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installation, start-up, and operating instructions

DOWNFLOW/HORIZONTAL GAS-FIRED, INDUCED-COMBUSTION FURNACES

376CAV Series D

Cancels: II 376C-40-6

II 376C-40-7

11-1-93

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

Index	Page
SAFETY CONSIDERATIONS	1-2
Clearances From Combustible Materials	1
INTRODUCTION	2-3
Dimensional Drawing	2
LOCATION	3
General	3
Location Relative to Cooling Equipment	3
Hazardous Locations	3
AIR FOR COMBUSTION AND VENTILATION	3-5
Unconfined Space	3
Confined Space	3-5
SUPPLY-AIR PLENUM INSTALLATION (DOWNFLOW)	5
Installation On a Concrete Slab	5
Installation On a Combustible Floor	5
HORIZONTAL ATTIC INSTALLATION	5
Construct a Working Platform	5
Install Furnace	5
HORIZONTAL CRAWLSPACE INSTALLATION	5-6
FILTER ARRANGEMENT	6
GAS PIPING	6-7
ELECTRICAL CONNECTIONS	7-9
115-v Wiring	7
24-v Wiring	8
Accessories	8
VENTING	9
START-UP, ADJUSTMENT, AND SAFETY CHECK	9-15
General	9
Sequence Of Operation	9-11
Heating Mode	9-10
Cooling Mode	9
Continuous Blower Mode	10
Heat Pump Mode	10
Start-up Procedures	11-15
Adjustments	11-14
Check Safety Controls	14-15
Checklist	15

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.

Follow all safety codes. In the United States, follow all safety codes including the National Fuel Gas Code NFPA No. 54-1992/ANSI Z223.1-1992 (NFGC). In Canada, refer to the current edition of the National Standard of Canada CAN/CGA-B149.1-



→ **TABLE 1—CLEARANCES FROM COMBUSTIBLE MATERIALS (IN.)**

UNIT SIZE	050 AND 070	096-135
DOWNFLOW (In Alcove or Closet)		
Sides Single-Wall Vent	1	0
Type B-1 Double-Wall Vent	0	0
Back	0	0
Top	1	1
Front Single-Wall Vent	6†	6†
Type B-1 Double-Wall Vent	3†	3†
Vent Single-Wall Vent	6	6
Type B-1 Double-Wall Vent	1	1
HORIZONTAL (Attic, Alcove, or Crawl space)		
Sides *	1	0
Back	0	0
Top Single-Wall Vent	1	1
Type B-1 Double-Wall Vent	1	1
Front† Single-Wall Vent	6†	6†
Type B-1 Double-Wall Vent	3†	3†
Vent Single-Wall Vent	6	6
Type B-1 Double-Wall Vent	1	1
HORIZONTAL (In Closet)		
Sides *	1	1
Back	0	0
Top Single-Wall Vent	2	2
Type B-1 Double-Wall Vent	2	2
Front Single-Wall Vent	6	6
Type B-1 Double-Wall Vent	3	3
Vent Single-Wall Vent	6	6
Type B-1 Double-Wall Vent	1	1

* Indicates supply or return sides when furnace is in the horizontal position.
† Clearance shown is for outlet end. The inlet end must maintain 6-in. minimum clearance from the vent to combustible materials when using single-wall vent.

‡ Minimum 18-in. front clearance required for alcove.

NOTES:

1. Provide 30-in. front clearance for servicing. An open door in front of the furnace can meet this requirement.
2. A minimum clearance of 3 in. must be provided in front of the furnace for combustion air and proper operation.
3. Line contact is permitted as shown in Fig. 7.

and .2-M91 Natural Gas and Propane Gas 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 unit and in instructions or manuals, be alert to the potential for personal injury.

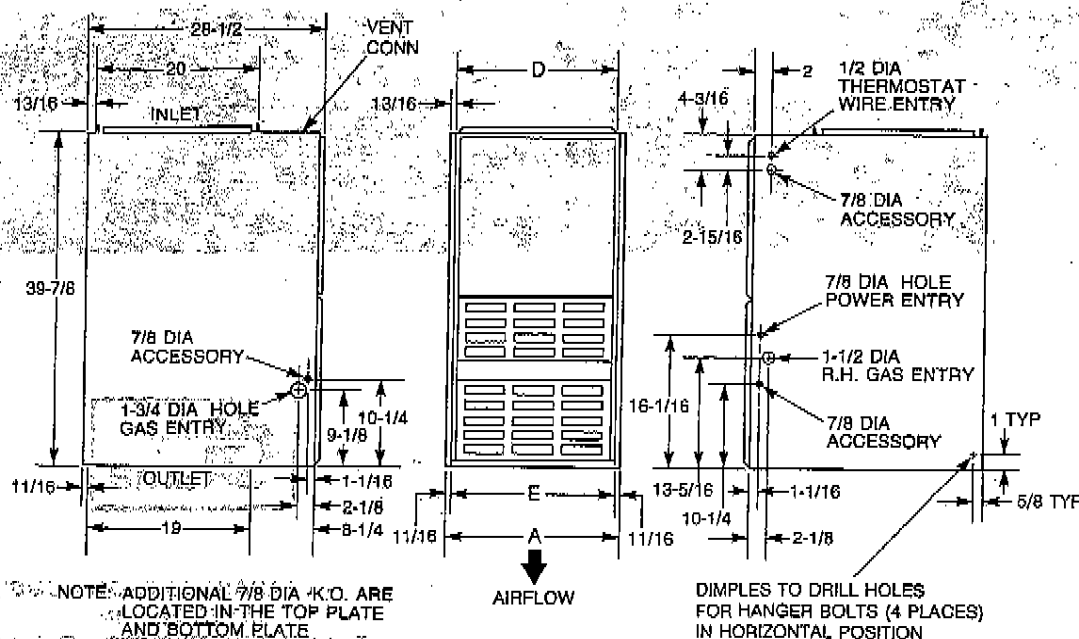


Fig. 1—Dimensional Drawing

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Understand the signal word DANGER, WARNING, or 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 that 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. NOTE is used to highlight suggestions that will result in enhanced installation, reliability, or operation.

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.

INTRODUCTION

The model 376CAV Series D Furnaces are available in sizes 50,000 through 135,000 Btu input capacities:

The design of the downflow/horizontal gas-fired furnace is A.G.A./C.G.A. certified for natural and propane gas and for installation on noncombustible flooring. The furnace may be installed on combustible flooring when installed with the accessory downflow subbase. This furnace is for installation in alcoves, attics, crawlspaces, basements, closets, or utility rooms. 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, refer to the current edition of the NFPA. Canadian installations must be installed in accordance with NSCPIC and all authorities having jurisdiction. For further information, the NFPA is available from National Fire Protection Association Inc. Batterymarch Park, Quincy, MA 02269, American Gas Association, 1515 Wilson Boulevard, Arlington, VA 22209, or from Literature Distribution.

TABLE 2—DIMENSIONS (IN.)

UNIT SIZE	A	D	E	VENT CONN	SHIP. WT
024050	14-3/16	12-9/16	12-11/16	4	124
036050	14-3/16	12-9/16	12-11/16	4	127
024070	14-3/16	12-9/16	12-11/16	4	141
036070	14-3/16	12-9/16	12-11/16	4	145
036096	17-1/2	15-7/8	16	4	154
048096	17-1/2	15-7/8	16	4	154
048115	17-1/2	15-7/8	16	4	171
048115	21	19-3/8	19-1/2	4	181
060135	24-1/2	22-7/8	23	5	192



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.

Installation must conform to the regulations of the serving gas supplier and the local building, heating, and plumbing codes in effect in the area in which the installation is made, or in the absence of local codes with the requirements of the NFPA.

