
INSTALL FIELD-SUPPLIED FILTER FILLER STRIP UNDER FILTER.

**24½-IN. WIDE CASINGS ONLY:**  
CUT AND FOLD FACTORY-PROVIDED FILTERS AS SHOWN TO DESIRED SIZE.

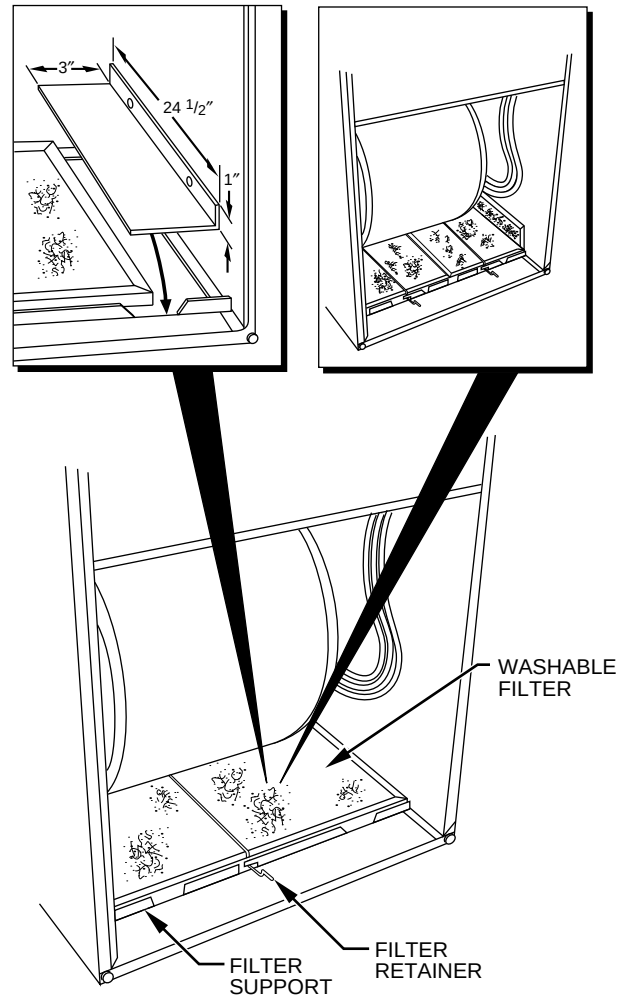


**Fig. 6—Bottom Filter Arrangement (Control Removed for Clarity)**

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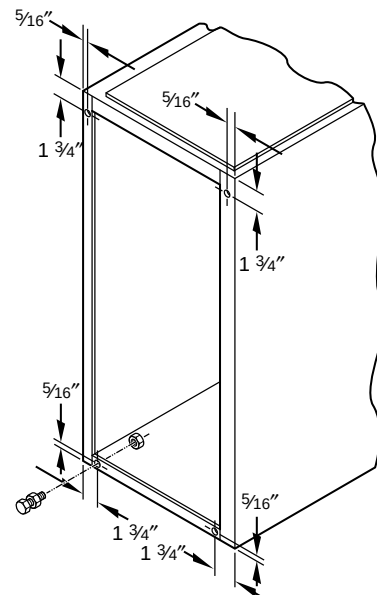


**Fig. 7—Leveling Leg Installation**

A89014

1. Lay furnace on its back. Locate and drill 5/16-in. diameter hole in each bottom corner of furnace as shown in Fig. 7.
2. Install nut on bolt and install bolt and nut in hole. (Install flat washer if desired.)
3. Install another nut on other side of furnace base. (Install flat washer if desired.)
4. Adjust outside nut to provide desired height, and tighten inside nut to secure arrangement.

## VII. GAS PIPING

Gas piping must be installed in accordance with national and local codes and all authorities having jurisdiction. In the U.S.A., Refer to the current edition of the NFPA. Canadian installations must be installed in accordance with NSCNGPIC.

Refer to Table 4 for the recommended gas pipe size. Risers must be used to connect to the furnace and the meter.

**TABLE 3—FILTER INFORMATION (IN.)**

| FURNACE CASING WIDTH | FILTER SIZE*     |                  | FILTER TYPE |
|----------------------|------------------|------------------|-------------|
|                      | Side Return      | Bottom Return    |             |
| 14-3/16              | (1) 16 X 25 X 1† | (1) 14 X 25 X 1  | Cleanable   |
| 17-1/2               | (1) 16 X 25 X 1† | (1) 16 X 25 X 1  | Cleanable   |
| 21                   | (1) 16 X 25 X 1  | (1) 20 X 25 X 1† | Cleanable   |
| 24-1/2               | (2) 16 X 25 X 1† | (1) 24 X 25 X 1  | Cleanable   |

\* Filters can be field modified by cutting the frame as marked and folding to the desired size. Alternate sizes can be ordered from your distributor or dealer.  
† Factory-provided with the furnace.

**TABLE 4—MAXIMUM CAPACITY OF PIPE\***

| NOMINAL IRON PIPE SIZE (IN.) | INTERNAL DIAMETER (IN.) | LENGTH OF PIPE (FT) |      |      |     |     |
|------------------------------|-------------------------|---------------------|------|------|-----|-----|
|                              |                         | 10                  | 20   | 30   | 40  | 50  |
| 1/2                          | 0.622                   | 175                 | 120  | 97   | 82  | 73  |
| 3/4                          | 0.824                   | 360                 | 250  | 200  | 170 | 151 |
| 1                            | 1.049                   | 680                 | 465  | 375  | 320 | 285 |
| 1-1/4                        | 1.380                   | 1400                | 950  | 770  | 660 | 580 |
| 1-1/2                        | 1.610                   | 2100                | 1460 | 1180 | 990 | 900 |

\* Cubic ft of gas per hr for gas pressures of 0.5 psig (14-in. wc) or less, and a pressure drop of 0.5-in. wc (based on a 0.60 specific gravity gas). Ref: Table 10-2 NFPA 54-1996.

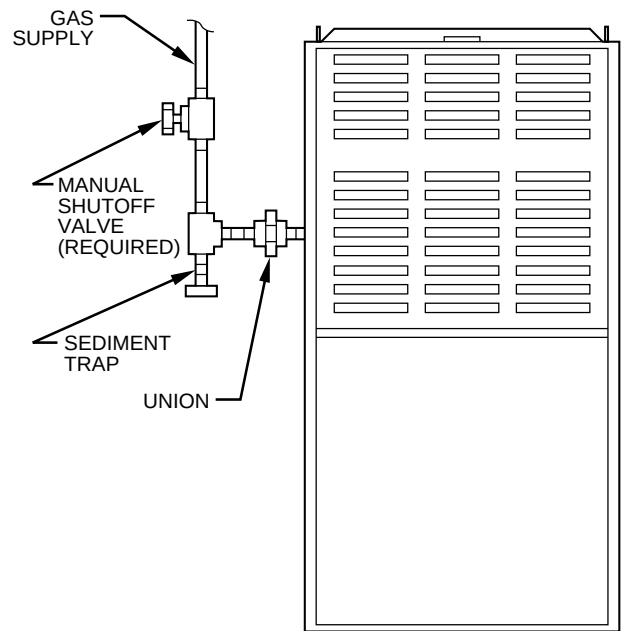
**CAUTION:** If a flexible connector is required or allowed by the authority having jurisdiction, black iron pipe shall be installed at the gas valve and extend a minimum of 2 in. outside the furnace casing.

Piping should be pressure tested in accordance with local and national plumbing and gas codes before the furnace has been attached. If the furnace has been attached, it is recommended that the ground joint union be loosened before pressure testing. If a subsequent test pressure exceeds 0.5 psig (14-in. wc), the gas supply pipe must be disconnected from the furnace and capped before the pressure test. If a subsequent test pressure is equal to or less than 0.5 psig (14-in. wc), turn off electric shutoff switch located on the gas valve before the test. After all connections have been made, purge the lines and check for leakage with regulated gas supply pressure.

Install a sediment trap in the riser leading to the furnace. The trap can be installed by connecting a tee to the riser leading from the furnace. Connect a capped nipple into the lower end of the tee. The capped nipple should extend below the level of the gas controls. (See Fig. 8.)

Apply joint compound (pipe dope) sparingly and only to the male threads of each joint. The compound must be resistant to the action of propane gas.

An accessible manual shutoff valve **MUST** be installed upstream of the furnace gas controls and within 72 in. of the furnace. A 1/8-in. NPT plugged tapping, accessible for test gage connection,



A89417

**Fig. 8—Typical Gas Pipe Arrangement**

**MUST** be installed immediately upstream of the gas supply connection to the furnace and downstream of the manual shutoff valve. Place ground joint union between the gas control manifold and the manual shutoff valve.

