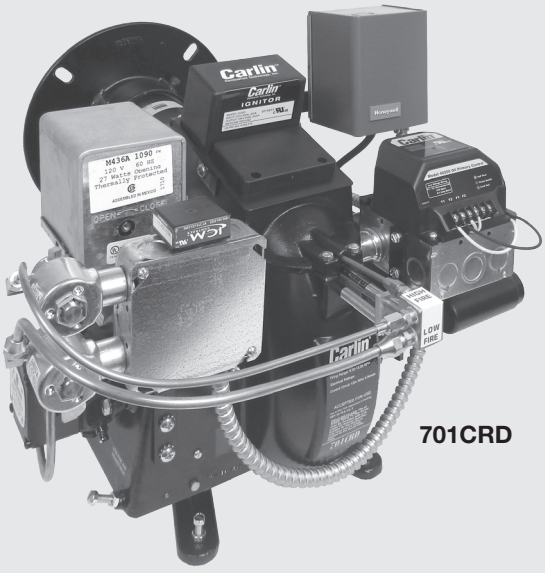
Carlin®
Combustion Technology, Inc.

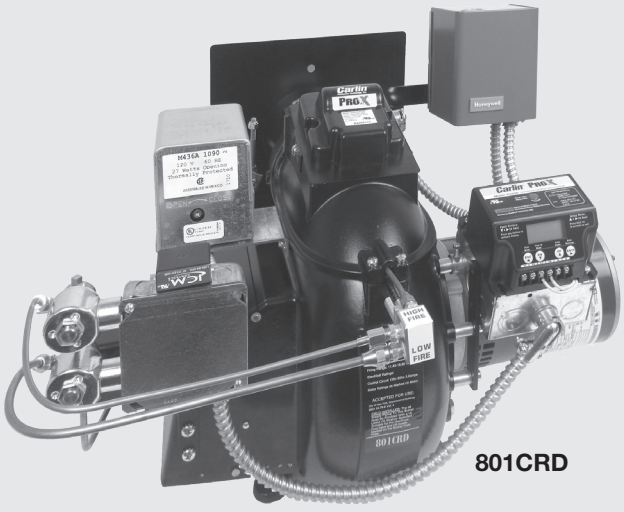
701CRD/801CRD Oil Burners

Installation and Operating Instructions

For Use By Qualified Service Technicians Only



701CRD



801CRD

It is important that the installation of the oil burner, piping and fittings, safety devices, controls, electrical wiring and equipment be done in accordance with national and/or local regulations of the authorities having jurisdiction over such installation.

DESCRIPTION

"CRD" burners feature a combustion head incorporating a design concept which provides a means to control the air pattern to match the nozzle requirements. The aerodynamics for optimum combustion are easily adjusted for any nozzle size without changing the air-handling hardware. The flame front is initiated inside the airtube so that no erratic recirculating gases from the main chamber area can quench the flame at the retention ring.

The letters "CRD" stand for "Controlled Retention–Double Speed." Carlin Models 70lCRD and 80lCRD, for use with No. 2 fuel oil, are low-high-low-off (step modulating) high speed flame retention burners. Oil flow–rate is step-modulated by the use of two oil valves and two nozzles. Combustion air is controlled by a damper motor. It's end-switch energizes the second stage valve as the air shutter approaches a wide open position.

Due to the low-high-low feature of these burners they are very versatile and efficient:

1. They can operate in forced draft boilers or furnaces at pressures up to 0.50 inches W.C.
2. They will save typically. 20% in seasonal fuel consumption compared to conventional single-stage flame retention burners.
3. They can operate with or without refractory lined combustion chambers.
4. They are superior for process applications.
5. They can be installed through fire door openings.