This furnace is designed for a minimum continuous return-air temperature of 60°F db or 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, loss of life, 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 could result in electrical shock, fire, personal injury, or death.

For accessory installation details, refer to the applicable installation 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 followed, in addition to all local codes and ordinances.

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 will 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.

This furnace must be installed so the electrical components are protected from water.

Locate the furnace 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.

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.

Provide ample space for servicing and cleaning. Always comply with the minimum fire protection clearances shown on the unit rating plate. This furnace shall not be installed directly on carpeting, tile, or any combustible material other than wood flooring. The furnace may be installed on combustible flooring when installed with the accessory downflow subbase, which is available from your distributor or branch when required.

B. Location Relative to Cooling Equipment

The cooling coil must be installed parallel with or on the downstream side of the furnace 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, Air for Combustion and Ventilation, of the NFPA, or applicable provisions of the local building codes.

Canadian installations must be installed in accordance with NSC-NGPIC 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.

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.

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 avoid pulling air from the burner area and draft safeguard opening.

The requirements for combustion and ventilation air depend upon whether the furnace is located in a **UNCONFINED** or **CONFINED** space.

A. Unconfined Space

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

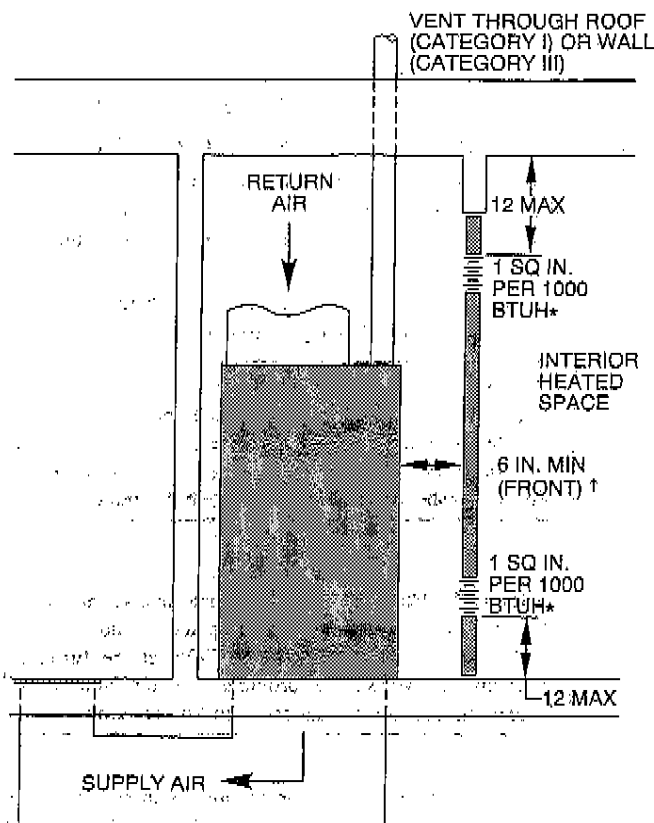
For Example:

376CAV FURNACE INPUT BTUH	MINIMUM SQ FT WITH 7-1/2 FT CEILING
46,000	307
69,000	460
92,000	613
115,000	767
135,000	920

If the unconfined space is constructed unusually tight, 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. A minimum opening with a total of at least 1 sq in. per 5000 Btuh of total input rating for all equipment must be provided. 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 one whose volume is less than 50 cu ft per 1000 Btuh of the total input ratings of all appliances installed in that space. A confined space **MUST** have 2 permanent openings, 1 within 12 in. of the ceiling, and the other within 12 in. of the floor. (See Fig. 2.)



* Minimum opening size is 100-square in. with minimum dimensions of 3 in.

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

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Fig. 2—Air for Combustion and Ventilation (Inside Air)

NOTE: In determining the free area of an opening, the blocking effect of the louvers, grilles, and screens must be considered. If the free area of a 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 the air comes from inside or outside the structure.

1. All air from inside the structure:

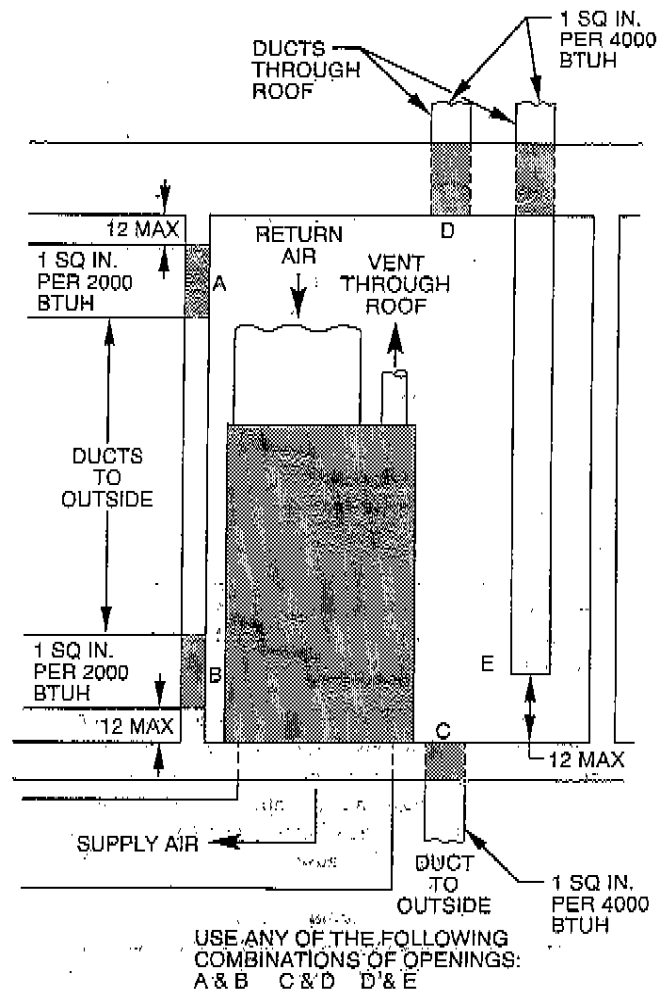
- a. Each opening **MUST** have at least 1 sq. in. of free area per 1000 Btuh of the total input for all equipment within the confined space, but not less than 100 sq in. per opening. (See Fig. 2.)

For Example:

376CAV FURNACE INPUT BTUH	FREE AREA PER OPENING (SQ IN.)
46,000	100
69,000	100
92,000	100
115,000	115
135,000	138

- b. If the building is constructed unusually tight, a permanent opening directly communicating with the outdoors should be provided. This opening should have a minimum free area of 1 sq in. per 5000 Btuh of total input rating for all equipment in the enclosure.

- c. If the furnace is installed on a raised platform to provide a return-air plenum, and return air is taken directly from the hallway or space adjacent to the furnace, all air for combustion must come from outdoors. (See Fig. 3.)



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Fig. 3—Air for Combustion and Ventilation (Outside Air)

2. All air from outside the structure:

- a. If combustion air is taken from outdoors through vertical ducts, the openings and ducts **MUST** have at least 1 sq in. of free area per 4000 Btuh of the total input for all equipment within the confined space.

For Example:

376CAV FURNACE INPUT BTUH	FREE AREA PER OPENING (SQ IN.)	ROUND PIPE (IN. DIA)
46,000	11.5	4
69,000	17.3	5
92,000	23.0	6
115,000	28.8	7
135,000	34.5	7

- b. If combustion air is taken from the outdoors through horizontal ducts, the openings and ducts **MUST** have at least 1 sq in. of free area per 2000 Btuh of the total input for all equipment within the confined space.