**WARNING:** Use the proper length of pipes to avoid stress on the gas control manifold. Failure to follow this warning can result in a gas leak, causing fire, explosion, personal injury, or death.

**CAUTION:** Connect the gas pipe to the furnace using a backup wrench to avoid damaging furnace gas controls.

**WARNING:** Never purge a line into a combustion chamber. Never use matches, candles, flame, or other sources of ignition for the purpose of checking leakage. Use a soap-and-water solution to check for leakage. Failure to follow this warning can cause a fire, explosion, personal injury, or death.

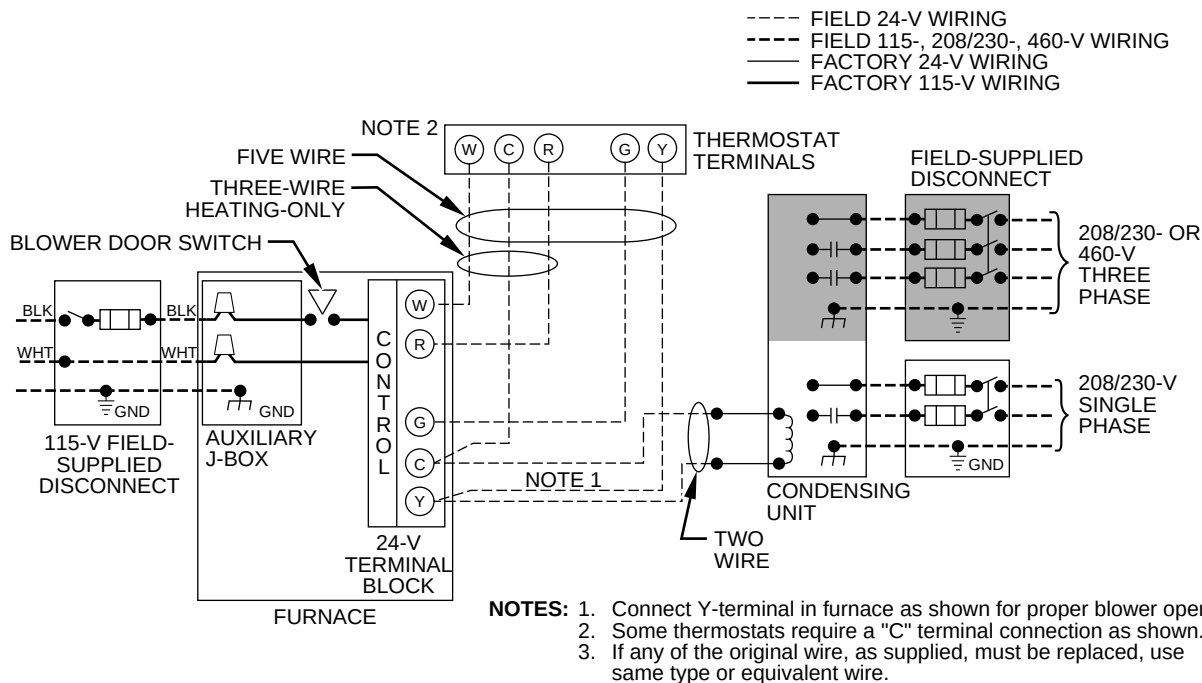
## VIII. ELECTRICAL CONNECTIONS

### A. 115-v Wiring

Refer to the unit rating plate or Table 5 for equipment electrical requirements. The control system requires an earth ground for proper operation.

**CAUTION:** Do not connect aluminum wire between disconnect switch and furnace. Use only copper wire.

Make all electrical connections in accordance with the National Electrical Code (NEC) ANSI/NFPA 70-1996 in the U.S.A. and local codes or ordinances that might apply or authorities having jurisdiction. For Canadian installations, all electrical connections must be made in accordance with CSA C22.1 Canadian Electrical Code.



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→ Fig. 9—Heating and Cooling Application Wiring Diagram

→ TABLE 5—ELECTRICAL DATA

| UNIT SIZE | VOLTS—HERTZ—PHASE | OPERATING VOLTAGE RANGE |          | MAXIMUM UNIT AMPS | MINIMUM WIRE GAGE | MAXIMUM WIRE LENGTH (FT)‡ | MAXIMUM FUSE OR CKT BKR AMPS† |
|-----------|-------------------|-------------------------|----------|-------------------|-------------------|---------------------------|-------------------------------|
|           |                   | Maximum*                | Minimum* |                   |                   |                           |                               |
| 024070    | 115—60—1          | 127                     | 104      | 5.9               | 14                | 47                        | 15                            |
| 036070    | 115—60—1          | 127                     | 104      | 8.7               | 14                | 32                        | 15                            |
| 042091    | 115—60—1          | 127                     | 104      | 9.0               | 14                | 31                        | 15                            |
| 048111    | 115—60—1          | 127                     | 104      | 10.1              | 14                | 28                        | 15                            |
| 060135    | 115—60—1          | 127                     | 104      | 13.3              | 12                | 33                        | 20                            |
| 060155    | 115—60—1          | 127                     | 104      | 14.0              | 12                | 31                        | 20                            |

\* Permissible limits of the voltage range at which the unit operates satisfactorily.

† Time-delay type is recommended.

‡ Length shown is as measured 1 way along wire path between unit and service panel for maximum 2 percent voltage drop.



**WARNING:** The cabinet MUST have an uninterrupted or unbroken ground according to NEC, ANSI/NFPA 70-1996 and Canadian Electrical Code, CSA C22.1 or local codes to minimize personal injury if an electrical fault should occur. This may consist of electrical wire or conduit approved for electrical ground when installed in accordance with existing electrical codes. Do not use gas piping as an electrical ground. Failure to follow this warning could result in electrical shock, fire, or death.

The auxiliary junction box (J-box) can be moved to the left-hand side of the furnace when a left-side power supply is desired. Remove the 2 screws holding the auxiliary J-box. Mount the J-box on the left-hand side of the furnace (holes have been pre-drilled in casing). When moved, tuck the wiring harness behind the clip provided to keep extra wire lengths out of the way.

**NOTE:** Proper polarity must be maintained for 115-v wiring. If polarity is incorrect, the furnace control status code indicator light will flash rapidly and the furnace will not operate.

#### B. 24-v Wiring

Make field 24-v connections at the 24-v furnace thermostat terminals. (See Fig. 10.) Connect terminal Y as shown in Fig. 9 for proper cooling operation. Use only AWG No. 18, color-coded, copper thermostat wire.

The 24-v circuit contains an automotive-type, 3-amp fuse located on the furnace control. Any direct shorts during installation, service, or maintenance could cause this fuse to blow. If fuse replacement is required, use ONLY a 3-amp fuse of identical size.

#### C. Accessories

##### 1. Electronic Air Cleaner (EAC)

Two spring clamp terminals (for 12 gage maximum, solid or stranded wire), marked EAC-1 and EAC-2 are provided for EAC connection. (See Fig. 10.) These terminals are energized with 115-v, (1-amp maximum) during blower motor operation. To connect EAC power leads to furnace control center, strip approximately 1/8 in. of insulation from wire. Open terminal by depressing switch arm with a screwdriver or finger, and insert wire as shown in Fig. 11.

##### 2. Humidifier (HUM)

Screw terminals (HUM and Com 24v) are provided for 24-v humidifier connection. The terminals are energized with 24v (0.5-amp maximum) during burner operation.

**NOTE:** A field-supplied, 115-v controlled relay connected to EAC terminals may be added if humidifier operation is desired during all blower operation.

