

SERVICE MANUAL

397 H Deluxe Gas-Fired Induced-Draft Furnace

BDP
Company



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SERVICE MANUAL FOR MODEL 397H DELUXE INDUCED-DRAFT, GAS-FIRED FURNACE

I. INTRODUCTION

This Service Manual has been written to help you diagnose field problems faster and easier, and to simplify the replacement of parts. It *must* be used in conjunction with the furnace Installation Instructions, the Procedure for Induced-Draft Gas-Fired Furnaces, and the Replacement Parts List. We also recommend that this Service Manual be used with the Field Training Program.

The electrical checkout is accomplished by first presenting the sequence of operation. After the sequence of operation is understood, a Trouble Analysis Chart and standard instruments are used to pinpoint failed components.

Because there are several new features in this line, the sequence of operations should be thoroughly understood and the Trouble Analysis Chart should be used to remove any mental roadblocks that tend to stand in the way of working with new types of equipment.

The illustrated parts breakdown, Figure 4, shows the individual components and how they are removed. This prevents removing unnecessary screws to remove a part.

The removal and cleaning of the front loader heat exchanger is described in detail.

The diagnostic module, which is used to pinpoint

failed components on the furnace, is shown in Figure 14. It is plugged into the edge connectors on the furnace, then the furnace Molex connectors are plugged into the edge connectors on the test leads.

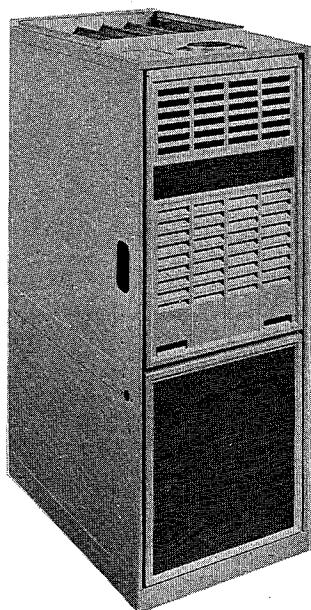
A. Product Description

Figures 1 and 2 show the furnace with all access panels in place, and an open view with the access panels removed. The furnace is divided into three sections as follows:

- Inducer compartment (upper)
- Burner compartment (center)
- Blower compartment (lower)

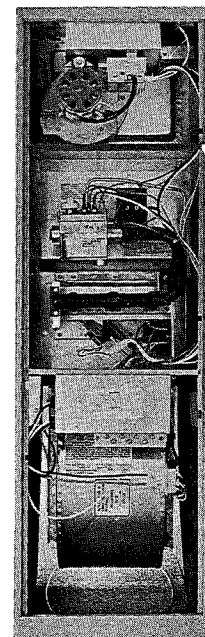
The design of the high-efficiency induced-draft furnace has been tested and certified by the A.G.A. Laboratory.

The induced-draft system is A.G.A. tested for connection to an approved natural-draft-type vent or chimney. (Unlined masonry chimneys are not approved.) Standard vent connections can be used because the static pressure at the relief-box vent connection is zero. The static pressure at the secondary-air-inlet restrictor plate is reduced as the products of combustion flow through the heat exchanger, into the collector box, through the inducer housing, into the relief box, and then into the vent pipe.



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Figure 1 — Furnace With Access Panels in Place



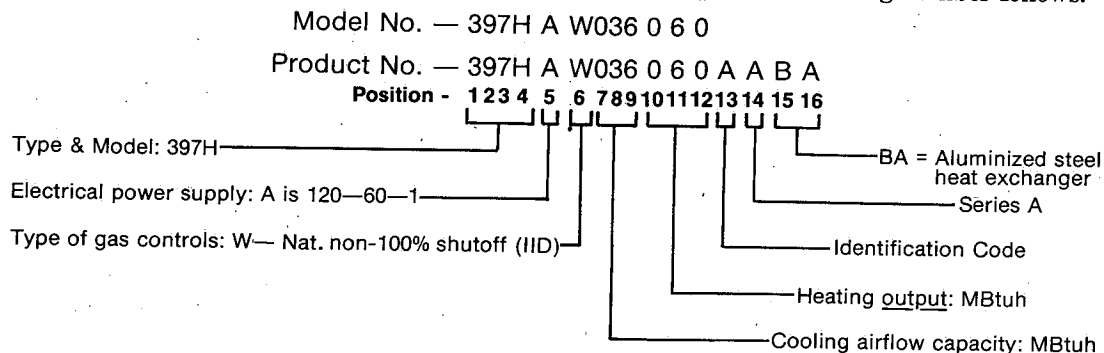
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Figure 2 — Furnace With Access Panels Removed

B. Model and Serial Number Explanation

1. Model Number

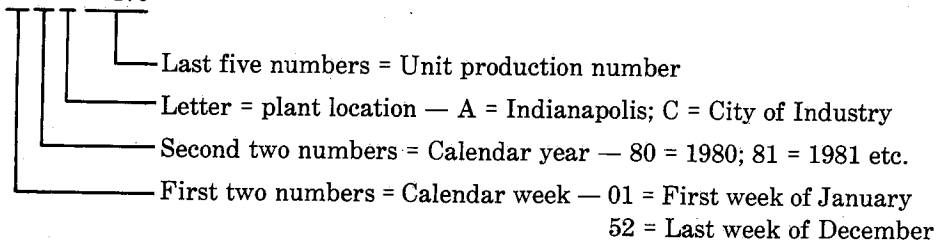
The model number appearing on the furnace rating plate will have 12 positions. A brief explanation of how to use the first 12, plus the last 4, of the product ordering number follows:



2. Serial Number

Ten-digit serial number used on this furnace is made up of four numbers, one letter, and five numbers. See Figure 3.

Example: 4480C 12470



C. Rating Plate

The furnace rating plate (See Figure 3.) is located on the divider panel between the inducer section and the burner compartment. When ordering parts, the product number and serial number must be included with your order to obtain correct part numbers.

BDP COMPANY DIVISION OF CARRIER CORPORATION
 INDIANAPOLIS, IND. CITY OF INDUSTRY, CA.

TO SET IN OPERATION:

1. TURN OFF ELECTRIC POWER TO FURNACE.
2. TURN DIAL ON GAS CONTROL TO OFF POSITION.
3. **WAIT 5 MINUTES.**
4. TURN DIAL ON GAS CONTROL TO ON POSITION.
5. TURN ELECTRIC POWER ON AND SET THERMOSTAT TO COMFORT LEVEL.
6. PILOT WILL LIGHT AUTOMATICALLY WHEN THERE IS A CALL FOR HEAT. MAIN BURNERS WILL OPERATE WHEN THE PILOT FLAME IS PROVEN.
7. NOTE: DURING THERMOSTAT OFF CYCLE MAIN BURNERS AND PILOT FLAME ARE BOTH EXTINGUISHED.

TO SHUT DOWN:

1. SET THERMOSTAT TO LOWEST SETTING.
2. TURN DIAL ON GAS CONTROL TO OFF POSITION.

MODEL 397HAW036060

PRODUCT 397HAW036060AABA

SERIAL 4480C12470

INPUT 71,000 BTU/HR

ANSI Z21.47
CENTRAL FURN — 1978

NATURAL: GAS MANIFOLD PRESS. 3.5 IN. WC.

MAX. SUPPLY PRESSURE 13.6 IN. WC.	MAX. AMPS 8.0	115 VOLTS 60 Hz SINGLE PHASE
MIN. SUPPLY PRESSURE 4.5 IN. WC.	DESIGNED MAX. OUTLET AIR TEMPERATURE 200 °F	

FOR MAX. EXTERNAL STATIC PRESS. (IN. WC.) & AIR TEMP. RISE OF: WITH BLOWER & MOTOR H.P. AS SHOWN.