For Example:

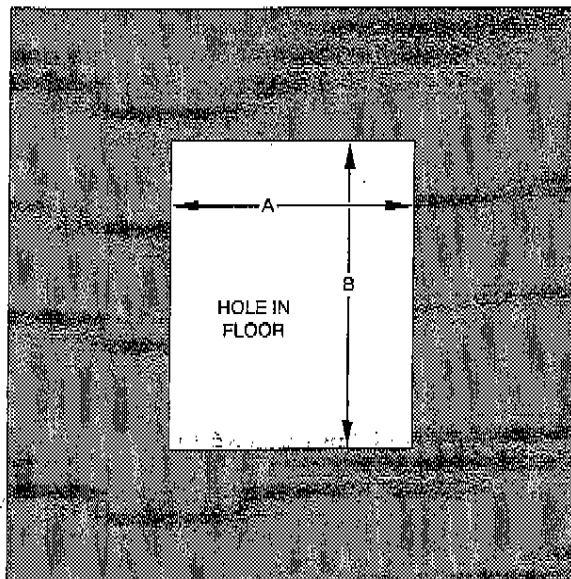
376CAV FURNACE INPUT BTUH	FREE AREA PER OPENING (SQ IN.)	ROUND PIPE (IN. DIA)
46,000	23.0	6
69,000	34.3	7
92,000	46.0	8
115,000	57.6	9
135,000	69.0	10

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 rectangular ducts must not be less than 3 in. (See Fig. 3.)

III. SUPPLY-AIR PLENUM INSTALLATION (DOWN-FLOW)

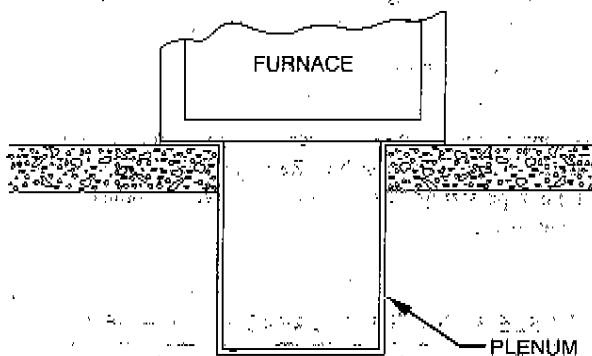
A. Installation On a Concrete Slab

1. Construct hole in floor per dimensions in Fig. 4 and Table 3.
2. Install plenum and furnace as shown in Fig. 5.



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Fig. 4—Floor Opening for Concrete Slab



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Fig. 5—Furnace on a Concrete Slab (Non-Garage Installation)

TABLE 3—OPENING DIMENSIONS (IN.)

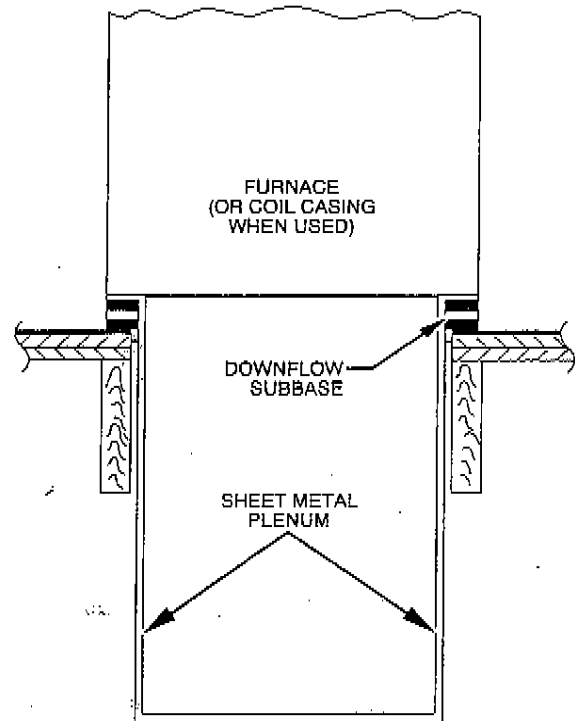
FURNACE CASING WIDTH	A	B	
		Heat-Only	Heat/Cool*
14-3/16	13-1/8	19-5/8	19-7/16
17-1/2	16-7/16	19-5/8	19-7/16
21	19-7/8	19-5/8	19-7/16
24-1/2	23-7/16	19-5/8	19-7/16

*These dimensions apply when a model CB or CD Evaporator Coil casing is to be installed.

B. Installation On a Combustible Floor

1. Cut and frame hole in floor per dimensions in Installation Instructions packaged with downflow subbase.

2. When completed, downflow subbase, plenum, and furnace (or coil casing when used) should be installed as shown in Fig. 6.



A78651

Fig. 6—Furnace, Plenum, and Subbase Installed on a Combustible Floor

IV. HORIZONTAL ATTIC INSTALLATION

WARNING: Do not install the furnace on its back; safety control operation will be adversely affected. Never connect return-air ducts to the sides or back of the furnace. Failure to follow this warning could result in fire, personal injury, or death.

The furnace can be installed horizontally on either the lefthand (LH) or righthand (RH) side. A typical attic installation is shown in Fig. 7.

A. Construct a Working Platform

Construct working platform on location where all required furnace clearances are met. (See Table 1 and Fig. 7.)

B. Install Furnace

1. Position furnace in desired location.
2. Connect gas supply pipe. See Fig. 7 for typical piping entry.
3. Install field-supplied filter retainers as indicated in Fig. 8 and Table 4 before connecting return-air duct to furnace.
4. Connect supply- and return-air ducts.
5. Install 24- X 24-in. sheet metal shield on platform in front of louvered control panel as shown in Fig. 7.

V. HORIZONTAL CRAWLSPACE INSTALLATION

The furnace can be installed horizontally with either the LH or RH side up. In a crawlspace, the furnace can either be hung from the floor joist or installed on suitable blocks or pad. The furnace can be suspended from each corner by hanger bolts (4 each 3/8-in. all-thread rod) cut to desired length, 1- X 3/8-in. flat washer, 3/8-in. lockwasher, and 3/8-in. nut. Dimples are provided for hole locations. (See Fig. 1.)