#### IX. VENTING

Refer to the NFGC in the U.S.A. or NSCNGPIC in Canada for proper vent sizing and installation requirements and the enclosed Venting Tables for Category I Fan-Assisted Furnaces. When a

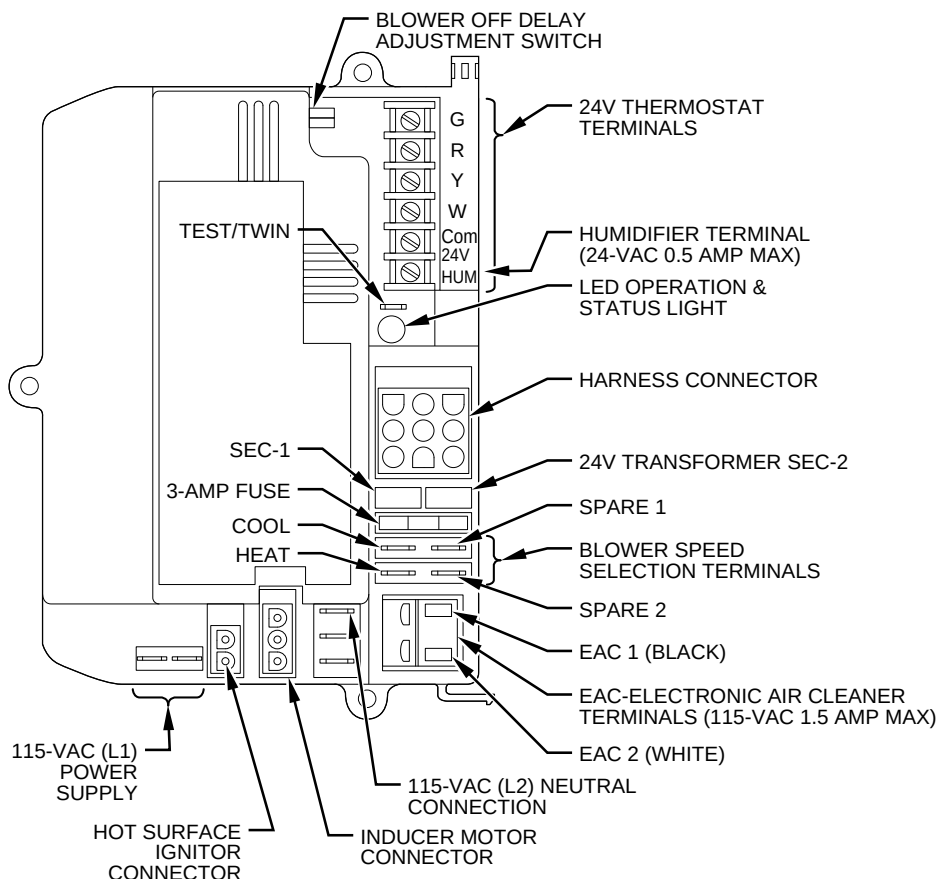


Fig. 10—Furnace Control

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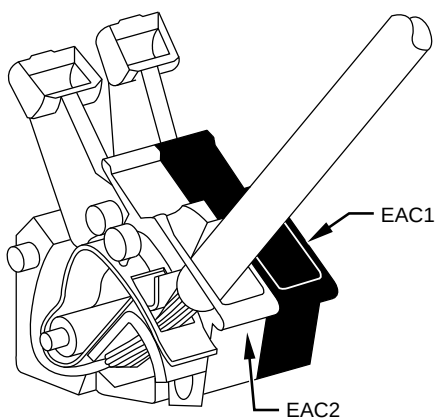


Fig. 11—EAC Terminals on Control Board

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chimney adapter kit is used, refer to the Installation Instructions included in the kit. The horizontal portion of the venting system shall maintain a minimum of 1/4-in. upward slope per linear ft and it shall be rigidly supported every 5 ft or less with hangers or straps to ensure that there will be no movement after installation.

## X. START-UP, ADJUSTMENT, AND SAFETY CHECK

### A. General

**NOTE:** Proper polarity must be maintained for 115-v wiring. If polarity is incorrect, the furnace control status indicator light will flash rapidly and furnace will not operate.

The furnace must have a 115-v power supply properly connected and grounded. Proper polarity must be maintained for correct operation. Thermostat wire connections at R, W, Com 24v, and Y must be made at the 24-v terminal block on the control board. The gas service pressure must not exceed 0.5 psig (14-in. wc), but must be no less than 0.16 psig (4.5-in. wc).

**CAUTION:** This furnace is equipped with a manual reset limit switch or fuse link in the gas control area. The switch or fuse link opens and shuts off power to the gas valve if a flame rollout or overheating condition occurs in the gas control area. DO NOT bypass the switch. Correct inadequate combustion air supply problem, and reset the switch or replace the fuse link.

Before operating the furnace, check each manual reset switch for continuity. If necessary, press the button to reset the switch.

The blower compartment door must be in place to complete the 115-v circuit to the furnace.

### B. Sequence of Operation

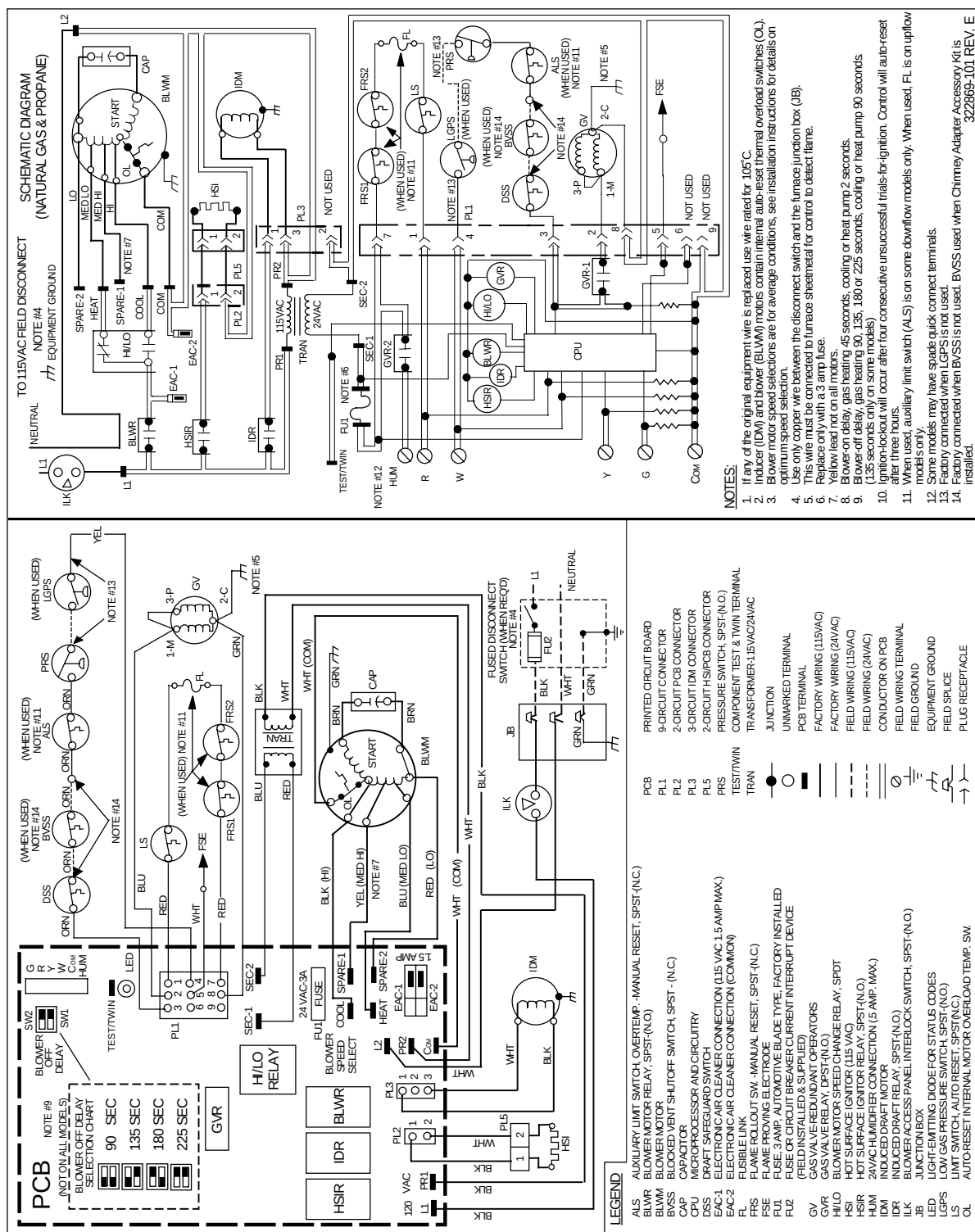
**CAUTION:** Furnace control must be grounded for proper operation, or control will lockout. Control is grounded through green wire routed to gas valve and burner bracket screw. Connect furnace ground wire to earth ground.

Using the schematic diagram shown in Fig. 12, follow the sequence of operation through the different modes. Read and follow the wiring diagram very carefully.

**NOTE:** If there is a power interruption and any thermostat call, the control initiates a 90-sec blower only on period before starting a cycle.

#### 1. Heating mode

When the wall thermostat "calls for heat," the R-W circuit closes. The furnace control performs a self-check, verifies the pressure switch contacts are open, and starts inducer motor.



