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installation, start-up, and operation instructions

DELUXE DOWNFLOW/HORIZONTAL GAS-FIRED, INDUCED-COMBUSTION FURNACES

376CAV Series C

Cancels: II 376C-40-5

II 376C-40-6

10-1-92

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

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, tags, and labels attached to or shipped with the unit and other safety precautions that may apply.

**TABLE 1—CLEARANCES FROM
COMBUSTIBLE MATERIALS (In.)**

SIZES		040 AND 055	075 THRU 110
DOWNFLOW (In 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
ALCOVE (Downflow/Horizontal*)			
Sides *		1	0
Back		0	0
Top	Single-Wall Vent	1	1
	Type B-1 Double-Wall Vent	1	1
Front		18	18
Vent	Single-Wall Vent	6	6
	Type B-1 Double-Wall Vent	1	1
HORIZONTAL (In Closet, Attic, or Crawl Space)			
Sides *		1	1
Back		3	3
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.

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.

Follow all safety codes. In the United States, follow all safety codes including the National Fuel Gas Code NFPA No. 54-1988/ANSI Z223.1-1988. In Canada, refer to the current edition of the National Standard of Canada CAN/CGA.B149.1- and .2-M91 Natural Gas and Propane Gas Installation Codes. 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 Δ . When you see this symbol on the unit and in instructions or manuals, be alert to the potential for personal injury.

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 hazards 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.

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 C Furnaces are available in sizes 40,000- through 110,000-Btuh output 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, crawl spaces, 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 National Fuel Gas Code NFPA No. 54-1988/ANSI Z223.1-1988. Canadian installations must be installed in accordance with CAN/CGA.B149 Installation Code and all authorities having jurisdiction. For further information, the National Fuel Gas Code 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.

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 of the structure.

1. All air from inside the structure:

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

For Example:

376CAV FURNACE INPUT BTUH	FREE AREA PER OPENING (SQUARE 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 square 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.)

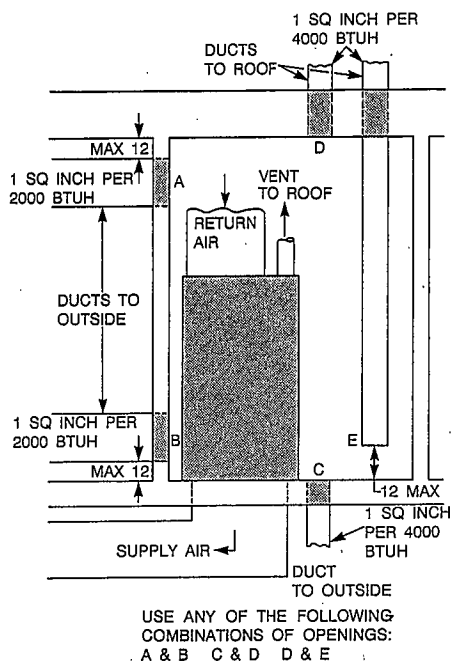


Fig. 3—Air for Combustion and Ventilation

2. All air from outdoors:

- a. If combustion air is taken from outdoors through vertical ducts, the openings and ducts MUST have at least 1 square inch 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 (SQUARE 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 square 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 (SQUARE 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. Place plenum and furnace as shown in Fig. 5.

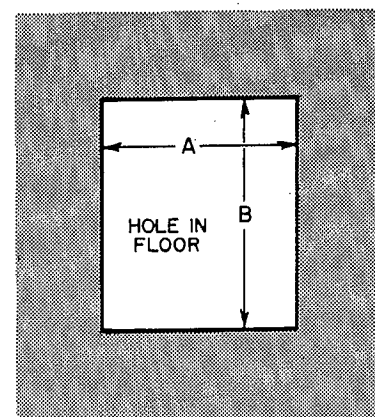


Fig. 4—Floor Opening for Concrete Slab

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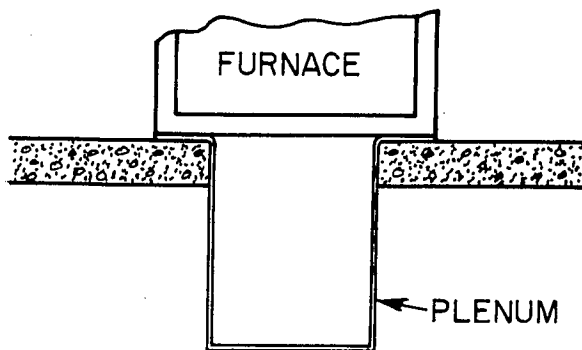


Fig. 5—Furnace on a Concrete Slab
(Non-Garage Installation)
TABLE 3—OPENING DIMENSIONS

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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.