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LOW-HIGH-LOW (STEP-MODULATION) FIRING

Advantages: There are several strong advantages to low-high-low firing in both heating and process applications:

1. Smooth ignition both in natural and forced draft operations.
2. Closer control than with a single input.
3. Less strain or wear on the burner, boiler and combustion chamber components:
   a. Longer cycles.
   b. Gradual changes; less thermal shock.
4. Lower fuel consumption:
   a. Higher efficiencies of both low and high fire.
   b. Lower stand-by loss due to longer ON cycles and to the closed air damper during OFF cycles.

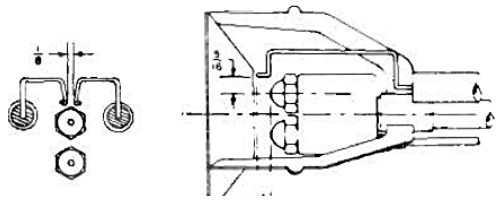
Operation: A true low-high-low burner controls both air and oil flow rates. A low fire start burner (low-high-off) controls only the oil rate and has a fixed air setting with none of the advantages of 1, 2, 3, or 4 above. The low-high-low burner cycle operates as follows:

1. Call for heat. Burner motor and ignition are energized. Air is in the low fire position. The low fire oil valve admits oil to the low fire nozzle and its spray ignites, burning clean with proper air/fuel ratio.
2. If demand exceeds low fire, the damper motor is energized through a high fire operating control (aquastat, airstat, pressure-trol, or outdoor thermostat.) As the damper motor approaches a wide open position, the auxiliary end switch energizes the high fire valve and the full fire with open air. Burns clean with high CO_2 and high efficiency.
3. As the high fire input begins to exceed the demand of the high fire operator, the operating control opens to de-energize the damper motor. As the damper motor returns the air shutter to low fire the auxiliary end switch in the damper motor opens and de-energizes the high fire valve.
4. If the demand exceeds low fire, the high fire operating control would again call for more heat as in Step 2 and then followed by Step 3.
5. If, after returning to low fire, the load should drop to below the low fire output, the operating limit would shut off the burner completely.

ASSEMBLING THE BURNER (TWO-PAK)

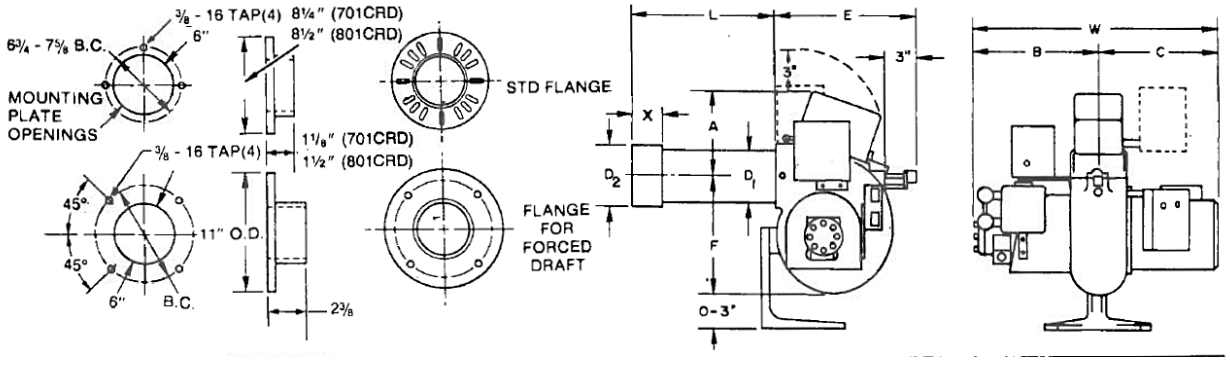
1. Remove the air tube and nozzle line assembly from the smaller carton. If nozzles are not installed, see instructions under (4).
2. Remove the main housing assembly from the larger carton.
3. Install air tube assembly in housing using set screws provided. Be sure air tube is fully seated against step in housing
4. Install and tighten the proper nozzles (see Tables 5 & 6. page 4) in the adapter. Be careful not to damage the electrode insulators or to bend the wires.
5. Check the electrode settings.