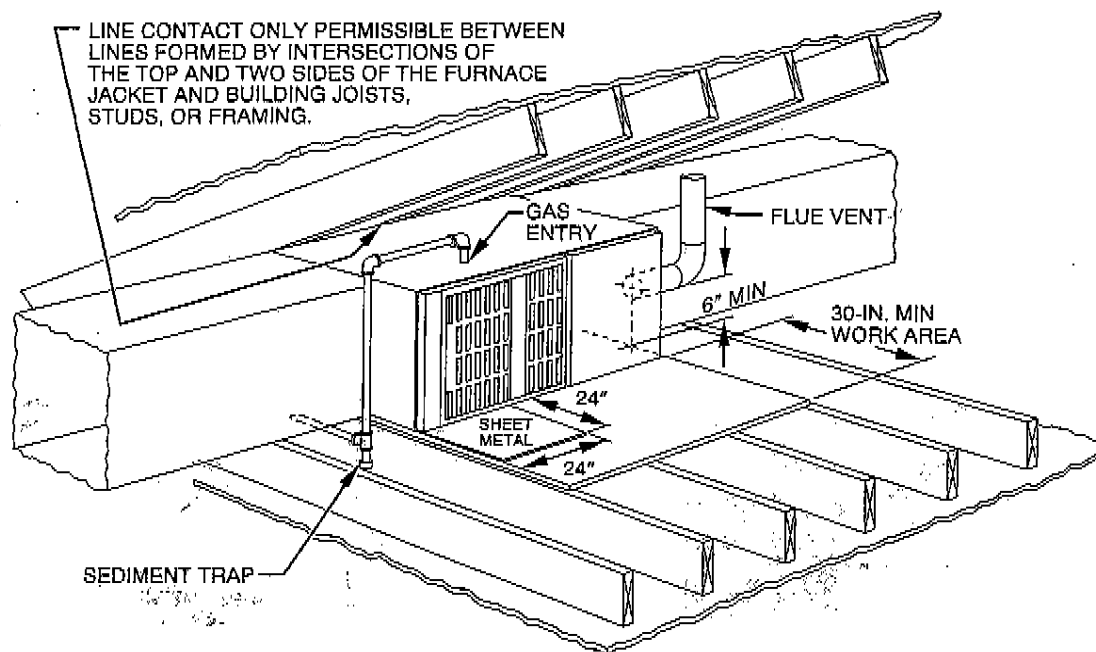


Fig. 7—Typical Attic Installation

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Since horizontal crawlspace installation is very similar to the attic refer to Section IV. The installation of a sheet metal shield in front of the louvered control panel is covered in Section IV. For a crawlspace installation, this same sheet metal shield must be installed above the louvered control panel. Extend the sheet metal shield over the furnace top far enough to cover the gas pipe entry hole.

VI. FILTER ARRANGEMENT

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

The 2 factory-supplied filters are shipped in the blower compartment. After the return-air duct has been connected to the furnace, install the filters in a V-formation inside the return-air plenum. See Fig. 8 and Table 4 for horizontal applications. Horizontal filter retainers must be field supplied. See Fig. 9 for downflow applications.

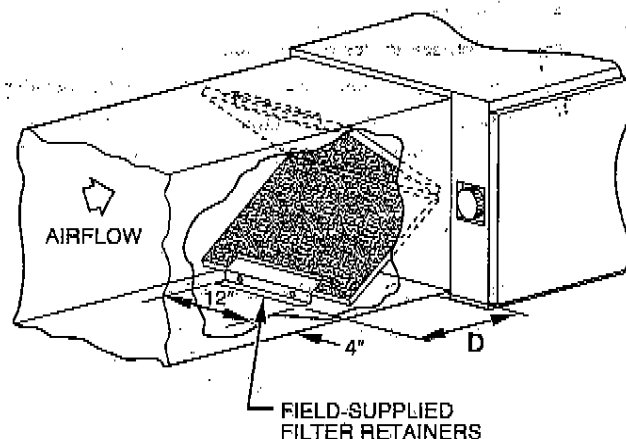


Fig. 8—Horizontal Filter Arrangement

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TABLE 4—FILTER RETAINER (IN.)

FURNACE CASING WIDTH	FILTER SIZE AND QUANTITY	D
14-3/16	(2) 14 X 20 X 1	14-3/8
17-1/2	(2) 14 X 20 X 1	13-3/8
21	(2) 16 X 20 X 1	11-5/8
24-1/2	(2) 16 X 20 X 1	10-1/4

VII. GAS PIPING

Gas piping must be installed in accordance with national and local codes. Refer to the current edition of the NFPA.

Canadian installations must be installed in accordance with NSC-NGPIC and all authorities having jurisdiction.

The gas supply line should be a separate line directly from the meter to the furnace, if possible. Refer to Table 5 for recommended gas pipe sizing. Risers should be used to connect to the furnace and to the meter.

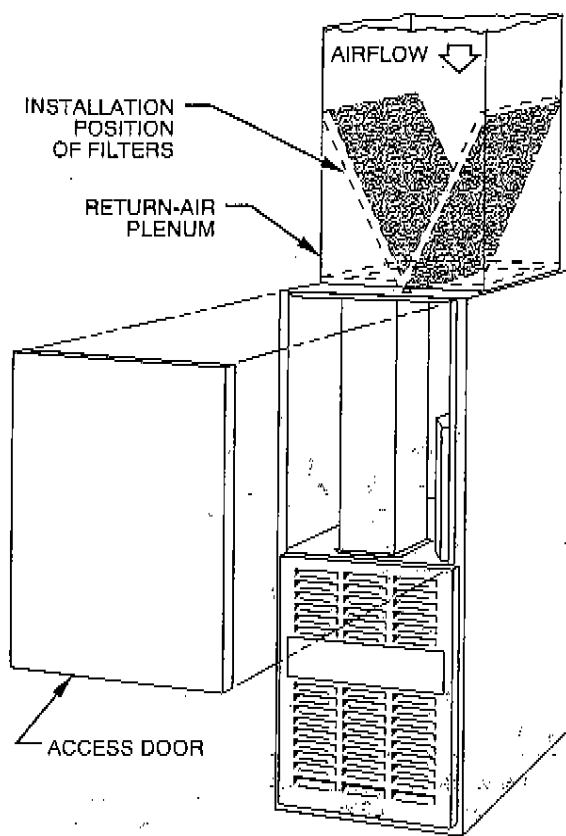
TABLE 5—MAXIMUM CAPACITY OF PIPE *

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

Ref: Table C-4 NFPA 54/ANSI Z223.1-1992.

* 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).

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.



A88486

Fig. 9—Downflow Filter Arrangement.

WARNING: Use the proper length of pipes to avoid stress on the gas control manifold. Failure to follow this warning could 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 gas controls.

WARNING: Never purge a line into a combustion chamber. Never use matches, candles, flame, or other sources of ignition to check for gas leakage. Use a soap-and-water solution to check for gas leaks. Failure to follow this warning could result in fire, explosion, personal injury, or death.

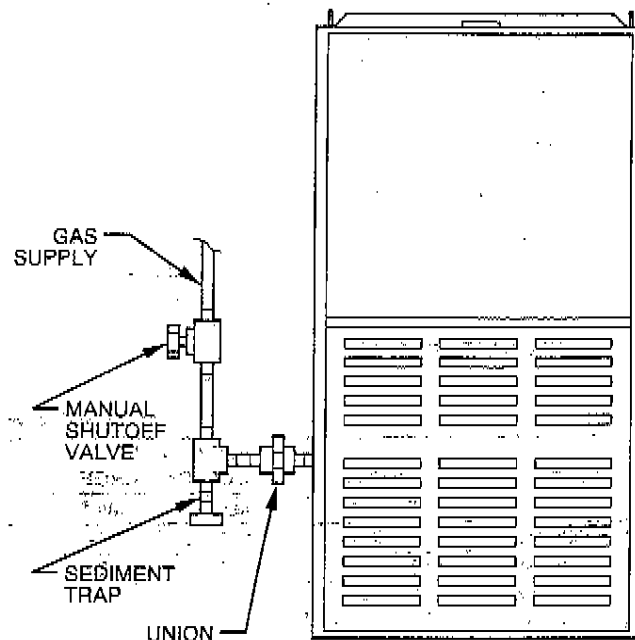
Joint compounds (pipe dope) should be applied sparingly and only to the male threads of the joints. This pipe dope must be resistant to the action of propane gas.

Install an accessible manual shut-off valve 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, must be installed immediately upstream of the gas supply connection to the furnace and downstream of the manual shut-off valve. Place a ground joint union between the gas control manifold and the manual shut-off.

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. 10.)

Piping should be pressure-tested in accordance with local and national plumbing and gas codes before the furnace has been attached. If the 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 the test pressure is equal to or less than 0.5 psig (14-in. wc), close the manual shut-off valve located on the gas valve before the test. It is recommended that the ground joint union be loosened before pressure testing.

After all connections have been made, purge the lines and check for gas leakage with regulated gas supply pressure.