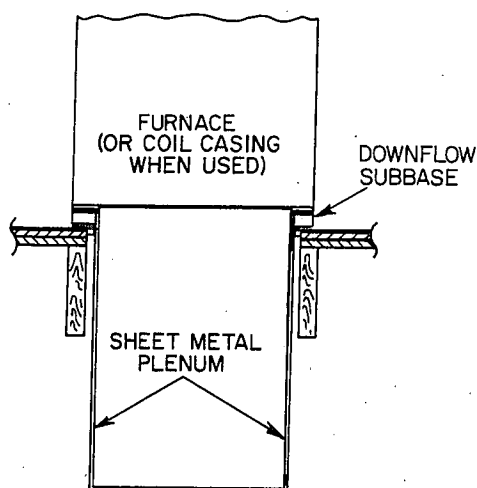


Fig. 6—Furnace, Plenum, and
Subbase Installed on a Combustible Floor

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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. A 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

1. Construct working platform on location where all required furnace clearances are obtainable. (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. Connect supply- and return-air ducts.
 - a. Install field-supplied filter retainers as indicated in Fig. 8 and Table 4 before connecting return-air duct to furnace.
4. Install 24- x 24-in. sheet metal shield on platform in front of louvered control panel as shown in Fig. 7.

V. HORIZONTAL CRAWL SPACE INSTALLATION

The furnace can be installed horizontally with either the LH or RH side up. In a crawl space, 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.)

The horizontal crawl space installation is very similar to the attic; therefore, 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 crawl space 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. A 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.

TABLE 4—FILTER RETAINER

FURNACE CASING WIDTH	FILTERS	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 National Fuel Gas Code.

Canadian installations must be installed in accordance with CAN/CGA.B149 Installation Code, 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.

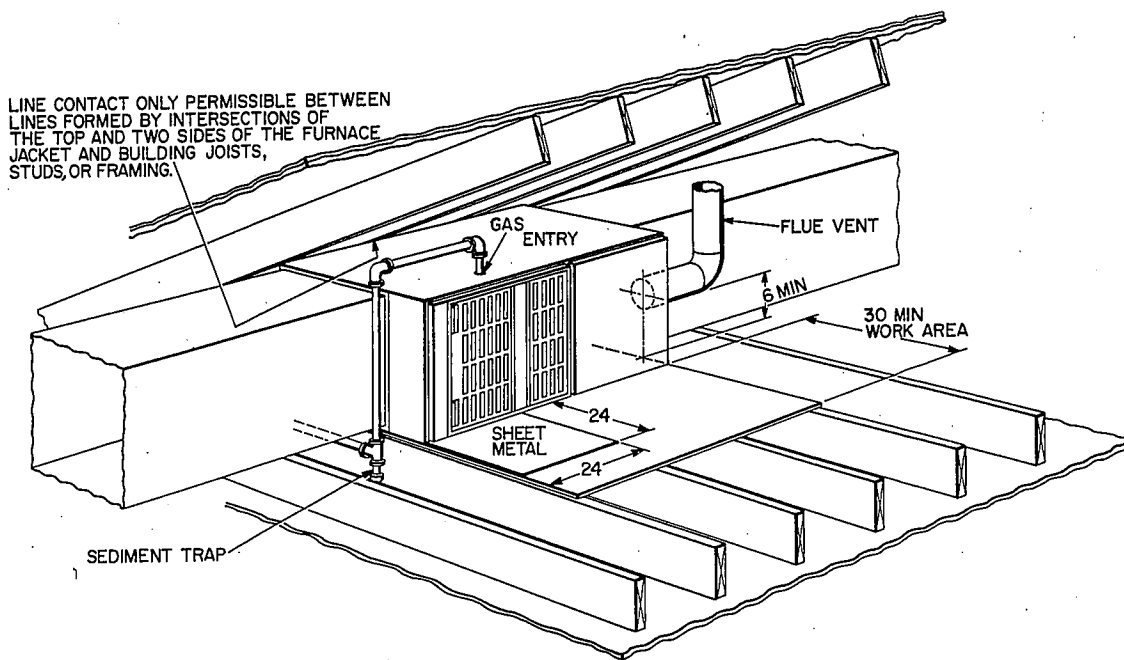


Fig. 7—Typical Attic Installation

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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 Z223.1-1988.

* Cubic feet 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.