FIG. 1



6. Swing open the transformer and slide the nozzle line assembly into the air tube. On Model 801CRD, the flame retention ring must be lifted and guided through the throttle ring (a reduced diameter) in the end of the airtube. DO NOT FORCE IT.
7. Fasten the high tension leads to the transformer terminals.
8. Place the nozzle line yoke in the groove in the adjusting screw.
9. Swing the transformer to the closed position.
10. Connect the flared fitting on the copper oil lines to the nozzle lines and tighten.
11. See sections on page 4 for adjustments of combustion head and combustion air.

DIMENSIONS



MODEL	STD. FLANGE	B.C.	FORCED DRAFT FLANGE	B.C.	O.D.
701CRD	59642	6¾-7⅞	59444	9-10"	11"
801CRD	59683	6⅞-7⅞	59535	10"	11"

MODEL	A	B	C	D_1	D_2	E	F	L	W	X
701CRD	7½	9½	10	4⅛	5⅞	13	9	10¹¹⁄₁₆-14¹¹⁄₁₆	19½	2½
801CRD	8	12	11	5¼	5⅞	14½	10½	10-15	23	3

FIRING BOILERS WITH COMBUSTION CHAMBERS

The Models 701CRD and 801CRD operate with superior efficiency and cleanliness in properly designed refractory-type combustion chambers. Very wide tolerance to burner adjustments and other variables is found when these chambers are used.

Tables 1 and 2, show the recommended minimum inside dimensions for refractory brick, refractory pre-cast and pre-formed refractory fiber chambers. Due to their quick warm-up properties, the light, insulating-type materials are slightly preferable although these burners show less dependence upon refractory temperature than previous models. Refractory materials in boilers and furnaces should be capable of withstanding 2600°F (1427°C) or higher.

The notes accompanying Table 1 and 2 provide further details relative to variations in dimensions and geometry.

TABLE 1 701CRD
MINIMUM DIMENSIONS RECOMMENDED IN REFRACTORY COMBUSTION CHAMBERS–(Inches)

1 High Fire Oil Delivery Rate GPH @ 150 PSI	2 Length L	3 Width W	4 Dimens. C	5 Suggested Height H	6 Minimum Dia. Vertical Cyl.
6.00	19	13.5	7.0	13	17
6.60	22	14.0	7.0	14	20
7.20	24	14.5	7.5	14	24
7.80	27	15.0	7.5	15	25
8.40	30	15.5	8.0	15	28
9.00	33	15.5	8.0	15	31
9.60	34	16.0	8.0	16	32
10.20	35	16.0	8.0	16	33
10.80	36	16.0	8.0	16	34
11.40	37	16.5	8.5	16	35
12.00	48	16.5	8.5	16	46
12.60	52	16.5	8.5	16	50
13.20	55	16.5	8.5	16	53

Note: These are MINIMUM dimensions and each may be exceeded without much effect.

TABLE 2 801CRD
MINIMUM DIMENSIONS RECOMMENDED IN REFRACTORY COMBUSTION CHAMBERS–(Inches)

1 High Fire Oil Delivery Rate GPH @ 150 PSI	2 Length L	3 Width W	4 Dimens. C	5 Suggested Height H	6 Minimum Dia. Vertical Cyl.
11.4	33	15	7.5	15	31
12.0	34	16	8.0	16	32
12.6	35	16	8.0	16	33
13.2	36	17	8.5	17	34
13.2	38	17	8.5	17	36
14.4	39	18	9.0	18	37
15.0	40	18	9.0	18	38
15.6	41	19	9.5	19	39
16.2	43	19	9.5	19	41
16.8	44	20	10.0	20	42
17.4	46	20	10.0	20	44
18.0	47	21	10.5	21	45
18.6	49	21	10.5	21	47
19.2	51	22	11.0	22	49
19.8	52	22	11.0	22	50

Note: These are MINIMUM dimensions and each may be exceeded without much effect. Refer to Fig. 2 for details showing L, C & H.