A89414

Fig. 10—Typical Gas Pipe Arrangement

VIII. ELECTRICAL CONNECTIONS

A. 115-v Wiring

Refer to the unit rating plate or Table 6 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 current edition of the National Electrical Code ANSI/NFPA 70-1993, and any local codes or ordinances that might apply. For Canadian installations, all electrical connections must be made in accordance with Canadian Electrical Code CSA C22.1, or authorities having jurisdiction.

NOTE: Proper polarity must be maintained for 115-v wiring. If polarity is incorrect, the microprocessor will shut off gas flow shortly after the completion of ignition trial period.

WARNING: The cabinet MUST have an uninterrupted or unbroken ground according to National Electrical Code ANSI/NFPA 70-1990 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.

B. 24-v Wiring

Make field 24-v connections at the 24-v terminal strip. (See Fig. 11.) Connect terminal Y as shown in Fig. 12 for proper operation in cooling mode. Use AWG No. 18 color-coded wire only.

When the furnace is installed in the horizontal position with RH discharge air, 24-v wire connections can be made more easily by removing the 2 control box mounting screws and letting the control box turn so the 24-v screw terminals are visible. Be sure to reinstall the control box after the connections are made.

The 24-v circuit contains an automotive-type, 3-amp fuse located on the main control board. 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 screw terminals (EAC-1 and EAC-2) are provided for EAC connection. The terminals are energized with 115-v, 1-amp maximum during blower motor operation.

2. Humidifier (HUM)

Screw terminals (HUM-1 and C) are provided for 24-v humidifier connection. The terminals are energized with 24-v, 0.5-amp maximum during heating blower motor operation.

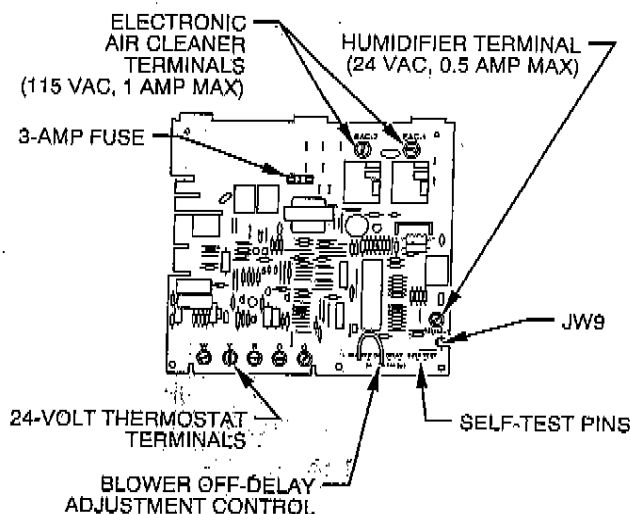


Fig. 11—Control Center

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TABLE 6—ELECTRICAL DATA

UNIT SIZE	VOLTS—HERTZ—PHASE	OPERATING VOLTAGE RANGE		MAX UNIT AMPS	MIN WIRE GAGE	MAX WIRE LENGTH FT†	MAX FUSE OR HACR-TYPE CKT BKR AMPS†
		Max*	Min*				
024050	115-60-1	127	104	6.6	14	42	15
036050	115-60-1	127	104	8.1	14	34	15
024070	115-60-1	127	104	6.7	14	42	15
036070	115-60-1	127	104	8.4	14	33	15
036096	115-60-1	127	104	9.2	14	30	15
048096	115-60-1	127	104	10.2	14	28	15
048115	115-60-1	127	104	10.1	14	28	15
060115	115-60-1	127	104	13.3	12	33	20
060135	115-60-1	127	104	14.3	12	31	20

* Permissible limits of the voltage range at which the unit will operate satisfactorily.

† Time-delay fuse is recommended.

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

IX. VENTING

Refer to the enclosed Installation Instructions, GAMA Venting Tables for Category I Furnaces, and EZ Vent™ Tables for Category I Fan-Assisted Furnaces. 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

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, C, 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).

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.

CAUTION: This furnace is equipped with 2 manual reset limit switches in the gas control area. The switches will open and shut off power to the gas valve if a flame rollout or an overheating condition occurs in the gas control area. DO NOT bypass the switches. Correct inadequate combustion air supply problem and reset the switches.

B. Sequence of Operation

Using the schematic diagram shown in Fig. 13, 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 will initiate a 90-sec blower only before starting another cycle.

1. Heating mode

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

- Prepurge period**—As the inducer motor comes up to speed, the pressure switch contacts close to begin a 15-sec prepurge period.
- Ignitor warm-up**—At the end of the prepurge period, the ignitor is energized for a 17-sec ignitor warm-up period. If ignition is not established during the first cycle, the next warm-up period is increased to 45 sec. All subsequent ignition cycles are 45 sec, or until the 115-v power supply is interrupted. By interrupting the 115-v power supply, the warm-up period is automatically reset to 17 sec.
- 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.
- 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 repeat the ignition cycle.
- Blower on delay**—Forty sec after burner flame is proven, the blower motor is energized on heating speed. Simultaneously, the humidifier and electronic air cleaner terminals (HUM-1 and C for humidifier, EAC-1 and EAC-2 for electronic air cleaner) are energized. Jumper JW9 should not be cut. If jumper JW9 has been cut, the blower on delay period 60 sec.
- Blower off delay**—When the thermostat is satisfied, the circuit between R and W is broken, de-energizing the gas valve and stopping gas flow to the burners. The blower motor, humidifier, and air cleaner remain energized 90, 135, 180, or 225 sec (depending on the blower off time selection). The furnace is factory set for a 135-sec blower off delay period.