TEMP. RISE	STATIC PRESS.	BLOWER	MOTOR H.P.	MAX. WATTS
45-75	0.5	152	1/3	515

FORCED AIR FURNACE FOR INSTALLATION IN BUILDING CONSTRUCTED ON SITE OR MANUFACTURED BUILDING. FOR INSTALLATION ON COMBUSTIBLE FLOORING IN ALCOVE OR CLOSET AT MINIMUM INCHES CLEARANCE FROM COMBUSTIBLE MATERIAL AS SHOWN.

TOP	SIDES	BACK	FRONT	VENT	
1	1	0	6	6	WHEN USING SINGLE WALL VENT
1	0	0	3	1	WHEN USING BT VENT

305758-4003

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Figure 3 — Typical Furnace Rating Plate

D. Component Identification

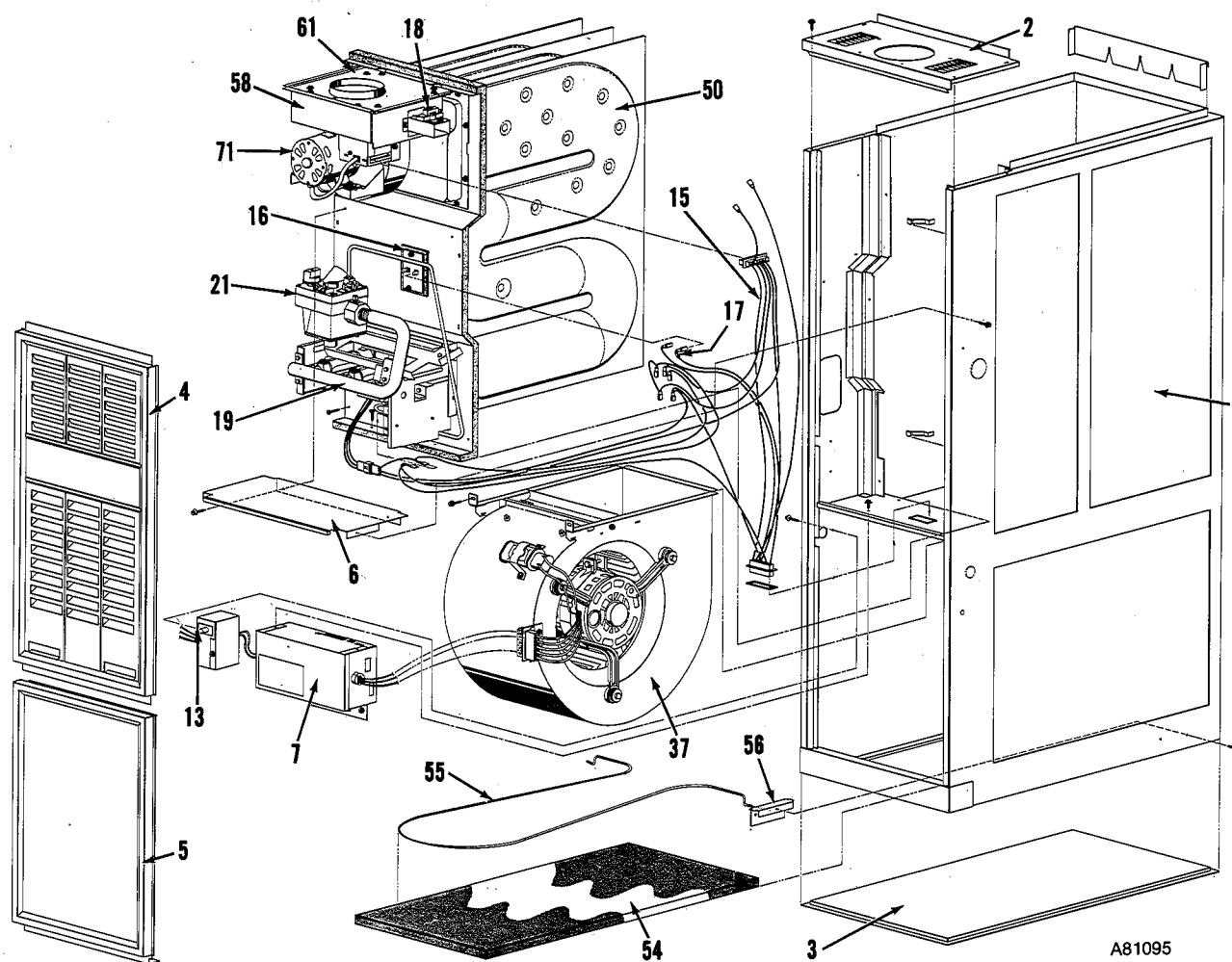


Figure 4 — Illustrated Parts Breakdown of Furnace

LEGEND

- | | |
|-------------------------|------------------------------|
| 1. Casing Assembly | 18. Switch — Draft-Safeguard |
| 2. Filler — Top | 19. Manifold |
| 3. Closure — Bottom | 21. Valve — Gas |
| 4. Door — Control | 37. Blower Assembly |
| 5. Door — Blower | 50. Tube — Heat Exchanger |
| 6. Panel — Divider | 54. Filter |
| 7. Control Box Assembly | 55. Spring — Filter |
| 13. Switch — Pushbutton | 56. Clip — Filter |
| 15. Harness — Wiring | 58. Relief Box Assembly |
| 16. Switch — Limit | 61. Cover — Relief Box |
| 17. Link — Fusible | 71. Motor — Inducer |

E. Service Instruments

- Volt/ohmmeter
- U-tube manometer and fittings
- Hook-around volt/ammeter
- Thermometers
- Stopwatch
- Inclined draft gauge
- Pitot tube

F. Tools Required

The handtools normally carried by a qualified serviceperson can be used to easily disassemble any part on the furnace.

II. UNIT OPERATION — ELECTRICAL

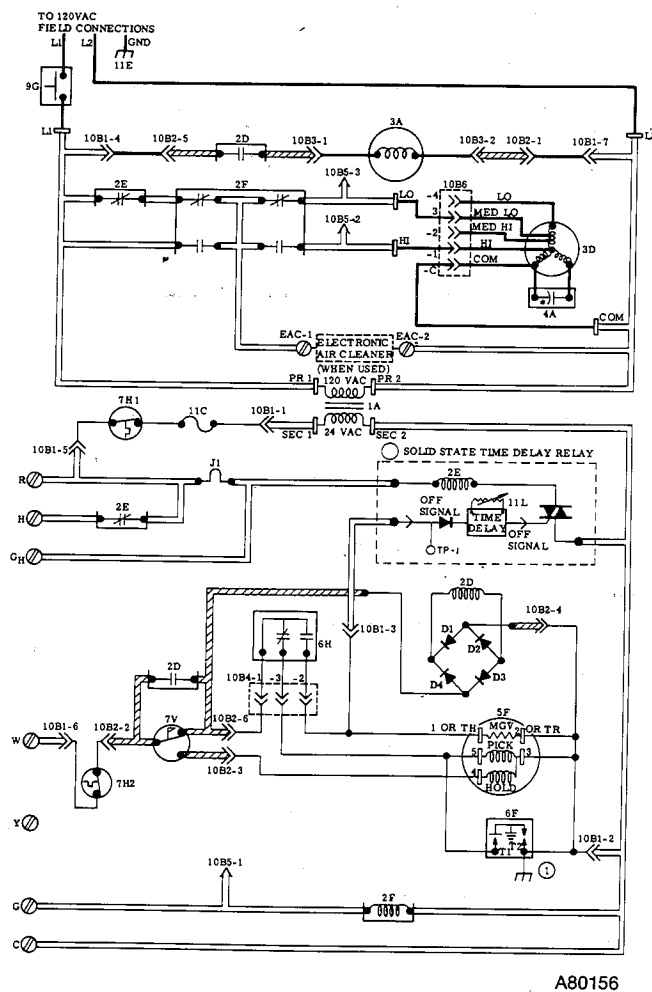
A. Sequence of Operation — Heating Cycle

Use the Schematic Wiring Diagram, Figure 5, to trace the sequence of operation for the heating cycle.