TABLE 3 701CRD
MINIMUM DIMENSIONS RECOMMENDED BOILERS FIRED WITHOUT COMBUSTION CHAMBERS–(Inches)

1 High Fire Oil Delivery Rate GPH @ 150 PSI	2 L With Target	3 L Withou Target	4 Width W	5 Dimens. C	6 Dimens. D
6.00	19	23	15.5	8.0	10.0
6.60	22	26	16.0	8.0	10.0
7.20	24	28	16.5	8.5	10.5
7.80	27	32	17.0	8.5	10.5
8.40	30	35	17.5	9.0	11.0
9.00	33	38	17.5	9.0	11.0
9.60	34	40	18.0	9.0	11.0
10.20	35	41	18.0	9.0	11.0
10.80	36	42	18.0	9.0	11.0
11.40	37	43	18.5	9.5	11.5
12.00	48	54	18.5	9.5	11.5
12.60	52	58	18.5	9.5	11.5
13.20	55	60	16.5	9.5	11.5

TABLE 4 801CRD
MINIMUM DIMENSIONS RECOMMENDED BOILERS FIRED WITHOUT COMBUSTION CHAMBERS–(Inches)

1 High Fire Oil Delivery Rate GPH @ 150 PSI	2 L With Target	3 L Withou Target	4 Width W	5 Dimens. C	6 Dimens. D
11.4	33	38	17	7.5	9.5
12.0	34	39	18	8.0	10.0
12.6	35	40	18	8.0	10.0
13.2	36	41	19	8.5	10.5
13.8	38	43	19	8.5	10.5
14.4	39	44	20	9.0	11.0
15.0	40	46	20	9.0	11.0
15.6	41	47	21	9.5	11.5
16.2	43	49	21	9.5	11.5
16.8	44	50	22	10.0	12.0
17.4	46	52	22	10.0	12.0
18.0	47	54	23	10.5	12.5
18.6	49	56	23	10.5	12.5
19.2	51	58	24	11.0	13.0
19.8	52	59	24	11.0	13.0

Refer to Figs. 3 and 4 for details showing L, C & D

FIRING BOILERS WITHOUT REFRACTORY CHAMBERS

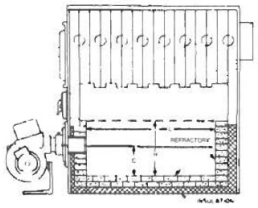
Depending upon the geometry of the combustion space some units perform better than others without refractory. When the back wall of the unit coincides approximately with the end ofthe flame, a target of refractory material is usually required.

Tables 3 and 4 show MINIMUM dimensions required for good combustion. They may be exceeded without much effect.

INSTALLING THE BURNER: FLANGE MOUNTED

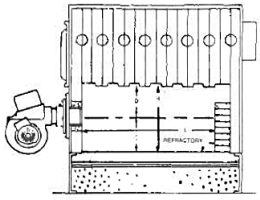
1. Measure, in the burner opening, the distance from the inside of the combustion chamber to the outside of the mounting plate to find the insertion length of air tube needed. Position flange with sleeve inside on air tube at a point from end of burner corresponding to this measurement. Tighten set screws to anchor flange. The flange is now located so that the end of the burner will be flush, or almost flush, with the inside of the combustion chamber.
2. Slide the end of the air tube into the opening and secure the flange to the front plate.

FIG. 2



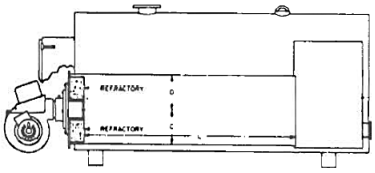
Brick combustion chamber, side view.

FIG. 3



Wet leg boiler. No combustion chamber, side view.

FIG. 4



Scotch Marine boiler. No combustion chamber.