→ **Fig. 12—Unit Wiring Diagram**

- a. Prepurge period—As the inducer motor comes up to speed, the pressure switch contacts close to begin a 15-sec prepurge period.
- b. Ignitor warm-up—At the end of the prepurge period, the ignitor is energized for a 17-sec ignitor warm-up period.
- c. Ignition sequence—When the ignitor warm-up period is completed, the gas valve opens, permitting gas flow to the burners where it is ignited. After 5 sec, the ignitor is de-energized and a 2-sec flame-sensing period begins.
- d. HUM terminal is energized with the gas valve. See accessories in the Electrical Connections section.
- e. Flame-sensing—When burner flame is sensed, the control begins the blower on delay period and continues holding the gas valve open. If burner flame is not sensed, the control closes the gas valve and repeats ignition sequence.

**NOTE:** Ignition sequence will repeat 3 additional times before a lockout occurs. Lockout automatically resets after 3 hr, or can be manually reset by turning 115v off (not at thermostat) for 3 sec minimum, then on again.

- f. Blower on delay—Forty sec after burner flame is proven, the blower motor is energized on heating speed. Simultaneously, the electronic air cleaner terminals (EAC-1 and EAC-2) are energized.
- g. Blower off delay—When the thermostat is satisfied, the circuit between R-W is broken, de-energizing the gas valve stopping gas flow to the burners. The blower motor and EAC remain energized 90, 135, 180, or 225 sec (depending on the blower off delay selection). The furnace is factory set for a 135-sec blower off delay.
- h. Post-purge—The inducer motor remains energized 5 sec after the burners are extinguished.

## 2. Cooling mode

When the thermostat "calls for cooling," R-G and R-Y circuits close. The R-Y circuit starts the outdoor condensing unit and the combined R-Y and R-G circuits start the furnace blower motor on cooling speed. The EAC-1 terminal is energized with 115v when the blower is operating on cooling speed.

When the thermostat is satisfied, R-G and R-Y circuits are broken. The furnace blower and EAC continue operating on cooling speed for an additional 90 sec.

## 3. Continuous blower mode

**NOTE:** EAC-1 terminal is energized with 115v whenever blower operates.

When the R-G circuit is made, the blower motor operates on heating speed. During a call for heat, the blower stops, allowing the furnace heat exchangers to heat up more quickly, then restarts at the end of the 40-sec blower on delay period.

The blower reverts to continuous operation after the heating cycle is completed.

When the thermostat "calls for cooling," the blower operates on cooling speed. When the thermostat is satisfied, the blower operates on cooling speed an additional 90 sec before reverting back to continuous operation on heating speed.

## 4. Heat pump mode

When installed with a heat pump, the furnace control automatically changes the timing sequence to avoid long blower on delay during defrost cycles. When the W-Y or

W-Y-G thermostat inputs are received at the same time, the control changes the blower to heating speed or starts the blower if it was off, and begins a heating cycle. The blower remains on until the end of the prepurge period, then shuts off until the end of the ignition warm-up and trial for ignition periods (a total of 24 sec). The blower then comes back on at heating speed.

When the W input signal disappears, the control begins the normal inducer post-purge period and the blower changes to cooling speed after a 1-sec delay. If the W-Y-G signals disappear at the same time, the blower remains on for the selected heating blower off delay period and the inducer goes through its normal post-purge period. If the W-Y inputs should disappear, leaving the G signal input, the control goes into continuous blower and the inducer remains on for the normal post-purge period.

Anytime the control senses false flame, the control locks out of the heating mode. This occurs because the control cannot sense the W input due to the false flame signal, and as a result, sees only the Y input and goes into cooling mode, blower off delay. All other control functions remain in standard format.

**NOTE:** EAC-1 terminal is energized whenever blower operates. HUM terminal is energized whenever the gas valve is energized.

## C. Start-up Procedures

1. Purge gas lines—After all connections have been made, purge the lines and check for leaks.



**WARNING:** Never purge a line into a combustion chamber. Never use matches, candles, flame, or other sources of ignition for the purpose of checking leakage. Use a soap-and-water solution to check for leakage. Failure to follow this warning can cause fire, explosion, personal injury, or death.

2. Component test—The furnace control allows all components, except gas valve, to be run for a short period of time. This feature helps diagnose a system problem in case of a component failure. To initiate component test procedure, short (jumper) the TEST 1/4-in. quick connect terminal on control board (adjacent to status light) and the Com 24v terminal on thermostat connection block for approximately 2 sec. (See Fig. 10.)

**NOTE:** Component test feature will not operate if any thermostat signal is present at control board.

Component test sequence is as follows.

- a. Momentarily jumper TEST and Com 24v terminals until LED goes off.
- b. LED will display previous status code 4 times.
- c. Inducer motor starts and continues to run for entire component test.
- d. Hot surface ignitor is energized for 15 sec, then de-energized.
- e. Blower motor operates on heating speed for 10 sec, then stops.
- f. Blower motor operates on cooling speed for 10 sec, then stops.
- g. Inducer motor stops.
3. To operate furnace, follow procedures on operating instructions label attached to furnace.
4. With furnace operating, set thermostat below room temperature and observe that furnace goes off. Set thermostat above room temperature and observe that furnace restarts.

## D. Adjustments

### 1. Set gas input rate

Furnace gas input rate on rating plate is for installations at altitudes up to 2000 ft. Furnace input rate must be within  $\pm 2$  percent of input on furnace rating plate.

#### a. Determine natural gas orifice size and manifold pressure for correct input.

- (1.) Obtain average yearly heat value (adjust for installed altitude) from local gas supplier.
- (2.) Obtain average yearly specific gravity from local gas supplier.
- (3.) Verify furnace model. Table 6 can only be used for model 393AAV Furnaces.
- (4.) Find installation altitude in Table 6.

**NOTE:** For Canada altitudes of 2000 to 4500 ft, use U.S.A. altitudes of 2001 to 3000 ft in Table 6.

- (5.) Find closest natural gas heat value and specific gravity in Table 6.
- (6.) Follow heat value and specific gravity lines to point of intersection to find orifice size and manifold pressure settings for proper operation .

**EXAMPLE:** (0—2000 ft altitude)

Heating value = 1025 Btu/cu ft Specific gravity = 0.62  
Therefore: Orifice No. 43\*

Manifold pressure 3.3-in. wc

\* Furnace is shipped with No. 43 orifices. In this example all main burner orifices are the correct size and do not need to be changed to obtain proper input rate.

- (7.) Check and verify burner orifice size in furnace. NEVER ASSUME ORIFICE SIZE. ALWAYS CHECK AND VERIFY.

#### b. Adjust manifold pressure to obtain input rate.

- (1.) Remove regulator adjustment seal cap. (See Fig. 13.)
- (2.) Turn adjusting screw, counterclockwise (out) to decrease manifold pressure or clockwise (in) to increase manifold pressure.

**NOTE:** This furnace has been approved for a manifold pressure of 3.2-in. wc to 3.8-in. wc when installed at altitudes up to 2000 ft. For altitudes above 2000 ft, the manifold pressure can be adjusted from 2.0-in. wc to 3.8-in. wc.



**CAUTION:** DO NOT bottom out gas valve regulator adjusting screw. This can result in unregulated manifold pressure and result in excess overfire and heat exchanger failures.

**NOTE:** If orifice hole appears damaged or it is suspected to have been redrilled, check orifice hole with a numbered drill bit of correct size. Never redrill an orifice. A burr-free and squarely aligned orifice hole is essential for proper flame characteristics.

- (3.) After correct manifold pressure is obtained, replace gas valve regulator adjustment screw cap and verify adjusted gas input rate using method outlined in item c.
- (4.) Burner flame should be clear blue, almost transparent. (See Fig. 14.)

#### c. Verify natural gas input rate by clocking gas meter.

**NOTE:** High-Altitude Adjustment

## UNITED STATES

At installation altitudes above 2000 ft, this furnace has been approved for a 4 percent derate for each 1000 ft above sea level. See Table 7 for derate multiplier factor.

**EXAMPLE:**

88,000 Btuh input furnace installed at 4300 ft.

| Furnace Input Rate at Sea Level | X | Derate Multiplier Factor | = | Furnace Input Rate at Installation Altitude |
|---------------------------------|---|--------------------------|---|---------------------------------------------|
| 88,000                          | X | 0.82                     | = | 72,160                                      |

## CANADA

At installation altitudes from 2000 to 4500 ft, this furnace must be derated 10 percent by an authorized Gas Conversion Station. To determine correct input rate for altitude, see example above and use 0.90 as derate multiplier factor.

- a. Turn off all other gas appliances and pilots.
- b. Start furnace and let operate for 3 minutes.
- c. Measure time (in sec) for gas meter test dial to complete 1 revolution.
- d. Refer to Table 8 for cu ft of gas per hr.
- e. Multiply gas rate (cu ft/hr) X heating value (Btu/cu ft) using natural gas heating value from local gas utility/supplier.