1. When the blower door is in place, 120 volts is supplied through blower door interlock switch 9G. Transformer 1A is energized, supplying 24 volts to heating-blower relay coil 2E, which

opens normally closed blower-relay contacts 2E in the low-speed circuit of blower motor 3D.

2. The wall thermostat "calls for heat," closing the R and W circuit. This closed circuit supplies power to the 24-volt safety circuit containing limit switch 7H1, fusible link 11C, and manual reset draft-safeguard switch 7H2.
3. Simultaneously, the pick coil of gas valve 5F, spark generator 6F, and inducer-motor relay coil 2D are energized. Inducer-motor relay contacts 2D in the 120-volt circuit close, starting inducer blower motor 3A. Also, another set of contacts in inducer-motor relay 2D close in the 24-volt circuit, and lock-in inducer-motor relay coil 2D. The coil is locked in until the R and W circuit or safety circuit opens.
4. When the pick coil of gas valve 5F is energized, gas flows to the pilot. The pilot gas is ignited by a spark produced by spark generator 6F. Simultaneously, inducer motor 3A comes up to speed, moving sail switch 7V and energizing the hold coil of gas valve 5F. The pick coil of gas valve 5F and spark generator 6F are deenergized



LEGEND

- 1A-Transformer, 120-VAC/24-VAC
- 2D-Relay, Inducer Motor DPST-N. O.
- 2E-Relay, Heating Blower (HFR) DPST-N. C.
- 2F-Relay, Cooling Blower (CFR) DPDT
- 3A-Motor, Inducer
- 3D-Motor, Blower
- 4A-Capacitor, Run
- 5F-Valve, Gas (Redundant)
- 6F-Generator, Spark (Solid-State)
- 6H-Switch, Pilot-Flame Sensing SPDT
- 7H1-Switch, Limit SPST-N. C.
- 7H2-Switch, Draft-Safeguard (SPST-N. C.) Manual-Reset
- 7V-Switch, Sail SPDT
- 9G-Switch, Blower Door Interlock SPST-N. O.
- 10B1-Connector, Edge (Furnace Control Board)
- 10B2-Connector, Edge (Inducer Control Board-7 CKT)
- 10B3-Connector, Edge (Inducer Control Board-2 CKT)
- 10B4-Connector, Pilot
- 10B5-Factory Test Points
- 10B6-Connector, Blower Motor
- 11C-Link, Fusible (Overtemperature)
- 11E-Ground, Equipment
- 11L-Resistor, Adjustable (Off Time)
- TP1-Test Point

- Factory Wiring (120VAC)
- Factory Wiring (24VAC)
- Conductors on 6C1 (Furnace Control Board)
- Conductors on 6C2 (Inducer Control Board)
- ⊗ Screw Terminal for Field Wiring
- 1/4-Inch Quick-Connect Terminals

Figure 5 — Furnace Schematic Wiring

when the contacts of pilot-flame sensing switch 6H move from the normally closed position, breaking the circuit to the pick coil and spark generator. In approximately 50 to 60 seconds, the normally open pilot-flame sensing contacts close, "making" the circuit to the main operator of gas valve 5F. The gas valve opens in approximately 10 seconds to allow gas flow to the main burners, which are ignited by pilot 6H. Simultaneously, time-delay circuit 11L in the blower control center is energized. Approximately 50 seconds after gas valve 5F opens, heating relay coil 2E is deenergized, which closes the 120-volt contacts of heating relay 2E, starting blower motor 3D on its heating speed.

5. When the thermostat is satisfied, the circuit between R and W is broken, deenergizing gas valve 5F, inducer motor relay 2D, and the solid-state time-delay circuit on the printed-circuit board. The gas flow stops immediately to the pilot and main burners. After approximately 90 to 240 seconds, depending on the off-time adjustment setting, heat relay 2E is energized and blower motor 3D stops.

NOTE: After a brief interruption of either electric or gas supply, the furnace will not resume normal operation until the contacts of pilot-flame sensing switch 6H move from the normally open to the normally closed position.

In addition, on some models the sail arm may not return to the normal operating position (indicating adequate inducer airflow) until the air flowing through the inducer cools to a more normal temperature.

B. Sequence of Operation —Cooling Cycle

1. The wall thermostat "calls for cooling."
2. The R, G, and Y circuits are energized. Simultaneously, the R-and-Y circuit starts the outdoor condensing unit, and the R-and-G circuit energizes cooling relay coil 2F, which closes normally open contacts 2F, energizing the cooling high-speed winding of motor 3D, and opening the normally closed contacts of cooling relay 2F.

C. Timing Cycle

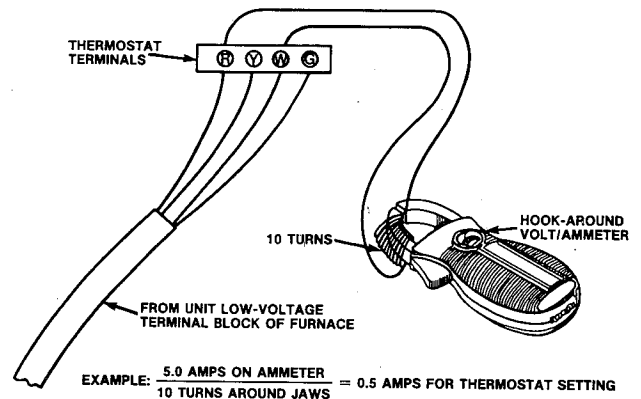
The timing cycle for the various components in the heating cycle after the wall thermostat closes the R-and-W circuit is as follows:

Sail Switch	5 - 10 seconds
Spark-to-Pilot Lit	0 - 5 seconds
Pilot Lit to Heat Motor Energized	45 - 60 seconds
Heat Motor Energized to Main Burners Lit	8 - 10 seconds

Total Cycle Time	58 - 85 seconds
Pilot-Flame Sensing	
Switch Cooling Period	60 - 90 seconds

D. Heat Anticipation

The heat anticipation setting on the wall thermostat must be set correctly for proper furnace operation. To make this setting, use either the hook-around volt/ammeter in the manner shown in Figure 6, or a direct-reading ammeter which reads in tenths of an ampere.



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Figure 6 — Amp-Draw Check With Ammeter

III. UNIT OPERATION — COMBUSTION

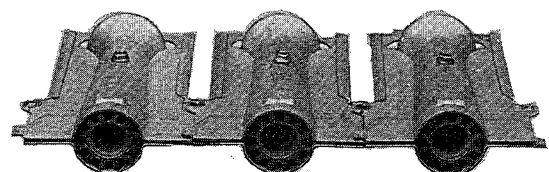
A. Inshot Burners

The inshot burners are designed with sintered head inserts. See Figure 7. These inserts control the main burner flame which results in excellent flame characteristics and flame retention at the outlet of the main burners.

The inshot burners do not have primary air adjustments. The screw in the venturi of the burner is not for adjustment. The burners operate satisfactorily over the range of heating values for natural gas found in the field.

It is imperative that the gas manifold pressure be checked and set as specified in the Installation Instructions. The furnaces also must be derated for high altitude.

LP (propane) capability is not presently available. We will notify our field distribution when it becomes available.