INSTALLING THE BURNER: PEDESTAL MOUNTED

1. Adjust the pedestal so that the height of the air tube matches the location of the burner opening.
2. Slide the end of the air tube into the opening so that it is flush or nearly flush with the inside ofthe combustion chamber.
3. From the outside of the unit, seal the space around the air tube with refractory cement or equivalent.

FIG. 5

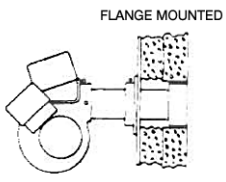
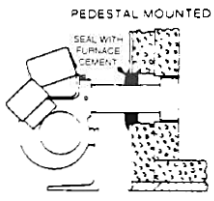


FIG. 6



HOW TO ADJUST THE COMBUSTION HEAD

The retention ring position ahead of the throttle ring is adjustable from zero (flush) to 1¼ inches (Dimension “A” Figs. 7 and 8). Turning the adjusting screw in (clockwise) increases the distance “A“ ahead. This distance is indicated by lifting the housing cover and reading the scale on the nozzle line across the corners on sides of the channel guiding the nozzle line. Each division is 1⁄16 inch.

Refer to “A” dimension given in Table 5 and 6 for corresponding nozzle selection. (If alternate nozzle sizes are used select “A” dimension from the high fire oil delivery rate. Column 5). EXAMPLE: 70ICRD firing at 11.40 GPH high fire. “A” column setting reads ¼".

1. Turn adjusting screw counterclockwise until zero on scale is aligned with rear of housing (“A” equals zero see Fig. 8).
2. Now turn adjusting screw clockwise until the ‘/J’ graduation on the scale coincides with rear of housing. Each mark (or line) is 1⁄16 inch. (See Fig. 8).
3. The retention ring will now be exactly ¼" ahead of the throttle ring. (See “A” dimension. Fig. 7).

CAUTION: Housing coxer should be raised slightly when attempting to change retention ring setting (“A” dimension) otherwise scale will be torn or distorted. This can be done by backing out the two hold-down screws 2 to 3 turns. and then lifting cover slightly while adjusting. Be sure to tighten screws after adjusting.

FIG. 7

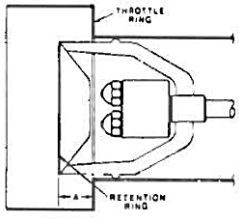
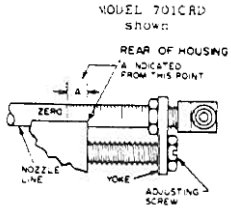


FIG. 8



COMBUSTION HEAD ADJUSTMENT FOR COMBUSTION AIR

When adjusting the combustion head forward or back, the space around the rim ofthe retention ring is increased or decreased which increases or decreases the amount of combustion air to correspond with the nozzle sizes used.

Also, by using the specified nozzle combinations for low and high fire (Tables 5 and 6), the air fuel ratio for both low and high fire are optimized by the automatic damper motor and its associated linkage. THIS LINKAGE HAS BEEN PRE-SET AT THE FACTORY AND SHOULD NOT BE ADJUSTED. It is set to be in the fully open position when the burner is in high fire.

By adjusting the combustion head according to Tables 5 and 6 (last column), for the firing rate delivered by the particular nozzles, the burner should deliver very close to the proper amount of combustion air and CO_2. Slight increases or decreases will usually be required depending upon the draft. Normally a draft of 0.02 to 0.04 inches W.C. (negative pressure) is recommended over the fire for natural draft applications.

Model 701CRD is provided with a low fire air shutter adjusting screw. This adjustment limits the amount of shutter

closure which thereby increases or decreases the amount of combustion air required for proper burning.

Model 801CRD is supplied with separate low fire and high fire air shutters. The low fire air shutter has an adjusting screw which should be adjusted to get a clean, low fire. The high fire air shutter is not adjustable and moves with the linkage that is preset at the factory.