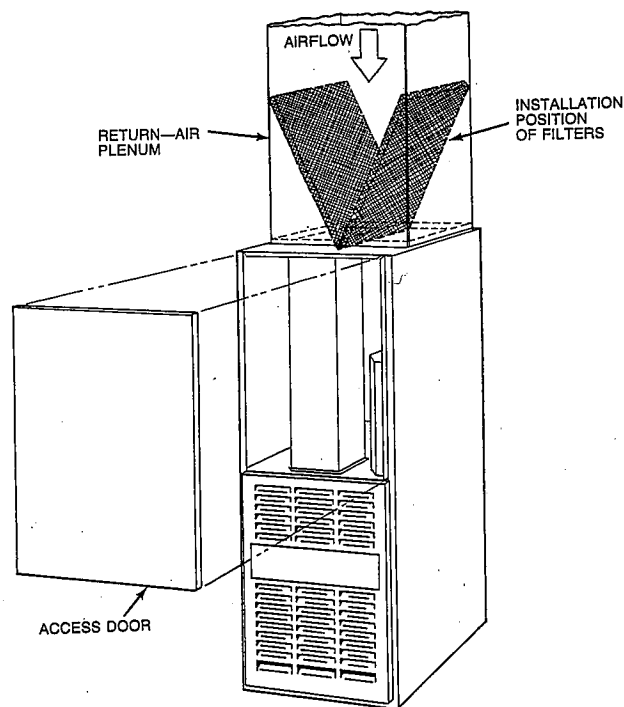


Fig. 9—Downflow Filter Arrangement

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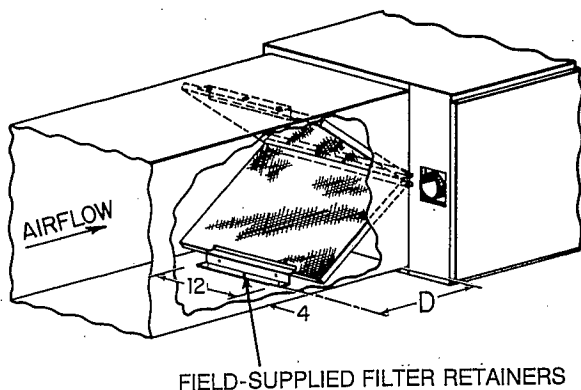


Fig. 8—Horizontal Filter Arrangement

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

CAUTION: Use a backup wrench when connecting the gas pipe to the furnace 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. A 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 shutoff 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 shutoff valve. Place a ground joint union between the gas control manifold and the manual shutoff.

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 shutoff 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.

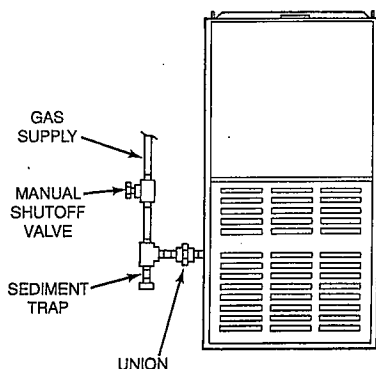


Fig. 10—Typical Gas Pipe Arrangement A89414

VIII. ELECTRICAL CONNECTIONS

A. 115-Vac 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 70-1990, and any local codes or ordinances that might apply. For Canadian installations, all electrical connections must be made in accordance with CSA C22.1 Canadian Electrical Code, 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-Vac 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 easier by removing the 2 control box mounting screws and letting the control box turn so that 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. Accessory

1. Electronic air cleaner

Two screw terminals (EAC-1 and EAC-2) are provided for electronic air cleaner connection. The terminals are energized with 115-vac, 1-amp maximum during blower motor operation.