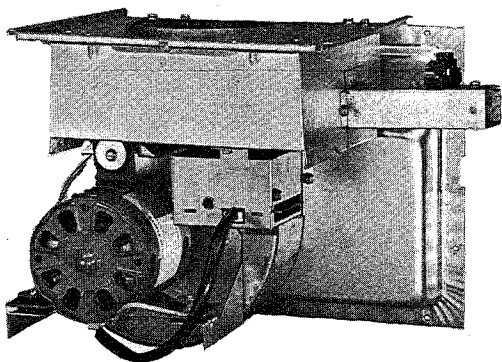


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Figure 7 — Inshot Burners

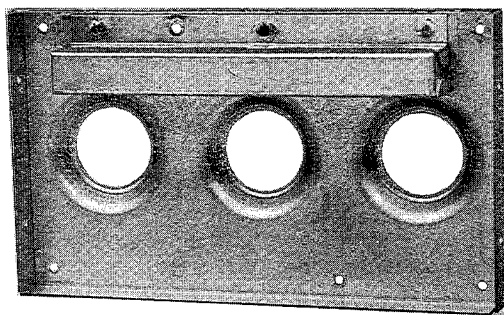
B. Combustion Process

The combustion process starts with the inducer, Figure 8, exerting a negative pressure at the secondary-air inlet restrictor plate, Figure 9. The main burners ignite, the flames pass through the circular openings in the inlet restrictor plate, then into the heat exchanger, Figure 10. Combustion is completed in the lower section of the heat exchanger.



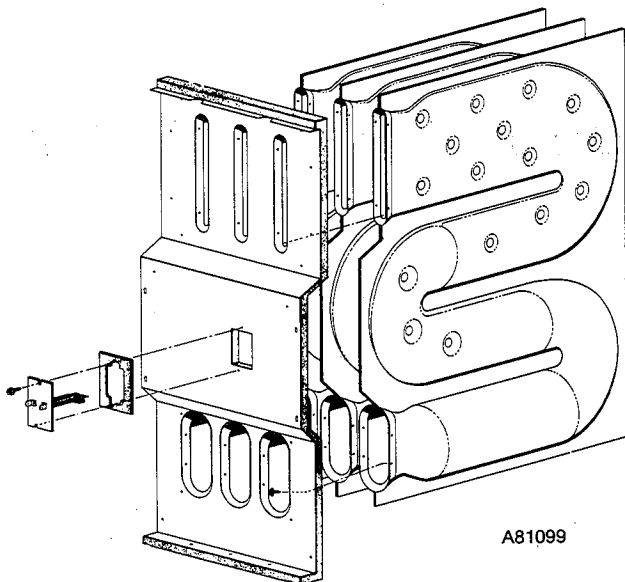
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Figure 8 — Inducer Assembly



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Figure 9 — Inlet Restrictor Plate



A81099

Figure 10 — Four-Pass Heat Exchanger

Flue gases continue through the heat exchanger to the collector box, into the inducer housing, then into the relief box where they are discharged into the external vent at zero static pressure.

NOTE: The design of the furnace eliminates the need for a drafthood and Vent Mizer®. Neither the Vent Mizer® nor any other vent damper can be used with this furnace.

IV. STARTUP, ADJUSTMENT, AND SAFETY CHECK

A. Intermittent Ignition Systems

Check to be sure that all connections have been properly made, then proceed as follows:

Light the furnace, using the procedure outlined on the lighting instructions plate attached to the furnace. However, when lighting the furnace for the first time, perform the following additional steps:

1. If the gas supply was not purged before connecting furnace, it will be full of air. Properly purge air from gas supply piping and light pilot, following instructions on furnace rating.
2. After pilot lights, the main burners should light in 25 to 75 seconds. If main burners do not light within prescribed time period, adjust pilot flame.
 - a. Locate pilot adjustment screw on top of gas valve.
 - b. Remove capscrew; turn pilot adjustment screw counterclockwise to decrease burner-on time delay, clockwise to increase burner-on time delay.
 - c. Replace capscrew.
3. With pilot gas supply turned off, allow pilot to cool for 5 minutes, then repeat time check.

B. Gas Input

Determine the gas input as follows:

1. Natural Gas
 - a. Turn off all other gas appliances and pilots.
 - b. Measure time (in seconds) for gas meter test dial to complete one revolution.
 - c. Refer to Table I for ft³ (cubic feet) of gas per hour.
 - d. Multiply ft³ per hour times heating value of gas (Btu/ft³). Obtain heating value of gas from local gas utility.

Example:

Btuh heating input = Btu/ft³ x ft³/hr

Heat value of gas = 1070 Btu/ft³

Time for one revolution of 2-ft³ dial = 72 seconds

Gas rate = 100 ft³/hr (from Table I)

Btuh heating input = 1070 x 100 = 107,000 Btuh

- e. Set measured gas input to that shown on unit rating plate.
- f. To adjust input rate, remove cap that conceals regulator adjustment. Turn adjusting screw counterclockwise (out) to decrease input. When adjusting, DO NOT change manifold pressure more than 0.3 in. wc. Make any major adjustment by changing main burner orifices.

2. High Altitude

Ratings are approved for altitudes to 2000 feet for all gases. Ratings for altitudes over 2000 feet are 4% less for each 1000 feet above sea level. See Table II. Check and note the orifice size required at that altitude. If the orifices shipped with the furnace are not the recommended size, remove them and install the proper size.

TABLE I — GAS RATE — FT³/HR

Seconds for one Revolution	SIZE OF TEST DIAL			Seconds for one Revolution	SIZE OF TEST DIAL		
	1 ft ³	2 ft ³	5 ft ³		1 ft ³	2 ft ³	5 ft ³
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				

C. Temperature Rise

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

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

TABLE II — EQUIVALENT ORIFICE SIZES AT HIGH ALTITUDES

(Includes 4% Input Reduction For Each 1000 Feet)

Orifice size at sea level	ORIFICE SIZE REQUIRED AT OTHER ELEVATIONS									
	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	
21	23	23	24	25	26	27	28	28	29	
22	23	24	25	26	27	27	28	29	29	
23	25	25	26	27	27	28	29	29	30	
24	25	26	27	27	28	28	29	29	30	
25	26	27	27	28	28	29	29	30	30	
26	27	28	28	28	29	29	30	30	30	
27	28	28	29	29	29	30	30	30	31	
28	29	29	29	30	30	30	30	31	31	
29	29	30	30	30	30	31	31	31	32	
30	30	31	31	31	31	32	32	33	35	
31	32	32	32	33	34	35	36	37	38	
32	33	34	35	35	36	36	37	38	40	
33	35	35	36	36	37	38	38	40	41	
34	35	36	36	37	37	38	39	40	42	
35	36	36	37	37	38	39	40	41	42	
36	37	38	38	39	40	41	41	42	43	
37	38	39	39	40	41	42	42	43	43	
38	39	40	41	41	42	42	43	43	44	
39	40	41	41	42	42	43	43	44	44	
40	41	42	42	42	43	43	44	44	45	
41	42	42	42	43	43	44	44	45	46	
42	42	43	43	43	44	44	45	46	47	
43	44	44	44	45	45	46	47	47	48	
44	45	45	45	46	47	47	48	48	49	
45	46	47	47	47	48	48	49	49	50	
46	47	47	47	48	48	49	49	50	50	
47	48	48	49	49	49	50	50	51	51	
48	49	49	49	50	50	51	51	51	52	
49	50	50	50	51	51	51	52	52	52	
50	51	51	51	51	52	52	52	53	53	
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55	55	55	55	56	56	56	56	56	57	
56	56	56	57	57	57	58	59	59	60	
57	58	59	59	60	60	61	62	63	63	
58	59	60	60	61	62	62	63	63	64	
59	60	61	61	62	62	63	64	64	65	
60	61	61	62	63	63	64	64	65	65	

D. Limit Control Safety Check

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

The recommended 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 been proven safe, the return-air opening must be unblocked to permit normal air circulation. By using this method to check the limit control, it can be established that the unit is functioning properly and will "fail-safe" if there is a blower failure.