TABLE 5 701CRD
NOZZLE DATA AND COMBUSTION HEAD SETTINGS

Nozzle Specifications Hago Products Corp.			Oil Delivery Rate GPH @ 150 PSI		"A"* Approximate Retention Ring Setting On Scale	Low Fire Air Shutter
1st Stage	2nd Stage	Spray	Low Fire	High Fire		
3.00	2.00	60°H	3.60	6.00	1/16"	1/8"
3.25	2.25	60°H	3.90	6.60	3/16"	1/8"
3.25	2.75	60°H	3.90	7.20	1/4"	1/8"
3.50	3.00	60°H	4.20	7.80	5/16"	1/4"
3.50	3.50	60°H	4.20	8.40	3/8"	1/4"
3.75	3.75	60°H	4.50	9.00	7/16"	3/8"
4.00	4.00	80°H	4.80	9.60	1/2"	1/2"
4.00	4.50	60°H	4.80	10.20	9/16"	1/2"
4.50	4.50	60°H	5.40	10.80	5/8"	5/8"
4.50	5.00	60°H	5.40	11.40	3/4"	3/8"
5.00	5.00	45°H	6.00	12.00	7/8"	3/4"
5.00	5.50	45°H	6.00	12.60	1 1/16"	3/4"
5.00	6.00	45°H	6.00	13.20	1 1/4"	3/4"

TABLE 6 801CRD
NOZZLE DATA AND COMBUSTION HEAD SETTINGS

Nozzle Specifications Hago Products Corp.		Oil Delivery Rate GPH @ 150 PSI		"A"* Approximate Retention Ring Setting On Scale	Low Fire Air Shutter
1st Stage	2nd Stage	Low Fire	High Fire		
5.50	4.00	6.60	11.40	1/16"	1/4"
5.50	4.50	6.60	12.00	1/16"	1/4"
5.50	5.00	6.60	12.60	1/48"	1/4"
5.50	5.50	6.60	13.20	3/16"	1/4"
6.00	5.50	7.20	13.80	1/4"	3/8"
6.00	6.00	7.20	14.40	5/16"	3/8"
6.00	6.50	7.20	15.00	3/8"	3/8"
6.50	6.50	7.80	15.60	7/16"	1/2"
6.50	7.00	7.80	16.20	1/2"	1/2"
6.50	7.50	7.80	16.80	3/8"	1/2"
6.50	8.00	7.80	17.40	3/4"	1/2"
6.50	8.50	7.80	18.00	7/8"	1/2"
7.00	8.50	8.40	18.60	1"	5/8"
7.00	9.00	8.40	19.20	1 1/8"	5/8"
7.00	9.50	8.40	19.80	1 1/4"	5/8"

*When field conditions are unusual or if the load requires it, the low fire and high fire may be altered such that the low fire is increased and the high fire decreased as needed. The low lire air shutter adjusting screw will require turning to the revised nozzle sizes.

*"A"–See Figs. 7 and 8, Page 4.

NOZZLE SPECIFICATIONS

The nozzles shown in Tables 5 and 6 are standard and usually provide the best fire. Substitutions are not normally recommended.

Other makes of nozzles may or may not prove satisfactory.

For special applications. other specifications might provide a more desirable pattern.

FORCED DRAFT FIRING

Due to the back pressure in forced draft units the maximum firing rate of a burner is reduced. The greater the pressure, the lower the maximum GPH capability becomes. Table 7 shows this. Note that the Table stops at 0.50 inches W.C.: the maximum recommended back pressure for these models.

TABLE 7
MAXIMUM FIRING RATES (GPH)–FORCED DRAFT

Burner Model	Combustion Chamber Pressure 0.00	0.10	0.20	0.30	0.40	0.50	INS.	W.C.
701CRD	13.20	12.70	12.30	11.80	11.30	10.90		
801CRD	19.80	19.40	19.00	18.60	18.20	17.80		

The combustion head settings for forced draft firing would be somewhat greater than those shown in Tables 5 and 6 which are for zero pressure or natural draft.