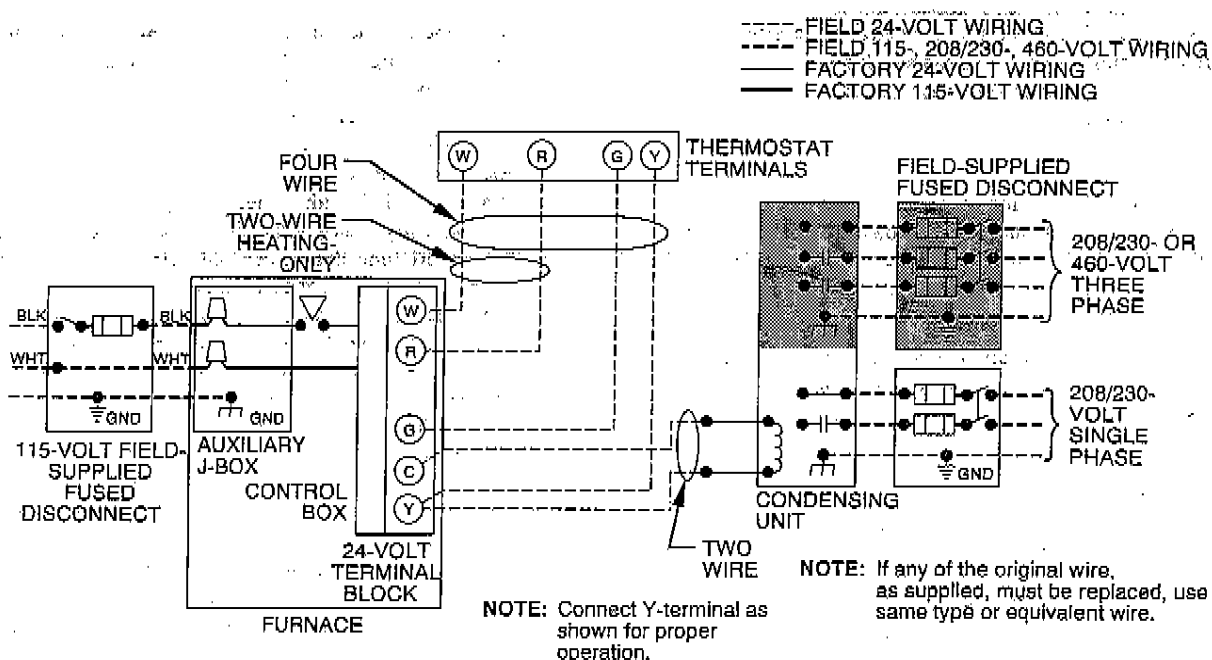


Fig. 12—Heating and Cooling Application Wiring Diagram

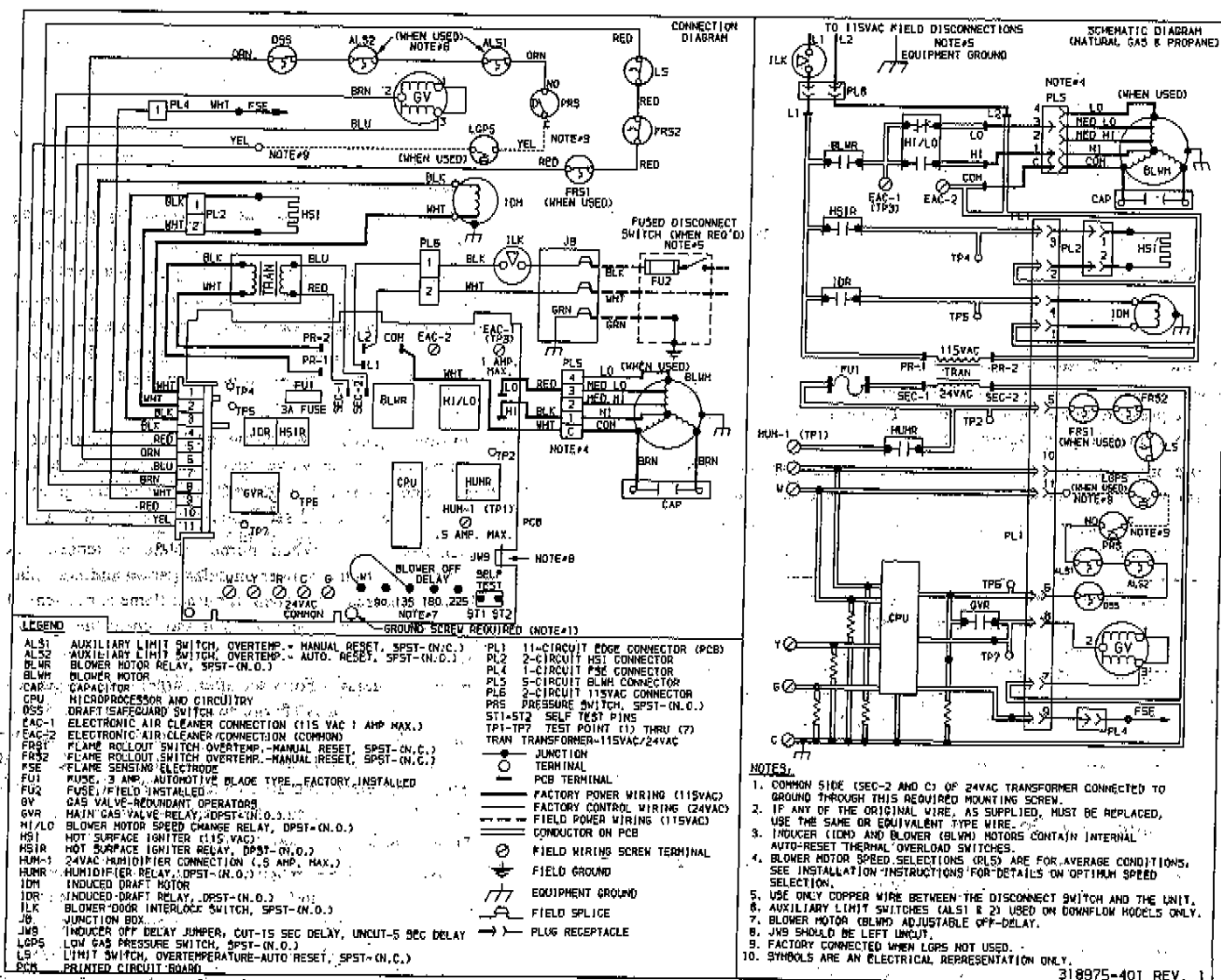


Fig. 13—Unit Wiring Diagram

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g. Post-purge—The inducer motor remains energized 5 sec after the burners are extinguished. Jumper JW9 should not be cut. If jumper JW9 has been cut, the post-purge period is 15 sec.

2. Cooling mode

When the thermostat "calls for cooling," R-Y circuit closes. The R-Y circuit starts the outdoor condensing unit and the furnace blower motor on cooling speed. The EAC terminals are energized with 115v whenever the blower is operating on cooling speed. HUM-1 terminal is not energized.

When the thermostat is satisfied, R-Y circuit is broken. The condensing unit stops and the furnace blower continues operating on cooling speed for an additional 90 sec.

3. Continuous blower mode

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. Jumper JW9 should not be cut. If jumper JW9 has been cut, the blower on delay period is 60 sec.

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 an additional 90 sec before reverting back to continuous operation on heating speed. EAC and HUM-1 terminals are energized.

4. Heat pump mode

When installed with a heat pump, the furnace control automatically changes the timing sequence to avoid long blower off time during demand 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 purge 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 should 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.

While in heat pump mode, the control uses only the 17-sec ignition warm-up period and does not use the 45-sec period at all.

Any time 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. EAC terminals are energized during blower operation. HUM-1 is energized only during gas heat or defrost operation.

C. Start-up Procedures

1. Self-test—The furnace features a self-test system to help diagnose a system problem in the case of a component failure. Two test pins (ST-1 and ST-2) are located in the lower right-hand corner of the control board as shown in Fig. 11. To initiate the self-test procedure, momentarily short across the 2 pins for approximately 0.5 sec.

NOTE: The self-test feature will not operate if the control board is receiving any thermostat signals.

The self-test sequence is as follows:

- a. The furnace control checks itself and operates the inducer motor for 10 sec, then stops.
 - b. The hot surface ignitor is energized for 15 sec, then de-energized.
 - c. The humidifier relay is energized for 10 sec, then de-energized.
 - d. The blower motor operates on cooling speed for 10 sec, then stops.
 - e. The blower motor operates on heating speed for 10 sec, then stops.
2. 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 to check for gas leakage. Use a soap-and-water solution to check for gas leaks. Failure to follow this warning could result in fire, explosion, personal injury, or death.

3. To operate furnace, follow procedures on operating instruction 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.

There are 2 methods of adjusting the gas input rate. The preferred method is by using Table 7 and following instructions in item a. The second method is by clocking the gas meter and following instructions in item b.

The gas valve regulator has been nominally set at 3.5-in. wc for natural gas. When adjusting input rate, do not set manifold pressure above 3.8-in. wc or below 3.2-in. wc.

- a. Check gas input rate using Table 7.

- (1.) Obtain average yearly heat value for local gas supply.
- (2.) Obtain average yearly specific gravity for local gas supply.
- (3.) Verify furnace model. Table 7 can only be used for model 376CAV Furnaces.
- (4.) Check and verify orifice size in furnace. **NEVER ASSUME THE ORIFICE SIZE. ALWAYS CHECK AND VERIFY.**

CAUTION: DO NOT redrill burner orifices. Improper drilling (burrs, out-of-round holes, etc.) can cause excessive burner noise and misdirection of burner flames. This can result in flame impingement of the burners and heat exchangers, causing failure.

- (5.) Find natural gas heat value and specific gravity in Table 7.
- (6.) Follow heat value and specific gravity lines to point of intersection. Find orifice size and manifold pressure settings for proper operation at given natural gas conditions.