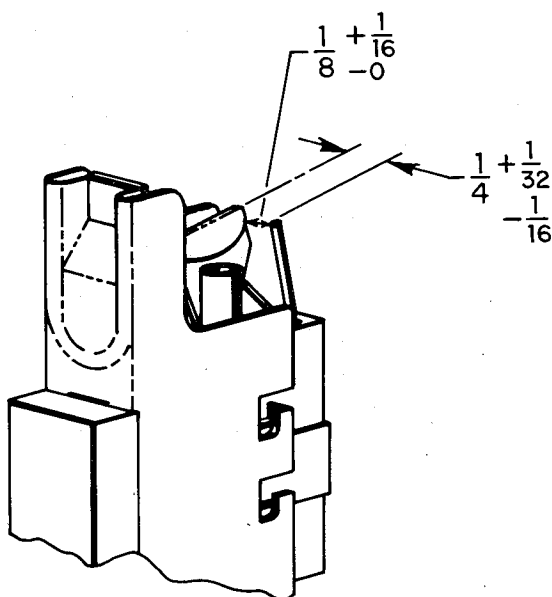
E. Sail Switch Safety Check

This control proves operation of the draft inducer blower. Check sail switch operation as follows:

1. Turn off 120-volt power to furnace.
2. Remove control door and disconnect inducer motor lead wires from inducer printed-circuit board.
3. Turn on 120-volt power to furnace.
4. Close thermostat switch as if making a normal furnace start. The pilot should light and then cycle off and on. If the main burners do not light, the sail switch is functioning properly.
5. Turn off 120-volt power to furnace.
6. Reconnect inducer motor wires, replace control door, and turn on 120-volt power.

F. Draft-Safeguard Switch Safety Check

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



A79080

Figure 11 — Position of Electrode to Pilot

1. Disconnect power to furnace, and remove vent pipe from furnace outlet collar. Be sure to allow time for vent pipe to cool before removing.
2. Set room thermostat above room temperature and restore power to furnace.
3. After normal startup, allow furnace to operate for 2 minutes, then block (100%) flue outlet. The furnace should cycle off within 2 minutes.
4. Reconnect vent pipe to furnace outlet collar.
5. Wait 5 minutes, then reset draft-safeguard switch.

V. TROUBLESHOOTING — ELECTRICAL

A. Trouble Analysis Chart

Trouble Analysis Chart TSP-397H-2 is a step-by-step procedure to determine which part has failed. The chart contains the following:

- Step-by-step checkout of components in pictorial form.
- Quick-analysis chart.
- Sequence of operation.
- Ladder-type wiring diagram and legend.

B. Pilot-Flame Sensing Switch

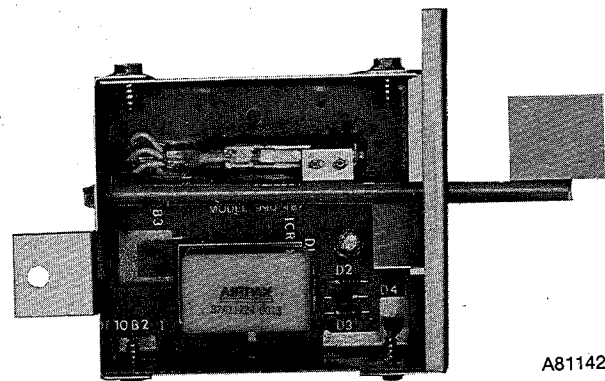
The pilot-flame sensing switch (733 pilot) and the correct electrode positioning for it is shown in Figure 11. If the positioning is not correct, the pilot may not light even though a spark is present. The location shown in Figure 11 places the electrode in a position where the spark can light the gas-air mixture.

C. Model 646 Redundant Gas Valve

The electrical components of the 646A Redundant Gas Valve can be checked by disconnecting all wires from the valve terminals (1 thru 5). Read approximate resistances as follows:

Heat Motor	60 ohms	Terminals 1 & 2
Pick Coil	22 ohms	Terminals 3 & 5
Hold Coil	220 ohms	Terminals 3 & 4

NOTE: Alternate gas valve resistances will be added at a later date.



A81142

Figure 12 — Inducer Control Box Assembly

D. Inducer Control Box

The inducer control box assembly must be ordered by the part number for the furnace model on which you are working. The smaller sizes of furnaces have a larger sail than the larger sizes of furnaces. See Figure 12.

E. Spark Generator

1. Remove wires from T₁ & T₂ on spark generator.
2. Connect jumper wire between T₁ on spark generator and SEC 1 on blower control center.
3. Connect jumper wire between T₂ on spark generator and SEC 2 on blower control center.
4. Set wall thermostat above room temperature.
5. Depress blower compartment door switch. Pilot electrode should begin sparking.
6. If no spark, remove electrode wire from pilot. Hold electrode wire 1/4 in. from T₂ on spark generator. In that position, it should spark. If it does not spark, replace spark generator.

F. Blower Motor and Run Capacitor

1. Disconnect motor leads from Molex plug and two capacitor terminals. The following checks can then be made:
 - a. Open Circuit — Check continuity between common and each motor speed tap. Also, check two capacitor leads for continuity. An open circuit will read "infinity."
 - b. Shorted — The same procedure used to check for an open circuit can be used to check for shorted circuits. However, a shorted winding will read zero ohms. Normally if a motor is shorted, there is a telltale odor from the burned windings. A visual check of the windings will show the effects of being overheated.
 - c. Grounded — Using an ohmmeter set on highest resistance scale, check for continuity between each motor lead and a bare metal

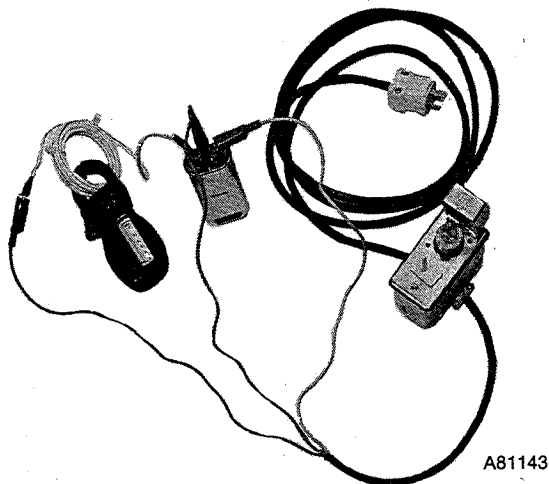


Figure 13 — Run Capacitor Amp Test

spot on motor frame. A grounded motor will read anything less than infinity.

2. Run Capacitor — Check run capacitor by using test device shown in Figure 13. This device consists of a J-box, a pushbutton door switch, a 10-amp fuse, an electrical cord, a plug, and clamp-on connectors.
 - a. Measure voltage at 120-volt standard wall outlet.
 - b. Set up capacitor for testing as shown in Figure 13, using 10 turns of wire as shown. After reading amps on ammeter scale, divide by ten; then use formula shown to obtain capacitance.

CAPACITOR FORMULA

$$\text{Capacitance (mfd or uf)} = \frac{\text{Amps} \times 2650}{\text{Volts}}$$

The capacitance reading of a good capacitor will be within $\pm 10\%$ of the rating stamped on the capacitor.

G. Safety Device Checks

The following safety devices should be checked by continuity. Be sure wires are disconnected from device being checked before continuity check is made.

- Main limit switch
- Manual reset draft-safeguard switch
- Fusible link

H. FDM-1 Analyzer

The FDM-1 Analyzer is an electrical service instrument which has been designed specifically for this line of heating products. See Figure 14. Operating instructions are included with the analyzer.