**EXAMPLE:** (0—2000 ft altitude)

Furnace rating plate input is 110,000 Btuh.

Btu heating input = Btu/cu ft X cu ft/hr

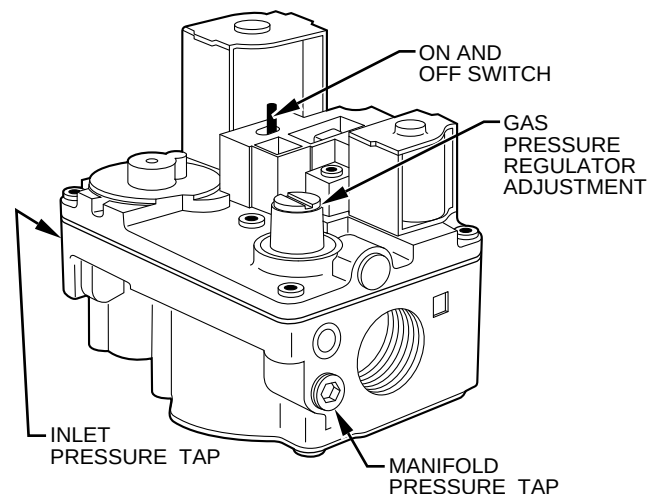
Heating value of gas = 1050 Btu/cu ft

Time for 1 revolution of 2-cu ft dial = 70 sec

Gas rate = 103 cu ft/hr (from Table 8)

Btu heating input = 103 X 1050 = 108,150 Btuh

In this example, the orifice size and manifold pressure adjustment is within  $\pm 2$  percent of the furnace input rate.



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**Fig. 13—Redundant Automatic Gas Control Valve**

### 2. Set temperature rise.

Furnace must operate within range of temperature rise specified on the unit rating plate. Determine the air temperature rise as follows.

**TABLE 6—MODEL 393AAV ORIFICE SIZE AND MANIFOLD PRESSURE FOR CORRECT INPUT**  
**(TABULATED DATA BASED ON 22,000 BTUH PER BURNER, DERATED 4 PERCENT PER 1000 FT ABOVE SEA LEVEL)**

| ALTITUDE RANGE (FT) |                                                                | AVG GAS HEAT VALUE AT ALTITUDE (BTU/CU FT) | SPECIFIC GRAVITY OF NATURAL GAS |                   |             |                   |             |                   |             |                   |             |                   |
|---------------------|----------------------------------------------------------------|--------------------------------------------|---------------------------------|-------------------|-------------|-------------------|-------------|-------------------|-------------|-------------------|-------------|-------------------|
|                     |                                                                |                                            | 0.58                            |                   | 0.60        |                   | 0.62        |                   | 0.64        |                   | 0.66        |                   |
|                     |                                                                |                                            | Orifice No.                     | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure |
| U.S.A. and Canada   | 0 to 2000                                                      | 850                                        | 42                              | 3.6               | 42          | 3.8               | 41          | 3.5               | 41          | 3.6               | 41          | 3.7               |
|                     |                                                                | 875                                        | 42                              | 3.4               | 42          | 3.6               | 42          | 3.7               | 42          | 3.8               | 41          | 3.5               |
|                     |                                                                | 900                                        | 42                              | 3.2               | 42          | 3.4               | 42          | 3.5               | 42          | 3.6               | 42          | 3.7               |
|                     |                                                                | 925                                        | 43                              | 3.7               | 42          | 3.2               | 42          | 3.3               | 42          | 3.4               | 42          | 3.5               |
|                     |                                                                | 950                                        | 43                              | 3.6               | 43          | 3.7               | 43          | 3.8               | 42          | 3.2               | 42          | 3.3               |
|                     |                                                                | 975                                        | 43                              | 3.4               | 43          | 3.5               | 43          | 3.6               | 43          | 3.7               | 43          | 3.8               |
|                     |                                                                | 1000                                       | 43                              | 3.2               | 43          | 3.3               | 43          | 3.4               | 43          | 3.5               | 43          | 3.6               |
|                     |                                                                | 1025                                       | 44                              | 3.5               | 43          | 3.2               | 43          | 3.3               | 43          | 3.4               | 43          | 3.5               |
|                     |                                                                | 1050                                       | 44                              | 3.3               | 44          | 3.4               | 44          | 3.6               | 43          | 3.2               | 43          | 3.3               |
|                     |                                                                | 1075                                       | 45                              | 3.8               | 44          | 3.3               | 44          | 3.4               | 44          | 3.5               | 43          | 3.2               |
|                     |                                                                | 1100                                       | 45                              | 3.7               | 45          | 3.8               | 44          | 3.2               | 44          | 3.4               | 44          | 3.5               |
| ALTITUDE RANGE (FT) |                                                                | AVG GAS HEAT VALUE AT ALTITUDE (BTU/CU FT) | SPECIFIC GRAVITY OF NATURAL GAS |                   |             |                   |             |                   |             |                   |             |                   |
|                     |                                                                |                                            | 0.58                            |                   | 0.60        |                   | 0.62        |                   | 0.64        |                   | 0.66        |                   |
|                     |                                                                |                                            | Orifice No.                     | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure |
| U.S.A. and Canada   | U.S.A. Altitudes 2001 to 3000 or Canada Altitudes 2000 to 4500 | 775                                        | 42                              | 3.4               | 42          | 3.5               | 42          | 3.6               | 42          | 3.7               | 42          | 3.8               |
|                     |                                                                | 800                                        | 43                              | 3.8               | 42          | 3.3               | 42          | 3.4               | 42          | 3.5               | 42          | 3.6               |
|                     |                                                                | 825                                        | 43                              | 3.6               | 43          | 3.7               | 42          | 3.2               | 42          | 3.3               | 42          | 3.4               |
|                     |                                                                | 850                                        | 43                              | 3.4               | 43          | 3.5               | 43          | 3.6               | 43          | 3.8               | 42          | 3.2               |
|                     |                                                                | 875                                        | 43                              | 3.2               | 43          | 3.3               | 43          | 3.4               | 43          | 3.5               | 43          | 3.6               |
|                     |                                                                | 900                                        | 43                              | 3.0               | 43          | 3.1               | 43          | 3.2               | 43          | 3.3               | 43          | 3.4               |
|                     |                                                                | 925                                        | 43                              | 2.9               | 43          | 3.0               | 43          | 3.1               | 43          | 3.2               | 43          | 3.3               |
|                     |                                                                | 950                                        | 43                              | 2.7               | 43          | 2.8               | 43          | 2.9               | 43          | 3.0               | 43          | 3.1               |
|                     |                                                                | 975                                        | 43                              | 2.6               | 43          | 2.7               | 43          | 2.8               | 43          | 2.9               | 43          | 2.9               |
|                     |                                                                | 1000                                       | 43                              | 2.5               | 43          | 2.5               | 43          | 2.6               | 43          | 2.7               | 43          | 2.8               |
|                     |                                                                | 1025                                       | 43                              | 2.3               | 43          | 2.4               | 43          | 2.5               | 43          | 2.6               | 43          | 2.7               |
| ALTITUDE RANGE (FT) |                                                                | AVG GAS HEAT VALUE AT ALTITUDE (BTU/CU FT) | SPECIFIC GRAVITY OF NATURAL GAS |                   |             |                   |             |                   |             |                   |             |                   |
|                     |                                                                |                                            | 0.58                            |                   | 0.60        |                   | 0.62        |                   | 0.64        |                   | 0.66        |                   |
|                     |                                                                |                                            | Orifice No.                     | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure |
| U.S.A. Only         | 3001 to 4000                                                   | 750                                        | 43                              | 3.8               | 42          | 3.3               | 42          | 3.4               | 42          | 3.5               | 42          | 3.6               |
|                     |                                                                | 775                                        | 43                              | 3.6               | 43          | 3.7               | 43          | 3.8               | 42          | 3.3               | 42          | 3.4               |
|                     |                                                                | 800                                        | 43                              | 3.4               | 43          | 3.5               | 43          | 3.6               | 43          | 3.7               | 43          | 3.8               |
|                     |                                                                | 825                                        | 43                              | 3.2               | 43          | 3.3               | 43          | 3.4               | 43          | 3.5               | 43          | 3.6               |
|                     |                                                                | 850                                        | 43                              | 3.0               | 43          | 3.1               | 43          | 3.2               | 43          | 3.3               | 43          | 3.4               |
|                     |                                                                | 875                                        | 43                              | 2.8               | 43          | 2.9               | 43          | 3.0               | 43          | 3.1               | 43          | 3.2               |
|                     |                                                                | 900                                        | 43                              | 2.7               | 43          | 2.8               | 43          | 2.9               | 43          | 2.9               | 43          | 3.0               |
|                     |                                                                | 925                                        | 43                              | 2.5               | 43          | 2.6               | 43          | 2.7               | 43          | 2.8               | 43          | 2.9               |
|                     |                                                                | 950                                        | 43                              | 2.4               | 43          | 2.5               | 43          | 2.6               | 43          | 2.6               | 43          | 2.7               |
|                     |                                                                | 975                                        | 43                              | 2.3               | 43          | 2.4               | 43          | 2.4               | 43          | 2.5               | 43          | 2.6               |
|                     |                                                                | 1000                                       | 43                              | 2.2               | 43          | 2.2               | 43          | 2.3               | 43          | 2.4               | 43          | 2.5               |
| ALTITUDE RANGE (FT) |                                                                | AVG GAS HEAT VALUE AT ALTITUDE (BTU/CU FT) | SPECIFIC GRAVITY OF NATURAL GAS |                   |             |                   |             |                   |             |                   |             |                   |
|                     |                                                                |                                            | 0.58                            |                   | 0.60        |                   | 0.62        |                   | 0.64        |                   | 0.66        |                   |
|                     |                                                                |                                            | Orifice No.                     | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure |
| U.S.A. Only         | 4001 to 5000                                                   | 725                                        | 43                              | 3.6               | 43          | 3.7               | 42          | 3.2               | 42          | 3.3               | 42          | 3.4               |
|                     |                                                                | 750                                        | 43                              | 3.4               | 43          | 3.5               | 43          | 3.6               | 43          | 3.7               | 43          | 3.8               |
|                     |                                                                | 775                                        | 43                              | 3.2               | 43          | 3.3               | 43          | 3.4               | 43          | 3.5               | 43          | 3.6               |
|                     |                                                                | 800                                        | 43                              | 3.0               | 43          | 3.1               | 43          | 3.2               | 43          | 3.3               | 43          | 3.4               |
|                     |                                                                | 825                                        | 43                              | 2.8               | 43          | 2.9               | 43          | 3.0               | 43          | 3.1               | 43          | 3.2               |
|                     |                                                                | 850                                        | 43                              | 2.6               | 43          | 2.7               | 43          | 2.8               | 43          | 2.9               | 43          | 3.0               |
|                     |                                                                | 875                                        | 43                              | 2.5               | 43          | 2.6               | 43          | 2.6               | 43          | 2.7               | 43          | 2.8               |
|                     |                                                                | 900                                        | 43                              | 2.3               | 43          | 2.4               | 43          | 2.5               | 43          | 2.6               | 43          | 2.7               |
|                     |                                                                | 925                                        | 43                              | 2.2               | 43          | 2.3               | 43          | 2.4               | 43          | 2.4               | 43          | 2.5               |
|                     |                                                                | 950                                        | 43                              | 2.1               | 43          | 2.2               | 43          | 2.2               | 43          | 2.3               | 43          | 2.4               |