FUEL UNITS AND OIL LINES

Standard burners are provided with a two-stage 3450 rpm fuel unit set at 150 PSI.

A single-pipe system is recommended whenever the bottom of the fuel tank is above the burner or is at the same level as the burner. This includes outdoor fuel tanks that are at such levels. The length of run should not exceed 100 ft. and the vacuum should not exceed 12" mercury (5.9 PSI). Be sure the by-pass plug has been removed for single-pipe systems.

A two-pipe system is recommended when the fuel tank is below the level of the burner and the fuel unit must pull (lift) the fuel up to the burner. The vacuum reading should not exceed 12" mercury (5.9 PSI). For two-pipe installations the by-pass plug must be installed.

Table 8 shows, for the standard two-stage fuel unit, the allowable lift and lengths of 1/2" and 5/8" OD tubing for both suction and return lines in two-pipe systems.

TABLE 8
MODEL 701CRD & MODEL 801CRD
TWO-STAGE UNITS–TWO-PIPE SYSTEMS (150 PSI)

	Length of Tubing (feet)	
Lift (feet)	1/2" OD	5/8" OD
0	100	100
2	88	100
4	78	100
6	69	100
8	59	100
10	49	100
12	39	100
14	29	82
15	24	68

Be sure that all oil line connections are absolutely air tight. Check all connections and joints. Flared fittings are required. Do not use compression fittings.

Open the air-bleed valve and start the burner. For clean bleed. slip a 1/16"" ID hose over the end of the bleed valve and bleed into a container. Continue to bleed for 15 seconds after oil is free of air bubbles. Stop the burner and close the bleed valve.

LIGHT-OFF AND ADJUSTMENT

NOTE: WHEN STARTING THIS BURNER THE FIRST TIME OR AFTER CHANGING NOZZLES, THE FLAME MAY GO OUT DURING THE SWING FROM LOW TO HIGH. BE READY TO SHUT THE BURNER DOWN JUST AFTER THE FLAME GOES OUT. REPEAT THIS UNTIL THE AIR IS PURGED OUT OF THE HIGH FIRE OIL LINE.

Before starting the burner, pre-set the retention ring position for the particular firing rate according to Table 5 for the 701CRD or Table 6 forthe 8O1CRD.

If the fire is a little too rich, move the combustion head forward by increasing dimension "A" (Fig. 7 and 8). At the lower inputs, a very slight change is usually enough. DO NOT ALTER THE LINKAGE. IT IS PRE-SET AT THE FACTORY.

Model 701CRD is provided with a low fire air shutter adjusting screw. This adjusting limits the amount of shutter closure which thereby increases or decreases the amount of combustion air required for proper burning.

Model 801CRD is supplied with separate low fire and high fire air shutters. The low fire air shutter has an adjusting screw which should be adjusted to get a clean, low fire. The high fire air shutter is not adjustable and moves with the linkage that is pre-set at the factory.

Adjust draft to 0.02 to 0.04 inches W.C. over the fire for natural draft units.

Run a smoke test. Strive for zero or a trace. Each time further adjustment of retention ring is made, reset the draft to 0.02 to 0.04 inches W.C. over the fire.

Check CO_2. This should be 12 to 12½ percent, and will often be over 13 percent, in a well-sealed unit.

Check for good ignition and clean cut-off. If cut-off continues to be poor, look for air leaks in the suction line and correct them.

For different boiler applications, it is sometimes necessary to have the high-fire pull in earlier or later than normal during the swing to achieve a smooth, cleaner transition.

If the swing from low-fire to high-fire is rough, i.e. bangs or rumbles or is extremely smoky, the internal end switch of the damper motor is possibly not set correctly. The high-fire should pull in as the air shutter, NOT THE DAMPER ARM, is about half way through its swing.