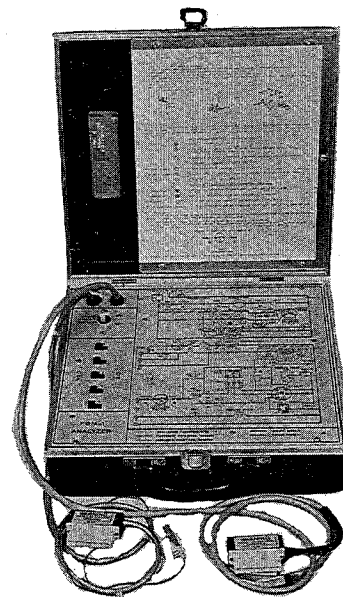


Figure 14 — FDM-1 Analyzer

VI. TROUBLESHOOTING — COMBUSTION

A. Burner Flashback

1. Wrong or missing sintered head inserts in burners.
2. The main burner carryover should be 0.050 ± 0.010 .
3. Misalignment of burners to secondary-air inlet plate openings.
4. Missing flame rollout shield.

B. Flame Rollout

1. The main cause of flame rollout, which opens the fusible link and shuts off the main burners, is the lack of combustion air.

Combustion air is covered in detail in the Installation Instruction (Procedures for Induced-Draft Gas-Fired Furnaces) supplied with the furnace.

2. Severe heat exchanger leaks.
3. Severe blockage of heat exchanger.
4. Oversized orifices which result in an over-fired furnace.
5. Excessive manifold gas pressure. The manifold pressure must be 3.5 inches w.c.
6. High-altitude installation where the smaller orifices for derating have not been installed. See high-altitude derating chart, Table II.
7. Although extremely unlikely, concurrent (during the same burner cycle) failure of the inducer and the sail switch can result in rollout.

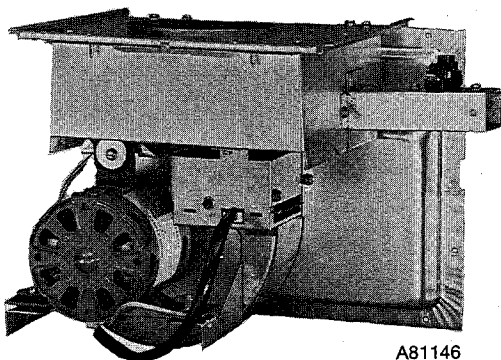


Figure 15 — Inducer Assembly

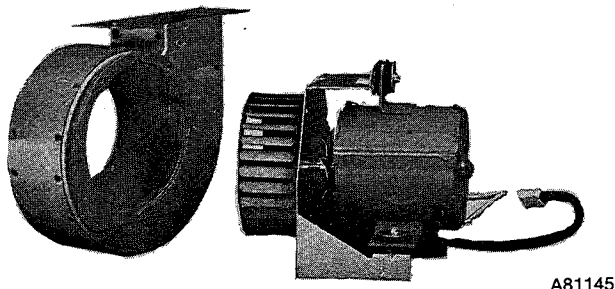


Figure 16 — Inducer Section

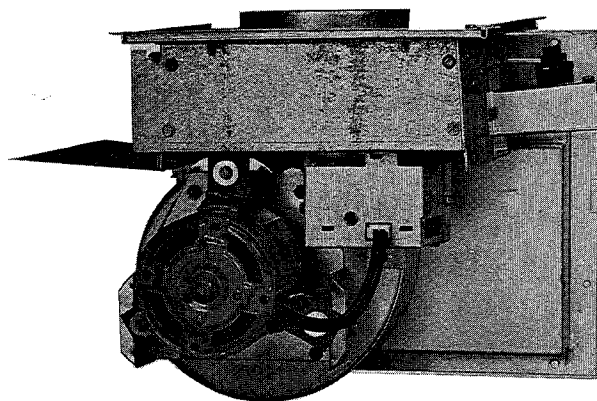
VII. REPAIR AND REPLACEMENT PROCEDURES

Figure 4 gives an overall view of how the furnace can be disassembled.

The inducer compartment, the burner compartment, and the blower compartment sections will be covered in more detail as we proceed through this section of the manual.

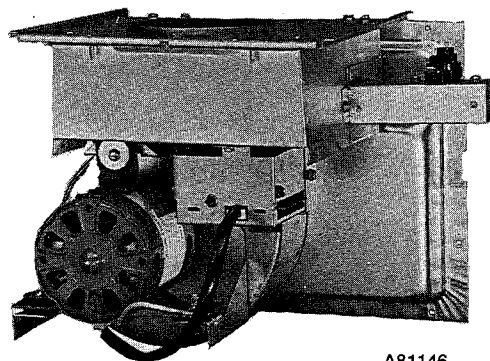
A. Inducer Compartment

1. The inducer can be easily removed as a complete assembly for servicing. See Figure 15.
2. Parts which may have to be replaced are as follows:
 - a. Inducer wheel, inducer motor, formed gasket, and propeller fan. These parts are removable as an assembly by removing four screws holding the assembly to the inducer housing. See Figure 16.
 - b. The inducer control box assembly contains the printed-circuit board and sail switch. Treat magnet on sail arm with care. Magnetism can be lost if the following precautions are not observed.
 - (1.) Do not let magnet touch metal.
 - (2.) Never put two magnets together.



A81141

Figure 17 — 1980 Inducer Assembly



A81146

Figure 18 — 1981 Inducer Assembly

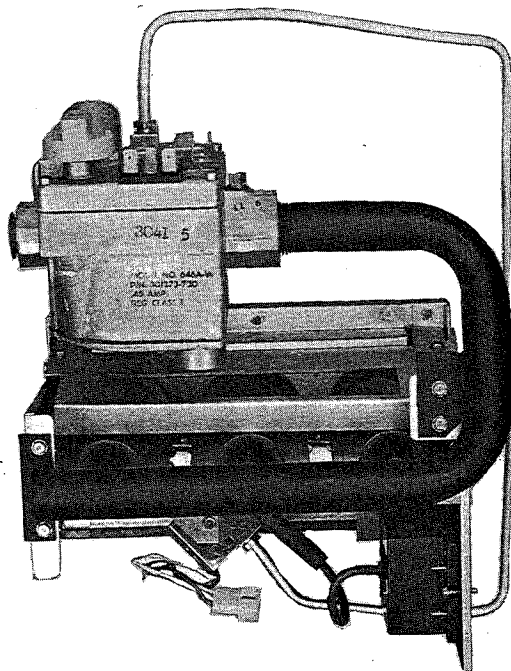
- (3.) Do not place magnet close to running AC motors.
 - c. The motor mount on 1980 furnaces, Figure 17, is different from the motor mount on 1981 furnaces, as shown in Figure 18.
- NOTE: Should a motor fail, the new motor mount must be ordered for the 1980 furnaces.

B. Burner Compartment

The burner compartment contains the 646 Redundant Gas Valve, the pilot-flame sensing switch, the 733 pilot, the inshot-type main burners, the spark electrode, the spark generator, the limit switch, and the fusible link. One additional safety feature in the burner compartment is designed into the wiring to the gas valve. The brown wire to the valve is looped around the blue wire to the valve and tied in a knot. Should flame rollout occur, the insulation on these wires melts, and a short circuit to the transformer is created. This short circuit will interrupt the electrical circuit to the gas valve and stop the gas flow to the main burners.

The entire burner and manifold control assembly can be removed as an assembly. This requires disconnecting the pilot Molex plug, the spark generator wires, the blower-control-center Molex plug, and the wires connected to the 646 Redundant Gas Valve. Figure 19 shows the complete assembly removed.