2. Humidifier

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

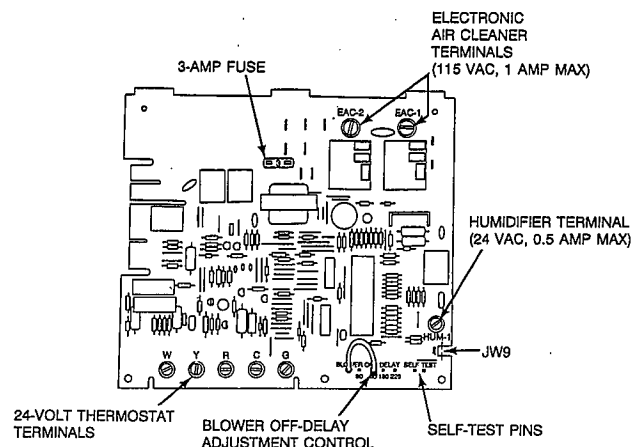


Fig. 11—Control Center

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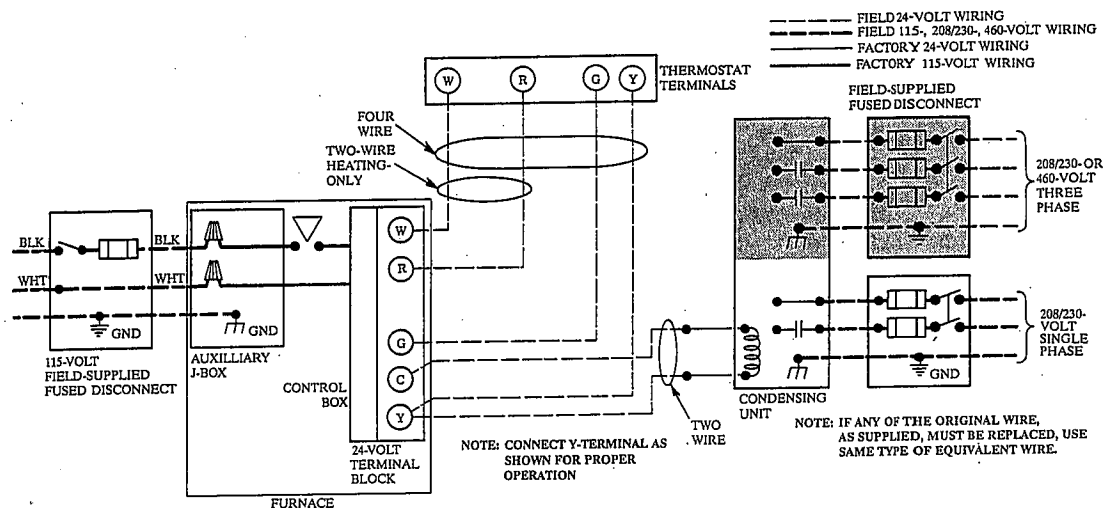


Fig. 12—Heating and Cooling Application Wiring Diagram

TABLE 6—ELECTRICAL DATA

FURNACE 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*				
024040	115—60—1	127	104	6.6	14	42	15
036040	115—60—1	127	104	8.1	14	34	15
024055	115—60—1	127	104	6.7	14	42	15
036055	115—60—1	127	104	8.4	14	33	15
036075	115—60—1	127	104	9.2	14	30	15
048075	115—60—1	127	104	10.2	14	28	15
048095	115—60—1	127	104	10.1	14	28	15
060095	115—60—1	127	104	13.3	12	33	20
060110	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 foot 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 proper 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, 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.

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. If ignition is not established during the first cycle, the next warm-up period is increased to 45 sec. All subsequent ignition cycles will be 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.

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. 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 will close the gas valve and repeat the ignition cycle.

- e. 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. If jumper JW9 has been cut, the blower on delay period will be 60 sec. Jumper JW9 should not be cut.
- f. 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 will 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.
- g. Post-purge—The inducer motor will remain energized 5 sec after the burners are extinguished. If jumper JW9 has been cut, the post-purge period will be 15 sec. Jumper JW9 should not be cut.

2. Cooling mode

When the thermostat "calls for cooling," R-Y circuit closes. The R-Y circuit starts the outdoor condensing unit, and starts the furnace blower motor on cooling speed. The electronic air cleaner EAC terminals are energized with 115 vac 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 will stop and the furnace blower will continue operating on cooling speed for an additional 90 sec.

3. Continuous blower mode

When the R-G circuit is made, the blower motor will operate on heating speed. During a call for heat, the blower will stop, allowing the furnace heat exchangers to heat up more quickly, then it will restart at the end of the blower on delay period (40 sec).

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

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

When the thermostat "calls for cooling," the blower will operate on cooling speed. When the thermostat is satisfied, the blower will operate 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 together, the control will change the blower to heating speed or start the blower if it was off, and begin a heating cycle. The blower will remain on until the end of the purge period, then shut off until the end of the ignition warm up and trial for ignition periods (a total of 24 sec). The blower will then come back on at heating speed.

When the W input signal disappears, the control will begin the normal inducer post-purge period and the blower will change to cooling speed after a 1-sec delay. If the W-Y-G signals should disappear together, the blower will remain on

for the selected heating blower off delay period, and the inducer will go through its normal post-purge period. If the W-Y inputs should disappear, leaving the G signal input, the control will go into continuous blower and the inducer will remain on for the normal post-purge period.