**TABLE 6—MODEL 393AAV ORIFICE SIZE AND MANIFOLD PRESSURE FOR CORRECT INPUT   Continued**  
**(TABULATED DATA BASED ON 22,000 BTUH PER BURNER, DERATED 4 PERCENT PER 1000 FT ABOVE SEA LEVEL)**

| ALTITUDE RANGE (FT) |              | AVG GAS HEAT VALUE AT ALTITUDE (BTU/CU FT) | SPECIFIC GRAVITY OF NATURAL GAS |                   |             |                   |             |                   |             |                   |             |                   |
|---------------------|--------------|--------------------------------------------|---------------------------------|-------------------|-------------|-------------------|-------------|-------------------|-------------|-------------------|-------------|-------------------|
|                     |              |                                            | 0.58                            |                   | 0.60        |                   | 0.62        |                   | 0.64        |                   | 0.66        |                   |
|                     |              |                                            | Orifice No.                     | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure |
| U.S.A. Only         | 5001 to 6000 | 700                                        | 43                              | 3.4               | 43          | 3.5               | 43          | 3.6               | 43          | 3.7               | 43          | 3.8               |
|                     |              | 725                                        | 43                              | 3.1               | 43          | 3.2               | 43          | 3.4               | 43          | 3.5               | 43          | 3.6               |
|                     |              | 750                                        | 43                              | 2.9               | 43          | 3.0               | 43          | 3.1               | 43          | 3.2               | 43          | 3.3               |
|                     |              | 775                                        | 43                              | 2.7               | 43          | 2.8               | 43          | 2.9               | 43          | 3.0               | 43          | 3.1               |
|                     |              | 800                                        | 43                              | 2.6               | 43          | 2.7               | 43          | 2.8               | 43          | 2.8               | 43          | 2.9               |
|                     |              | 825                                        | 43                              | 2.4               | 43          | 2.5               | 43          | 2.6               | 43          | 2.7               | 43          | 2.8               |
|                     |              | 850                                        | 43                              | 2.3               | 43          | 2.4               | 43          | 2.4               | 43          | 2.5               | 43          | 2.6               |
|                     |              | 875                                        | 43                              | 2.2               | 43          | 2.2               | 43          | 2.3               | 43          | 2.4               | 43          | 2.5               |
|                     |              | 900                                        | 43                              | 2.0               | 43          | 2.1               | 43          | 2.2               | 43          | 2.2               | 43          | 2.3               |
|                     |              | 925                                        | 48                              | 3.6               | 48          | 3.8               | 43          | 2.1               | 43          | 2.1               | 43          | 2.2               |
|                     |              | 950                                        | 48                              | 3.4               | 48          | 3.6               | 48          | 3.7               | 43          | 2.0               | 43          | 2.1               |
|                     |              | 975                                        | 49                              | 3.8               | 48          | 3.4               | 48          | 3.5               | 48          | 3.6               | 48          | 3.7               |
| 1000                | 49           | 3.6                                        | 49                              | 3.8               | 48          | 3.3               | 48          | 3.4               | 48          | 3.5               |             |                   |
| ALTITUDE RANGE (FT) |              | AVG GAS HEAT VALUE AT ALTITUDE (BTU/CU FT) | SPECIFIC GRAVITY OF NATURAL GAS |                   |             |                   |             |                   |             |                   |             |                   |
|                     |              |                                            | 0.58                            |                   | 0.60        |                   | 0.62        |                   | 0.64        |                   | 0.66        |                   |
|                     |              |                                            | Orifice No.                     | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure |
| U.S.A. Only         | 6001 to 7000 | 650                                        | 43                              | 3.4               | 43          | 3.5               | 43          | 3.6               | 43          | 3.7               | 43          | 3.8               |
|                     |              | 675                                        | 43                              | 3.1               | 43          | 3.2               | 43          | 3.4               | 43          | 3.5               | 43          | 3.6               |
|                     |              | 700                                        | 43                              | 2.9               | 43          | 3.0               | 43          | 3.1               | 43          | 3.2               | 43          | 3.3               |
|                     |              | 725                                        | 43                              | 2.7               | 43          | 2.8               | 43          | 2.9               | 43          | 3.0               | 43          | 3.1               |
|                     |              | 750                                        | 43                              | 2.5               | 43          | 2.6               | 43          | 2.7               | 43          | 2.8               | 43          | 2.9               |
|                     |              | 775                                        | 43                              | 2.4               | 43          | 2.5               | 43          | 2.5               | 43          | 2.6               | 43          | 2.7               |
|                     |              | 800                                        | 43                              | 2.2               | 43          | 2.3               | 43          | 2.4               | 43          | 2.5               | 43          | 2.5               |
|                     |              | 825                                        | 43                              | 2.1               | 43          | 2.2               | 43          | 2.2               | 43          | 2.3               | 43          | 2.4               |
|                     |              | 850                                        | 48                              | 3.7               | 43          | 2.0               | 43          | 2.1               | 43          | 2.2               | 43          | 2.3               |
|                     |              | 875                                        | 48                              | 3.5               | 48          | 3.6               | 48          | 3.8               | 43          | 2.1               | 43          | 2.1               |
| ALTITUDE RANGE (FT) |              | AVG GAS HEAT VALUE AT ALTITUDE (BTU/CU FT) | SPECIFIC GRAVITY OF NATURAL GAS |                   |             |                   |             |                   |             |                   |             |                   |
|                     |              |                                            | 0.58                            |                   | 0.60        |                   | 0.62        |                   | 0.64        |                   | 0.66        |                   |
|                     |              |                                            | Orifice No.                     | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure |
| U.S.A. Only         | 7001 to 8000 | 625                                        | 43                              | 3.1               | 43          | 3.3               | 43          | 3.4               | 43          | 3.5               | 43          | 3.6               |
|                     |              | 650                                        | 43                              | 2.9               | 43          | 3.0               | 43          | 3.1               | 43          | 3.2               | 43          | 3.3               |
|                     |              | 675                                        | 43                              | 2.7               | 43          | 2.8               | 43          | 2.9               | 43          | 3.0               | 43          | 3.1               |
|                     |              | 700                                        | 43                              | 2.5               | 43          | 2.6               | 43          | 2.7               | 43          | 2.8               | 43          | 2.9               |
|                     |              | 725                                        | 43                              | 2.3               | 43          | 2.4               | 43          | 2.5               | 43          | 2.6               | 43          | 2.7               |
|                     |              | 750                                        | 43                              | 2.2               | 43          | 2.3               | 43          | 2.3               | 43          | 2.4               | 43          | 2.5               |
|                     |              | 775                                        | 43                              | 2.0               | 43          | 2.1               | 43          | 2.2               | 43          | 2.3               | 43          | 2.3               |
|                     |              | 800                                        | 48                              | 3.6               | 48          | 3.7               | 43          | 2.1               | 43          | 2.1               | 43          | 2.2               |
|                     |              | 825                                        | 48                              | 3.4               | 48          | 3.5               | 48          | 3.6               | 48          | 3.8               | 43          | 2.1               |
|                     |              | 850                                        | 49                              | 3.8               | 48          | 3.3               | 48          | 3.4               | 48          | 3.5               | 48          | 3.6               |
| ALTITUDE RANGE (FT) |              | AVG GAS HEAT VALUE AT ALTITUDE (BTU/CU FT) | SPECIFIC GRAVITY OF NATURAL GAS |                   |             |                   |             |                   |             |                   |             |                   |
|                     |              |                                            | 0.58                            |                   | 0.60        |                   | 0.62        |                   | 0.64        |                   | 0.66        |                   |
|                     |              |                                            | Orifice No.                     | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure | Orifice No. | Manifold Pressure |
| U.S.A. Only         | 8001 to 9000 | 600                                        | 43                              | 2.9               | 43          | 3.0               | 43          | 3.1               | 43          | 3.2               | 43          | 3.3               |
|                     |              | 625                                        | 43                              | 2.7               | 43          | 2.8               | 43          | 2.9               | 43          | 3.0               | 43          | 3.1               |
|                     |              | 650                                        | 43                              | 2.5               | 43          | 2.6               | 43          | 2.7               | 43          | 2.8               | 43          | 2.8               |
|                     |              | 675                                        | 43                              | 2.3               | 43          | 2.4               | 43          | 2.5               | 43          | 2.6               | 43          | 2.6               |
|                     |              | 700                                        | 43                              | 2.2               | 43          | 2.2               | 43          | 2.3               | 43          | 2.4               | 43          | 2.4               |
|                     |              | 725                                        | 43                              | 2.0               | 43          | 2.1               | 43          | 2.1               | 43          | 2.2               | 43          | 2.3               |
|                     |              | 750                                        | 48                              | 3.5               | 48          | 3.6               | 43          | 2.0               | 43          | 2.1               | 43          | 2.1               |
|                     |              | 775                                        | 48                              | 3.3               | 48          | 3.4               | 48          | 3.5               | 48          | 3.6               | 48          | 3.8               |
|                     |              | 800                                        | 49                              | 3.6               | 49          | 3.8               | 48          | 3.3               | 48          | 3.4               | 48          | 3.5               |