Be extremely careful when removing parts, *especially where back-up wrenches must be used to prevent distortion and breaking of parts.*

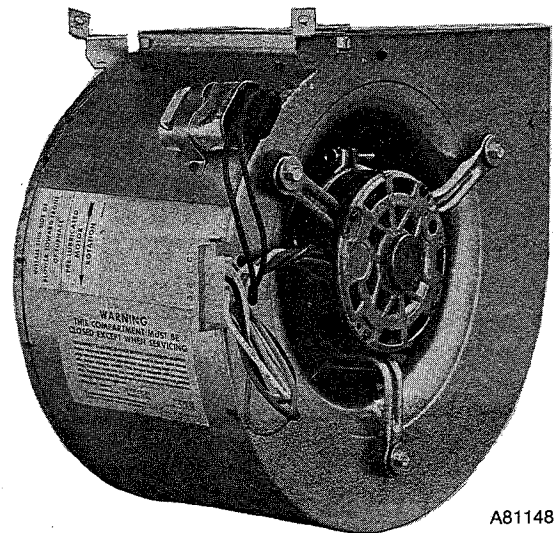


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Figure 19 — Burner Assembly

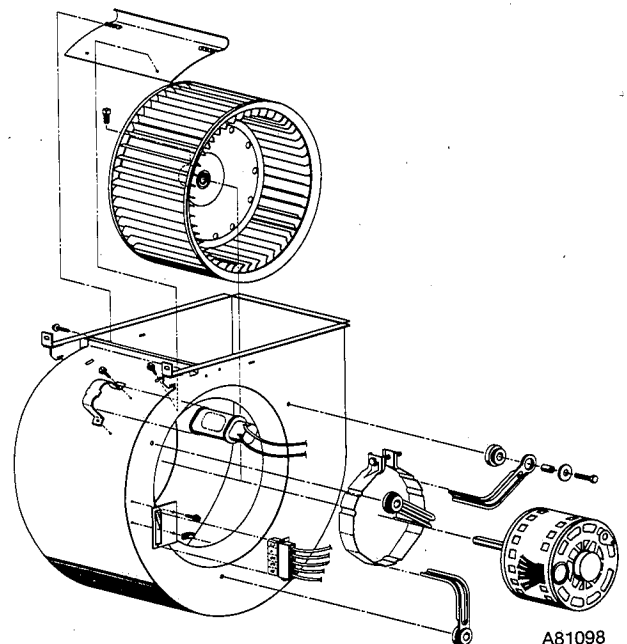
C. Blower Compartment

1. Blower Assembly — Figures 20 and 21
 - a. Motor and mount
 - b. Wheel
 - c. Capacitor and strap
 - d. Housing and cutoff
2. Door safety switch — Figures 22 and 24
3. Control box assembly — Figures 23 and 24
 - a. Blower control center
 - b. Transformer
4. High-velocity filter and retainer spring



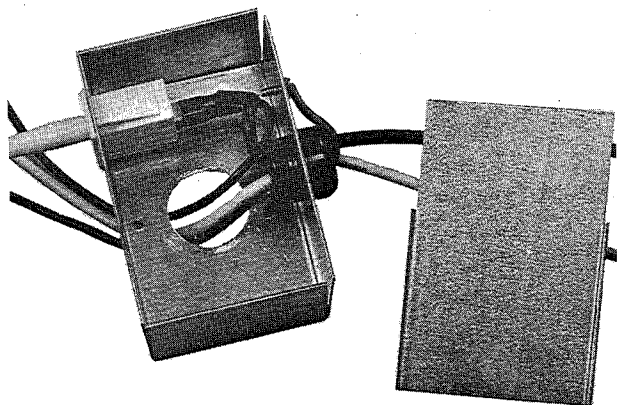
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Figure 20 — Blower Assembly



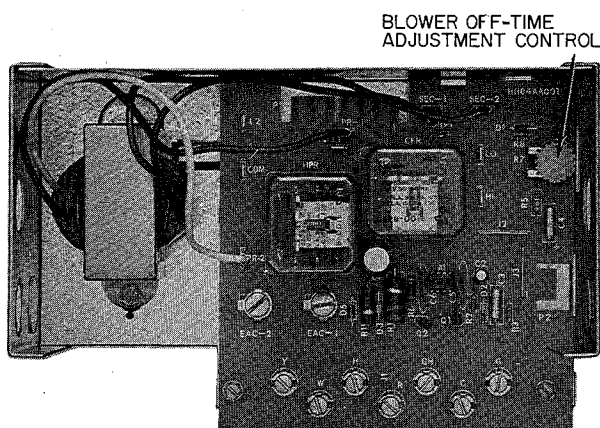
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Figure 21 — Exploded View of Blower Assembly



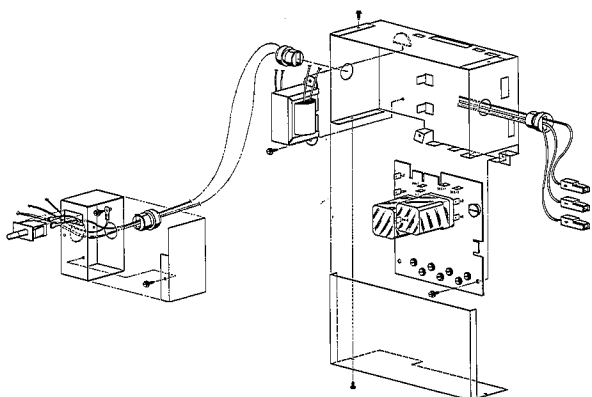
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Figure 22 — Door Safety Switch



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Figure 23 — Control Box



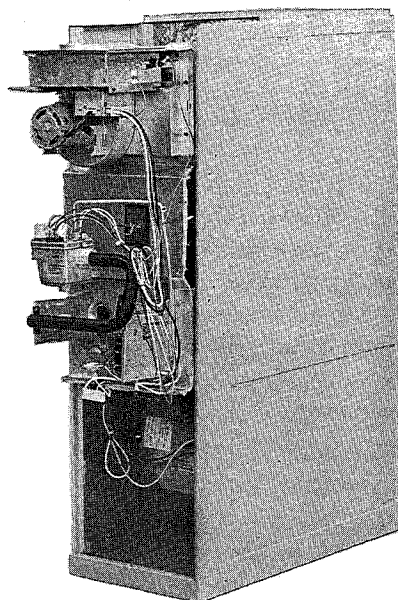
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Figure 24 — Exploded View of Control Box and Door Safety Switch

D. Heat Exchanger

The heat exchanger can be easily removed through the front of the furnace by performing the following steps:

1. Remove top front plate.
2. Disconnect Molex plug at blower shelf.
3. Remove screws from innerfront panel and remove innerfront panel with heat exchanger cells attached. See Figure 25.



A81150

Figure 25 — Heat Exchanger Removed From Front

VIII. MAINTENANCE

Each section requires that the electrical supply and gas be turned off before maintenance begins and while the work is in progress.

A. Filter

Follow the steps listed below for cleaning:

1. Turn OFF electrical supply to furnace. Remove control and blower access doors.
2. Compress filter retainer until it clears flange on furnace casing.
3. Gently remove filter and carefully turn dirty side up (if dirty) to avoid dislodging dirt from filter.
4. Inspect filter.
5. If filter is dirty, wash it in sink, bathtub, or outside with garden hose. Always use cold water. Use a mild liquid detergent, if necessary. Then, allow filter to air-dry.
6. Reinstall clean filter with cross-hatch binding side facing furnace blower. Be sure that filter retainer is under flange on furnace casing.
7. Replace blower and control access doors, and restore electrical power to the furnace. Should the filter need replacement, make sure it is replaced with the same type and size shown on the Replacement Parts List.

B. Lubrication of Inducer Motor

The inducer motor has sealed bearings; therefore, it does not require lubrication.