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

Any time the control senses false flame, the control will lock 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 upper right-hand corner of the control board as shown in Fig. 11. To initiate the self-test procedure, momentarily short across the 2 pins (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 will check itself then operate the inducer motor for 10 sec, then stop.
 - b. The hot surface ignitor is then energized for 15 sec, then de-energized.
 - c. The humidifier relay is then energized for 10 sec, then de-energized.
 - d. The blower motor will operate on cooling speed for 10 sec, then stop.
 - e. The blower motor will operate on heating speed for 10 sec, then stop.
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. A 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 item a. The second method is by clocking the gas meter and using 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- 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 cubic ft of gas per hr.
- (7.) Multiply gas rate (cubic ft/hr) x heating value (Btu/cubic 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 = $100 \times 1070 = 107,000$ Btuh

- (8.) Measured gas input should 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- or more than 3.8-maximum 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 altitude adjusted rating, adjust the manifold pressure, item c., and replace the main burner orifices as needed. Refer to National Fuel Gas Code 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

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 (BTUH/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.	Mnflid Press.	Orf No.	Mnflid Press.	Orf No.	Mnflid Press.	Orf No.	Mnflid Press.	Orf No.	Mnflid Press.	Orf No.	Mnflid Press.	Orf No.	Mnflid Press.	Orf No.	Mnflid Press.	Orf No.	Mnflid 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 060110 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. 4500 ft above sea level. See Table 9 for nominal burner orifice size. High altitude input ratings include a 10 percent derate as required by Canadian standards.

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				

TABLE 9—CANADIAN ORIFICE SIZE

GAS	SEA LEVEL 0—2000 FT	HIGH ALTITUDE 2000—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 will not affect thermometer readings. This is particularly important with straight-run ducts.

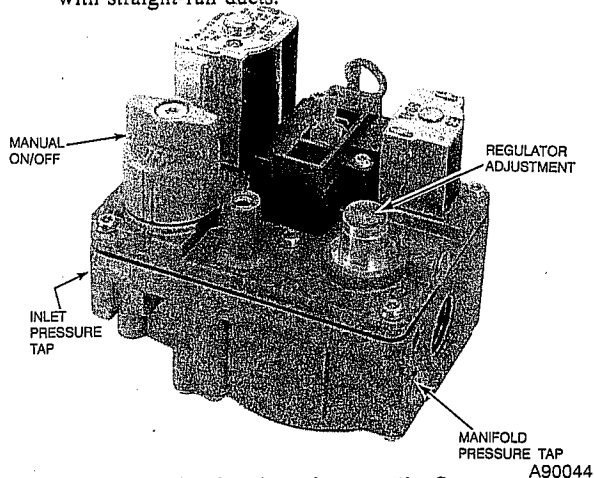


Fig. 14—Redundant Automatic Gas Control Valve

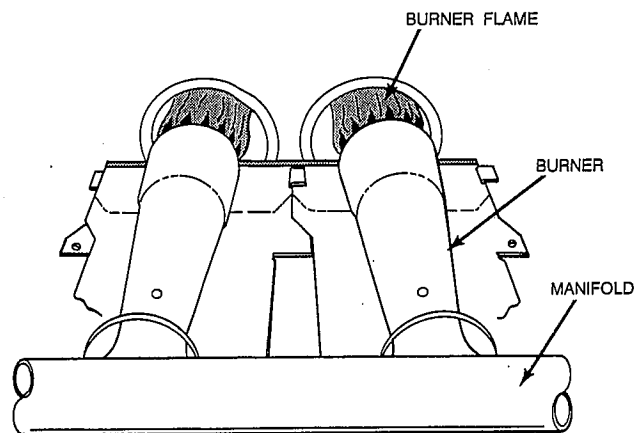


Fig. 15—Burner Flame

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- 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. A failure to follow this warning could result in personal injury.

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

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 024040 and 024055 units.



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

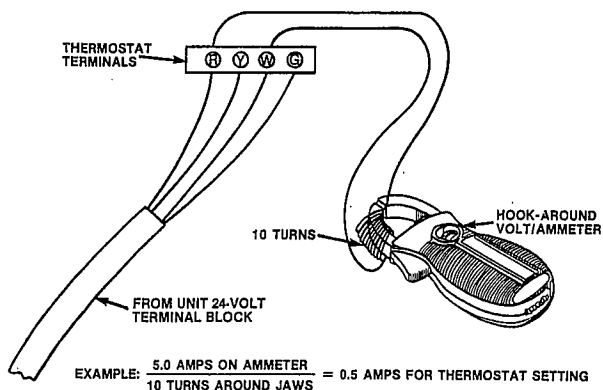
3. Set thermostat heat anticipator.

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 section as part of normal operation.



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Fig. 16—Amp Draw Check With Ammeter

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 will "operate" 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.

- a. 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 (100 percent) flue outlet. 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. Check List

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.