EXAMPLE:

Heat value 1070 Btu/cu ft

Specific gravity 0.58

Therefore; Orifice No. 44 *

Manifold pressure 3.6-in. wc

* The furnace is shipped with No. 43 orifices. Therefore, in this example all main burner orifices must be changed and the manifold pressure must be adjusted.

(7.) Proceed to item c. to adjust manifold pressure.

b. Check gas input rate by clocking gas meter:

(1.) Obtain average yearly heat value for local gas supply.

(2.) Check and verify orifice size in furnace. **NEVER ASSUME THE ORIFICE SIZE. ALWAYS CHECK AND VERIFY.**

(3.) Turn off all other gas appliances and pilots.

(4.) Start furnace and let run for 3 minutes.

(5.) Measure time (in sec) for gas meter to complete 1 revolution.

(6.) Refer to Table 8 for cu ft of gas per hr.

(7.) Multiply gas rate (cu ft/hr) by heating value (Btu/cu ft).

EXAMPLE:

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

Heating value of gas = 1070 Btu/cu ft

Time for 1 revolution of 2-cu.ft.dial = 72-sec

Gas rate = 100 X 1070 = 107,000 Btu/h

(8.) Check to make sure that measured gas input does not exceed gas input on unit rating plate.

(9.) Proceed to item c. to adjust manifold pressure.

c. Adjust gas input.

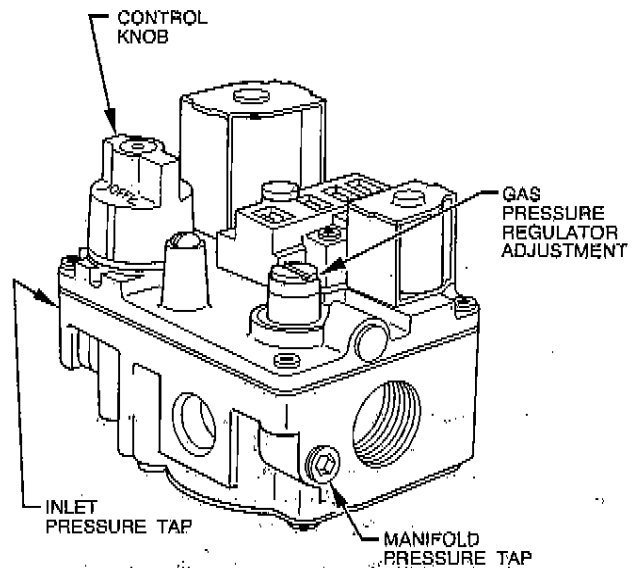
(1.) Remove regulator adjustment seal cap. (See Fig. 14.)

(2.) Turn adjusting screw counterclockwise to decrease input. Turn screw clockwise to increase input. **DO NOT** set manifold pressure less than 3.2-in. wc or more than 3.8-in. wc for natural gas. Make any major adjustments by changing main burner orifices.

(3.) When correct input is obtained, replace regulator adjustment seal cap. Main burner flame should be clear blue, almost transparent. (See Fig. 15.)

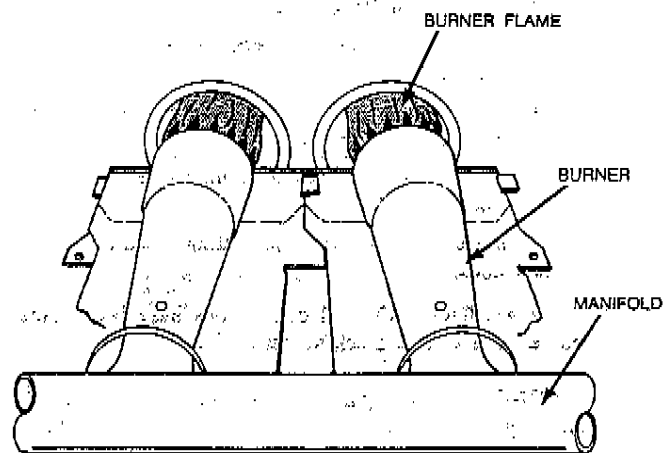
d. High altitude—In the United States, gas input on unit rating plate is for altitudes up to 2000 ft. Ratings for altitudes over 2000 ft must be 4 percent less for each 1000 ft above sea level. To obtain the adjusted altitude rating, adjust the manifold pressure, item c., and replace the main burner orifices as needed. Refer to NFPA Appendix F, Table F-4 for proper orifice sizing at high altitudes.

e. Canadian installations only—The Canadian ratings are approved for altitudes up to 2000 ft for natural and propane gases. High-altitude ratings are from 2000 ft to 4500 ft above sea level. See Table 9 for nominal burner orifice size. High-altitude input ratings include a 10 percent derated as required by Canadian standards.



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Fig. 14—Redundant Automatic Gas Control Valve



A89020

Fig. 15—Burner Flame

TABLE 7—MODEL 376CAV ORIFICE SIZE AND MANIFOLD PRESSURE FOR CORRECT INPUT RATE*
 (TABULATED DATA BASED ON ALTITUDE UP TO 2000 FT AND 23,000 BTUH PER BURNER)