C. Main Blower Motor and Wheel

For long life, economy, and high efficiency; clean accumulated dirt and grease from blower wheel and motor annually.

Lubricate motor every 5 years if motor is used in intermittent operation (thermostat FAN switch in AUTO position), or every 2 years if motor is used in continuous operation (thermostat FAN switch in ON position).

Remember to disconnect electrical supply before removing access panels.

Clean and lubricate as follows:

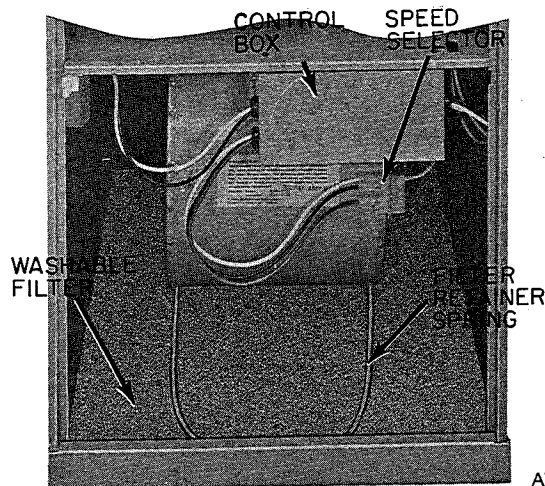
1. Remove access panels.
2. Remove control box from bottom side of blower deck, and lay it on top side. (Two clips are provided on back side of control box for hanging box on blower deck flange when desired.)
3. Remove electrical leads from numbered side of Molex speed selector. See Figure 26 and Table III. Note location of wires for reassembly.

TABLE III — SPEED SELECTOR

Speed	Tap No.
Common	C
Hi	1
Med-Hi	2
Med-Low	3
Low	4

NOTE: Some furnaces do not have the No. 4 speed tap.

4. Remove screws holding blower assembly against blower deck, and slide blower assembly out of furnace.
5. Squeeze side tabs of Molex speed selector, and pull it from blower housing.



A77241

Figure 26 — Furnace Blower Compartment

6. Loosen a screw in strap holding motor capacitor to blower housing, and slide capacitor from under strap.
7. Mark blower wheel, motor, and motor support in relation to blower housing before disassembly, to ensure proper reassembly.
8. Loosen setscrew holding blower wheel onto motor shaft.
9. Remove bolts holding motor mount to blower housing, and slide motor and mount out of housing. Some motors have a ground wire attached to the blower housing; disconnect it also.
10. Lubricate motor.
 - a. Remove dust caps or plugs from oil ports located at each end of motor.
 - b. Use a good grade of SAE 20 non-detergent motor oil and put one teaspoon, 5 cc, 3/16 oz, or 16 to 25 drops in each oil port.
 - c. Allow time for total quantity of oil to be absorbed by each bearing.
 - d. After oiling motor, be sure to wipe excess oil from motor housing.
 - e. Replace dust cap or plugs on oil ports.
11. Remove blower wheel from housing.
 - a. Mark blower wheel orientation and cutoff location to ensure proper reassembly.
 - b. Remove screws holding cutoff plate, and remove cutoff plate from housing.
 - c. Lift blower wheel from housing through opening.
12. Clean blower wheel and motor by using vacuum with soft brush attachment. Be careful not to disturb balance weights (clips) on blower wheel vanes. Also, take care not to drop or to bend wheel, as its balance will be affected.
13. Reassemble blower by reversing procedures 11a thru c. Be sure wheel is positioned for proper rotation.
14. Reassemble motor and blower by reversing procedures 5 thru 9. If motor has ground wire, be sure it is connected as before.
15. Reinstall blower assembly in furnace.
16. Connect electrical leads to Molex speed selector. Please note that connections are polarized for assembly — do not force.
17. Reinstall control box on bottom side of blower deck.
18. Turn on electrical power, and check for proper rotation and speed changes between heating and cooling.

D. Heat Exchanger Cleaning

It is recommended that the heat exchanger be cleaned with stainless steel brushes equipped with extensions. Several firms can supply these brushes; however, if you have difficulty locating them, you can definitely purchase them from:

Shaefer Brush Mfg Co, Inc.
117 West Walker Street
Milwaukee, Wisconsin 53204
Telephone (414) 645-3664

When ordering brushes and extensions from Shaefer, specify the following:

Quantity	Shaefer Part No.	Part Description
1	43802	1/4-in. dia x 3-in. long stainless steel brush
1	13044	0.162 dia x 48-in. rod with 8/32 male thread extension handle for 1/4-in. brushes

Before Starting the Following Steps, Disconnect Power to Furnace.

1. To clean heat exchanger without removing from furnace cabinet, proceed as follows:
 - a. Remove access panels and top plate.
 - b. Disconnect larger Molex plug from inducer control box.
 - c. Remove screws holding collector box to innerfront panel. It may be necessary to gently pry the collector box away from the innerfront panel because of the adhesive seal. The entire inducer assembly can now be removed.
 - d. Disconnect pilot Molex connector and spark generator leads.
 - e. Disconnect wires from gas valve and blower control center Molex.
 - f. Remove screws holding secondary-air inlet plate to the innerfront panel. The complete burner assembly can now be removed as a unit.
 - g. Use brush and extension rod to clean heat exchanger cell through each flue outlet. With tank-type vacuum cleaner, remove residue.
 - h. Clean each cell section in burner compartment and remove residue with vacuum cleaner.
 - i. To remove residue from two center sections of four-pass heat exchanger, it is necessary to make two plates, as shown in Figure 27.
 - j. Clean one cell at a time by installing vent plate over flue outlet. Tape plate in place.
 - k. Tape combustion plate over inlet opening of same cell.

- l. Insert vacuum cleaner attachment into 1-9/32-in. diameter hole of combustion plate. Some vacuum cleaner attachments have larger diameters and may require enlarging the 1-9/32-in. diameter hole.
- m. After vacuuming each cell, reassemble furnace.
- n. Install burner assembly, and reconnect pilot Molex plug.
- o. Using unit wiring diagram as a guide, reconnect wires to gas valve.
- p. Reinstall inducer assembly. If sealing material is damaged, remove all old sealant and apply new sealant. Use noncorrosive GE 162 or Dow Corning 738 sealant when available. However, if not available, use GE 102 or Dow Corning 732 sealant.
- q. Connect Molex plug to inducer control box assembly.
- r. Install access panels and top plate.
- s. After reconnecting power supply, operate furnace through one complete heating cycle, and check for proper operation.

E. General Cleaning

At the beginning of each heating season, perform the following steps:

1. Vacuum all compartments.
2. Check pilot, pilot orifice, and pilot tubing. They may need cleaning.
3. Clean main burner orifices.

F. Startup and Shutdown.

1. See the Procedures For Deluxe Gas-Fired, Induced-Draft Furnaces Instruction supplied with furnace.
2. Safety is primary. To prevent injury, the instructions supplied with the furnace must be followed.

G. Instructions to Owner

Explain the contents of the Owner's Manual to the owner. This includes startup, shutdown, thermostat operation, and general cleaning. Also, stress the importance of not storing flammable materials — liquid or solid — near the furnace.

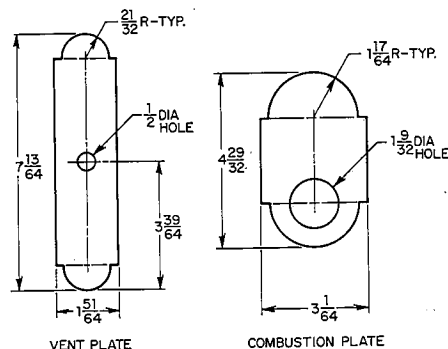


Figure 27 — Cell Opening Cover Plates

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