**TABLE 6—MODEL 393AAV ORIFICE SIZE AND MANIFOLD PRESSURE FOR CORRECT INPUT Continued**  
(TABULATED DATA BASED ON 22,000 BTUH PER BURNER, DERATED 4 PERCENT PER 1000 FT ABOVE SEA LEVEL)

| ALTITUDE<br>RANGE<br>(FT) |                  | AVG GAS<br>HEAT VALUE<br>AT ALTITUDE<br>(BTU/CU FT) | SPECIFIC GRAVITY OF NATURAL GAS |                      |                |                      |                |                      |                |                      |                |                      |
|---------------------------|------------------|-----------------------------------------------------|---------------------------------|----------------------|----------------|----------------------|----------------|----------------------|----------------|----------------------|----------------|----------------------|
|                           |                  |                                                     | 0.58                            |                      | 0.60           |                      | 0.62           |                      | 0.64           |                      | 0.66           |                      |
|                           |                  |                                                     | Orifice<br>No.                  | Manifold<br>Pressure | Orifice<br>No. | Manifold<br>Pressure | Orifice<br>No. | Manifold<br>Pressure | Orifice<br>No. | Manifold<br>Pressure | Orifice<br>No. | Manifold<br>Pressure |
| U.S.A. Only               | 9001             | 575                                                 | 43                              | 2.7                  | 43             | 2.8                  | 43             | 2.9                  | 43             | 3.0                  | 43             | 3.1                  |
|                           |                  | 600                                                 | 43                              | 2.5                  | 43             | 2.6                  | 43             | 2.7                  | 43             | 2.7                  | 43             | 2.8                  |
|                           |                  | 625                                                 | 43                              | 2.3                  | 43             | 2.4                  | 43             | 2.4                  | 43             | 2.5                  | 43             | 2.6                  |
|                           |                  | 650                                                 | 43                              | 2.1                  | 43             | 2.2                  | 43             | 2.3                  | 43             | 2.3                  | 43             | 2.4                  |
|                           | to<br><br>10,000 | 675                                                 | 48                              | 3.7                  | 43             | 2.0                  | 43             | 2.1                  | 43             | 2.2                  | 43             | 2.2                  |
|                           |                  | 700                                                 | 48                              | 3.4                  | 48             | 3.6                  | 48             | 3.7                  | 43             | 2.0                  | 43             | 2.1                  |
|                           |                  | 725                                                 | 49                              | 3.8                  | 48             | 3.3                  | 48             | 3.4                  | 48             | 3.5                  | 48             | 3.6                  |
|                           |                  | 750                                                 | 49                              | 3.5                  | 49             | 3.6                  | 49             | 3.8                  | 48             | 3.3                  | 48             | 3.4                  |
|                           |                  | 775                                                 | 49                              | 3.3                  | 49             | 3.4                  | 49             | 3.5                  | 49             | 3.6                  | 49             | 3.7                  |

- Place duct thermometers in return and supply ducts as near furnace as possible. Be sure supply-air thermometers do not "see" heat exchangers so that radiant heat will not affect thermometer readings. This is particularly important with straight-run ducts.
- When thermometer readings stabilize, subtract return-air temperature from supply-air temperature to determine temperature rise.
- Adjust air temperature rise by adjusting blower speed. Increase blower speed to reduce temperature rise. Decrease blower speed to increase temperature rise.

**WARNING:** Disconnect the electrical power before changing the blower motor speed tap. A failure to follow this warning can cause personal injury.

- To change blower motor speed selections for heating mode, remove blower motor lead from control HEAT terminal. (See Fig. 10.) Select desired blower motor speed lead from 1 of the other terminals and relocate it to HEAT terminal. See Table 9 for lead color identification. Reconnect unused lead on SPARE terminal.

**CAUTION:** Recheck temperature rise. It must be within the air temperature specified on unit rating plate. Recommended operation is at midpoint of rise or above.

- Set thermostat heat anticipator.

The thermostat heat anticipator must be set to match the amp draw of the electrical components in the R-W circuit. Accurate amp draw readings can be obtained at thermostat subbase terminals R and W. Fig. 15 illustrates an easy

**TABLE 7—ALTITUDE DERATE MULTIPLIER FOR U.S.A.**

| ALTITUDE (FT) | % OF DERATE | DERATE MULTIPLIER FACTOR FOR U.S.A.* |
|---------------|-------------|--------------------------------------|
| 0—2000        | 0           | 1.00                                 |
| 2001—3000     | 8—12        | 0.90                                 |
| 3001—4000     | 12—16       | 0.86                                 |
| 4001—5000     | 16—20       | 0.82                                 |
| 5001—6000     | 20—24       | 0.78                                 |
| 6001—7000     | 24—28       | 0.74                                 |
| 7001—8000     | 28—32       | 0.70                                 |
| 8001—9000     | 32—36       | 0.66                                 |
| 9001—10,000   | 36—40       | 0.62                                 |

\* Derate multiplier factor is based on midpoint altitude for altitude range.

method of obtaining the actual amp draw. The amp reading should be taken after the blower motor has started. See the thermostat manufacturer's instructions for adjusting the heat anticipator and for varying the heating cycle length.