GAS HEAT VALUE (BTU/CU FT)	SPECIFIC GRAVITY OF NATURAL GAS																	
	0.56		0.58		0.60		0.62		0.64		0.66		0.68		0.70		0.72	
	Orf No.	Manifd Press.	Orf No.	Manifd Press.	Orf No.	Manifd Press.	Orf No.	Manifd Press.	Orf No.	Manifd Press.	Orf No.	Manifd Press.	Orf No.	Manifd Press.	Orf No.	Manifd Press.	Orf No.	Manifd Press.
860	40	3.2	40	3.3	40	3.4	40	3.5	40	3.7	40	3.8	—	—	37	3.2	37	3.2
	41	3.5	41	3.6	41	3.7	41	3.8	38	3.2	38	3.3	38	3.4	38	3.5	38	3.6
	—	—	39	—	39	3.2	39	3.3	39	3.4	39	3.5	39	3.6	39	3.8	—	—
875	—	—	40	3.2	40	3.3	40	3.4	40	3.5	40	3.6	40	3.8	—	—	—	—
	41	3.3	41	3.5	41	3.6	41	3.7	41	3.8	38	3.2	38	3.3	38	3.4	38	3.4
	42	3.7	—	—	—	—	39	3.2	39	3.3	39	3.4	39	3.5	39	3.6	39	3.7
890	—	—	—	—	40	3.2	40	3.3	40	3.4	40	3.5	40	3.6	40	3.7	40	3.8
	41	3.2	41	3.4	41	3.5	41	3.6	41	3.7	41	3.8	—	—	38	3.2	38	3.3
	42	3.6	42	3.7	—	—	—	—	39	3.2	39	3.3	39	3.4	39	3.5	39	3.6
905	—	—	—	—	—	—	40	3.2	40	3.3	40	3.4	40	3.5	40	3.6	40	3.7
	—	—	41	3.2	41	3.4	41	3.5	41	3.6	41	3.7	41	3.8	—	—	38	3.2
	42	3.5	42	3.6	42	3.7	—	—	—	—	39	3.2	39	3.3	39	3.4	39	3.5
920	—	—	—	—	—	—	—	—	40	3.2	40	3.3	40	3.4	40	3.5	40	3.6
	—	—	—	—	41	3.2	41	3.4	41	3.5	41	3.6	41	3.7	41	3.8	—	—
	42	3.4	42	3.5	42	3.6	42	3.7	42	3.8	—	—	39	3.2	39	3.3	39	3.4
935	42	3.3	42	3.4	42	3.5	42	3.6	42	3.7	42	3.8	—	—	39	3.2	39	3.3
	—	—	—	—	—	—	—	—	—	—	40	3.2	40	3.3	40	3.4	40	3.5
	—	—	—	—	—	—	41	3.2	41	3.4	41	3.5	41	3.6	41	3.7	41	3.8
950	42	3.2	42	3.3	42	3.4	42	3.5	42	3.6	42	3.7	42	3.8	—	—	39	3.2
	—	—	—	—	—	—	—	—	—	—	—	—	40	3.2	40	3.3	40	3.4
	—	—	—	—	—	—	—	—	41	3.2	41	3.3	41	3.5	41	3.6	41	3.7
965	—	—	42	3.2	42	3.3	42	3.4	42	3.5	42	3.6	42	3.7	42	3.8	—	—
	43	3.7	—	—	—	—	—	—	—	—	—	—	—	—	40	3.2	40	3.3
	—	—	—	—	—	—	—	—	—	—	41	3.2	41	3.3	41	3.4	41	3.5
980	—	—	—	—	42	3.2	42	3.3	42	3.4	42	3.5	42	3.6	42	3.7	42	3.8
	43	3.6	43	3.7	—	—	—	—	—	—	—	—	—	—	—	—	44	3.2
	—	—	—	—	—	—	—	—	—	—	—	—	41	3.2	41	3.3	41	3.4
995	—	—	—	—	—	—	42	3.2	42	3.3	42	3.4	42	3.5	42	3.6	42	3.7
	43	3.5	43	3.6	43	3.8	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	41	3.2	41	3.3
1010	—	—	—	—	—	—	—	—	42	3.2	42	3.3	42	3.4	42	3.5	42	3.6
	43	3.4	43	3.5	43	3.6	43	3.6	—	—	—	—	—	—	—	—	41	3.2
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1025	—	—	—	—	—	—	—	—	—	—	42	3.2	42	3.3	42	3.4	42	3.5
	43	3.3	43	3.4	43	3.5	43	3.7	43	3.8	—	—	—	—	—	—	—	—
	44	3.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1035	—	—	—	—	—	—	—	—	—	—	—	—	42	3.2	42	3.3	42	3.4
	43	3.2	43	3.3	43	3.4	43	3.6	43	3.7	43	3.8	—	—	—	—	—	—
	44	3.7	44	3.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1055	—	—	—	—	—	—	—	—	—	—	—	—	—	—	42	3.2	42	3.3
	—	—	43	3.2	43	3.3	43	3.5	43	3.6	43	3.7	43	3.8	—	—	—	—
	44	3.6	44	3.7	44	3.8	—	—	—	—	—	—	—	—	—	—	—	—
1070	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	42	3.2
	—	—	—	—	43	3.3	43	3.4	43	3.5	43	3.6	43	3.7	43	3.8	—	—
	44	3.5	44	3.6	44	3.7	44	3.8	—	—	—	—	—	—	—	—	—	—
1085	—	—	—	—	43	3.2	43	3.3	43	3.4	43	3.5	43	3.6	43	3.7	43	3.8
	44	3.4	44	3.5	44	3.6	44	3.7	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1100	—	—	—	—	—	—	43	3.2	43	3.3	43	3.4	43	3.5	43	3.6	43	3.7
	44	3.3	44	3.4	44	3.5	44	3.6	44	3.7	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

*For size 060135 only, deduct 0.1-in. wc from manifold pressure shown in table due to 22,500 Btuh per burner input. If resultant manifold pressure falls below 3.2, change orifice size.

TABLE 8—GAS RATE (CU FT/HR)

SECONDS FOR 1 REVOLUTION	SIZE OF TEST DIAL			SECONDS FOR 1 REVOLUTION	SIZE OF TEST DIAL		
	1	2	5		1	2	5
cu ft	cu ft	cu ft	cu ft	cu ft	cu ft	cu ft	cu ft
10	380	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				

TABLE 9—CANADIAN ORIFICE SIZE

GAS	SEA LEVEL 0-2000 FT	HIGH ALTITUDE 2001-4500 FT
Natural	43	44
Propane	54	55

2. Set temperature rise.

Do not exceed the temperature rise range specified on the unit rating plate. Determine the air temperature rise as follows:

- Place duct thermometers in return and supply ducts as near furnace as possible. Be sure thermometers do not "see" heat exchangers so that radiant heat does 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 speed tap. Failure to follow this warning could result in personal injury.

- To change motor speed taps, remove the motor tap lead and relocate it on the desired terminal on the plug-in terminal block/speed selector located on the blower housing. (See Table 10.)

TABLE 10—SPEED SELECTOR

SPEED	TAP NO.*
Common	C
High	1
Med-High	2
Med-Low	3
Low	4†

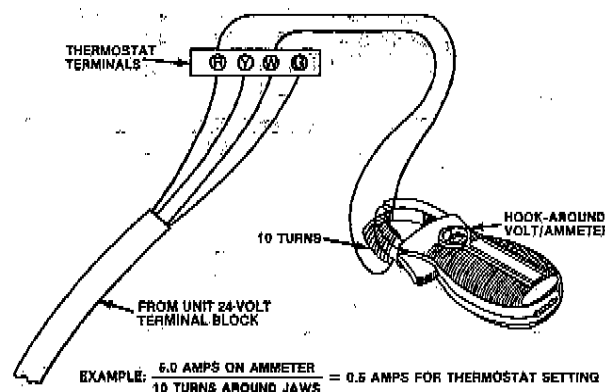
* White wire from control box to common; black wire from control box to cooling speed selection; red wire from control box to heating and constant fan speed selection.

† Speed tap No. 4 is not used on 024050 and 024070 units.



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

3. Set thermostat heat anticipator.



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Fig. 16—Amp Draw Check With Ammeter

The thermostat heat anticipation 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. 16 illustrates an easy 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 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.

1. Check primary limit control.

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

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 is functioning properly and operates if there is a motor failure.

2. Check draft safeguard switch.

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

- Disconnect power to furnace and remove vent connector from furnace outlet collar. Be sure to allow time for vent pipe to cool down before removing.

- b. Restore power to furnace and set room thermostat above room temperature.
 - c. After normal start-up, allow furnace to operate for 2 minutes, then block flue outlet (100 percent). Furnace should cycle off within 2 minutes.
 - d. Remove blockage and reconnect vent pipe to furnace outlet collar.
 - e. Wait 5 minutes and then reset draft safeguard switch.
3. Check pressure switch.
- This control proves operation of draft inducer blower.
- a. Turn off 115-v power to furnace.
 - b. Remove control door and disconnect inducer motor lead wires from wire harness.
 - c. Turn on 115-v power to furnace.
 - d. Close thermostat switch as if making normal furnace start. If the hot surface ignitor does not glow, then the pressure switch is functioning properly.
 - e. Turn off 115-v power to furnace.
 - f. Reconnect inducer motor wires, replace control door, and turn on 115-v power to furnace.
4. Check auxiliary limits.
- a. Turn off 115-v power to furnace.
 - b. Remove blower access door.
 - c. Disconnect red motor lead at blower speed selector. Mark terminal for proper reconnection.

- d. Replace blower access door.
- e. Turn on 115-v power to furnace. Be sure room thermostat is calling for heat.
- f. Allow furnace to operate until auxiliary limit activates, but DO NOT operate furnace longer than 4 minutes.
- g. If furnace operates for 4 minutes, check/replace limit switch(es).
- h. Turn off 115-v power to furnace.
- i. Remove blower access door.
- j. Reconnect red motor lead, reset switch, and replace door.
- k. Turn on 115-v power to furnace.

F. Checklist

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