If the fire is lean all the way to high-fire, the high-fire valve should be energized earlier. If during the swing, the fire gets very smoky, then cleans up again, the high-fire valve should be energized later.

To adjust the damper end switch, remove the damper motor cover. This will expose a white plastic gear with notches. With the burner off, use the end of a small bladed screwdriver inserted into one of the notches of the white gear. Turn the gear one notch clockwise if a later pull-in is required, or counter clockwise for an earlier pull-in.

The linkage between the damper motor arm and the air shutter crank is set at the factory and should only need adjustment if the damper motor or damper rod is replaced. With the burner in high-fire. there should be minimal play in the connecting rod.

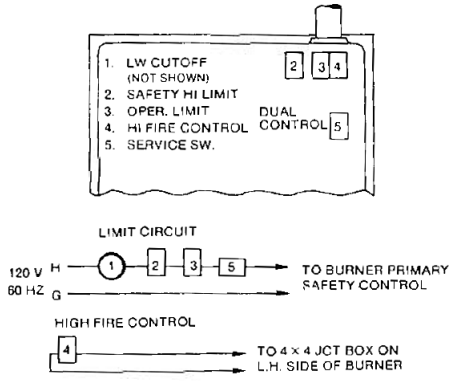
WIRING FOR LOW-HIGH-LOW STEP MODULATION

In order to take full advantage of the energy savings potential of these bumers they should be wired to operate with low-high-low cycles. Hence the firing cycle would be much longer by going from low to high to low once or several times before shutting off.

In the following illustrations are two examples: 1. Water Boiler. 2. Steam Boiler. In each case, we have a limit circuit which starts and stops the burner and a high fire control which brings the high fire on and off.

Also, prewired and built into the burner is a manual high fire switch which enables the installer or operator to hold the burner on low fire if so desired.

Refer to the appropriate example for your installation.



Example: Water Boiler

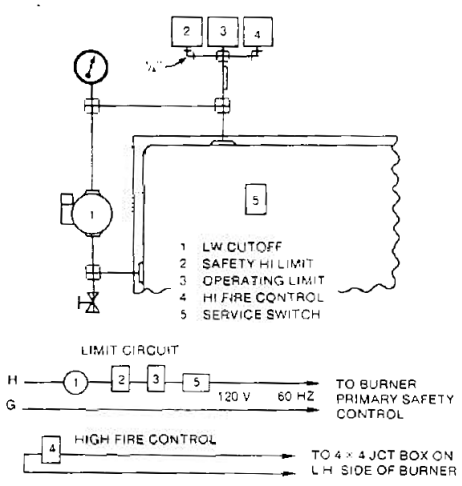
Operating Range 170°-190°F

2. Set Safety Hi Limit: Cut in 200 / Cut out 21O
3. Set Operating Limit: Cut in 180 / Cut out 190
4. Set Hi Fire Control: Cut in 170 / Cut out 180

Operation:

1. Call for heat: cold start. Burner starts on low and goes to high fire.
2. When the temperature rises to 130°F, the burner goes to low fire.
3. If temperature drops to 170°, burner returns to high fire.
4. If temperature rises to 190°, burner shuts off.

NOTE: Since the calibrations on the limit controls are seldom exact, it will be necessary to readjust the settings during operation.



Example: Steam Boiler

Operating Range 3 to 6 PS1

2. Set Safety Hi Limit: Cut in 8 PSl / Cut out I0 PSI

3. Set Operating Limit: Cut in 8 PSl / Cut out 6 PSI

4. Set Hi Fire Control: Cut in 3 PSl / Cut out 4 PSI

Operation:

1. Call for heat: cold start. Bunier starts on low and goes to high fire.
2. When pressure rises to 4 PSI, the burner goes to low fire.
3. If pressure drops to 3 PSl burner returns to high fire.
4. If pressure rises to 6 PS1 burner shuts off.

NOTE: Since the calibrations on the limit controls are seldom exact, it will be necessary to readjust the settings during operation.

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