**NOTE:** When using an electronic thermostat, set the cycle rate for 3 cycles per hr.

### E. Check Safety Controls

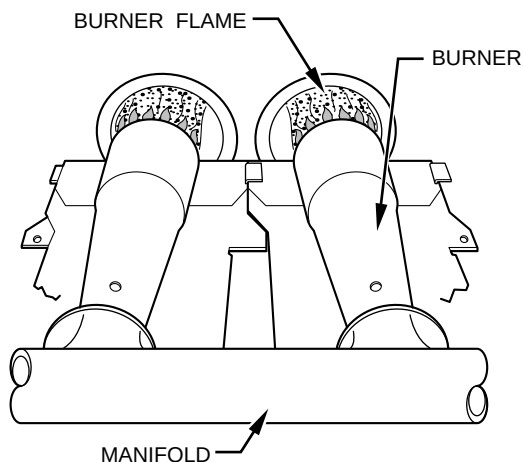
The flame sensor, gas valve, and pressure switch were all checked in the Start-up Procedures section as part of normal operation.

- Check primary limit control.

This control shuts off the combustion control system and energizes the circulating-air blower motor if the furnace overheats.

**TABLE 8—GAS RATE CU FT/HR**

| SECONDS FOR 1 REVOLUTION | SIZE OF TEST DIAL |         |         | SECONDS FOR 1 REVOLUTION | SIZE OF TEST DIAL |         |         |
|--------------------------|-------------------|---------|---------|--------------------------|-------------------|---------|---------|
|                          | 1 cu ft           | 2 cu ft | 5 cu ft |                          | 1 cu ft           | 2 cu ft | 5 cu ft |
| 10                       | 360               | 720     | 1800    | 50                       | 72                | 144     | 360     |
| 11                       | 327               | 655     | 1636    | 51                       | 71                | 141     | 355     |
| 12                       | 300               | 600     | 1500    | 52                       | 69                | 138     | 346     |
| 13                       | 277               | 555     | 1385    | 53                       | 68                | 136     | 340     |
| 14                       | 257               | 514     | 1286    | 54                       | 67                | 133     | 333     |
| 15                       | 240               | 480     | 1200    | 55                       | 65                | 131     | 327     |
| 16                       | 225               | 450     | 1125    | 56                       | 64                | 129     | 321     |
| 17                       | 212               | 424     | 1059    | 57                       | 63                | 126     | 316     |
| 18                       | 200               | 400     | 1000    | 58                       | 62                | 124     | 310     |
| 19                       | 189               | 379     | 947     | 59                       | 61                | 122     | 305     |
| 20                       | 180               | 360     | 900     | 60                       | 60                | 120     | 300     |
| 21                       | 171               | 343     | 857     | 62                       | 58                | 116     | 290     |
| 22                       | 164               | 327     | 818     | 64                       | 56                | 112     | 281     |
| 23                       | 157               | 313     | 783     | 66                       | 54                | 109     | 273     |
| 24                       | 150               | 300     | 750     | 68                       | 53                | 106     | 265     |
| 25                       | 144               | 288     | 720     | 70                       | 51                | 103     | 257     |
| 26                       | 138               | 277     | 692     | 72                       | 50                | 100     | 250     |
| 27                       | 133               | 267     | 667     | 74                       | 48                | 97      | 243     |
| 28                       | 129               | 257     | 643     | 76                       | 47                | 95      | 237     |
| 29                       | 124               | 248     | 621     | 78                       | 46                | 92      | 231     |
| 30                       | 120               | 240     | 600     | 80                       | 45                | 90      | 225     |
| 31                       | 116               | 232     | 581     | 82                       | 44                | 88      | 220     |
| 32                       | 113               | 225     | 563     | 84                       | 43                | 86      | 214     |
| 33                       | 109               | 218     | 545     | 86                       | 42                | 84      | 209     |
| 34                       | 106               | 212     | 529     | 88                       | 41                | 82      | 205     |
| 35                       | 103               | 206     | 514     | 90                       | 40                | 80      | 200     |
| 36                       | 100               | 200     | 500     | 92                       | 39                | 78      | 196     |
| 37                       | 97                | 195     | 486     | 94                       | 38                | 76      | 192     |
| 38                       | 95                | 189     | 474     | 96                       | 38                | 75      | 188     |
| 39                       | 92                | 185     | 462     | 98                       | 37                | 74      | 184     |
| 40                       | 90                | 180     | 450     | 100                      | 36                | 72      | 180     |
| 41                       | 88                | 176     | 439     | 102                      | 35                | 71      | 178     |
| 42                       | 86                | 172     | 429     | 104                      | 35                | 69      | 173     |
| 43                       | 84                | 167     | 419     | 106                      | 34                | 68      | 170     |
| 44                       | 82                | 164     | 409     | 108                      | 33                | 67      | 167     |
| 45                       | 80                | 160     | 400     | 110                      | 33                | 65      | 164     |
| 46                       | 78                | 157     | 391     | 112                      | 32                | 64      | 161     |
| 47                       | 76                | 153     | 383     | 116                      | 31                | 62      | 155     |
| 48                       | 75                | 150     | 375     | 120                      | 30                | 60      | 150     |
| 49                       | 73                | 147     | 367     |                          |                   |         |         |

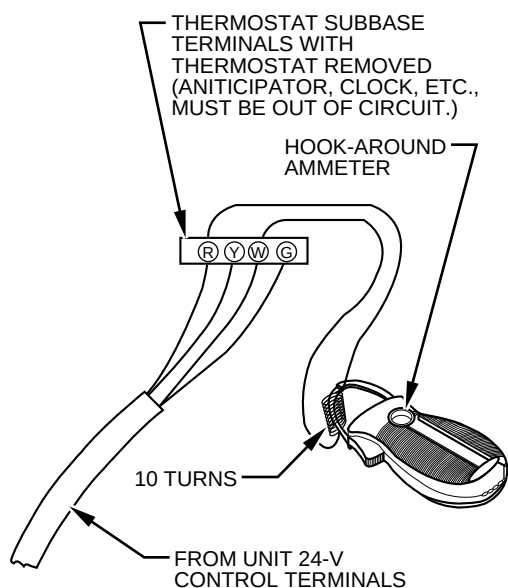


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**Fig. 14—Burner Flame**

**TABLE 9—SPEED SELECTOR**

| COLOR                 | SPEED       | FACTORY-ATTACHED TO |
|-----------------------|-------------|---------------------|
| Black                 | High        | Cool                |
| Yellow (When present) | Medium-High | Spare               |
| Blue                  | Medium-Low  | Heat                |
| Red                   | Low         | Spare               |
| White                 | Common      | COM                 |



EXAMPLE:  $\frac{5.0 \text{ AMPS ON AMMETER}}{10 \text{ TURNS AROUND JAWS}} = 0.5 \text{ AMPS FOR THERMOSTAT ANTICIPATOR SETTING}$

A96316

**Fig. 15—Amp Draw Check With Ammeter**

The preferred method of checking the limit control is to gradually block off the return air after the furnace has been operating for a period of at least 5 minutes. As soon as the

limit has shut off the burners, the return-air opening should be unblocked. By using this method to check the limit control, it can be established that the limit functions and operates properly if there is a motor failure.

## 2. Check blocked vent safeguard switch.

The purpose of this control is to cause the safe shutdown of the furnace during certain blocked vent conditions.

- Disconnect power to furnace and remove vent connector from furnace flue collar. Be sure to allow time for vent pipe to cool down before removing.
- Restore power to furnace and set room thermostat above room temperature.
- After normal start-up, allow furnace to operate for 2 minutes, then block flue collar 100 percent. Furnace should cycle off within 2 minutes.
- Remove blockage and reconnect vent pipe to furnace flue collar.
- Wait 5 minutes and then reset blocked vent safeguard switch.

## 3. Check pressure switch.

This control proves operation of draft inducer blower.

- Turn off 115-v power to furnace.
- Remove control door and disconnect inducer motor from wire harness.
- Turn on 115-v power to furnace.
- Set thermostat to "call for heat" and wait 1 minute. When pressure switch is functioning properly, hot surface ignitor should NOT glow and control status code light flashes code 31. If hot surface ignitor glows when inducer motor is disconnected, shut down furnace immediately. Determine reason pressure switch did not function properly and correct condition.
- Turn off 115-v power to furnace.
- Reconnect inducer motor wires, replace control door, and turn on 115-v power.

## F. Checklist

- Put away tools, instruments, and clean up debris.
- Verify manual reset switches have continuity.
- Ensure blower and control access doors are properly installed.
- Cycle test furnace with room thermostat.
- Check operation of accessories per manufacturer's instructions.
- Review User's Manual with owner.
- Leave literature packet near furnace.