SECOND EDITION

CARLIN
OIL BURNER AND WATER HEATER HANDBOOK

PRICE $1.00

HANDBOOK
of
OIL BURNERS
and
WATER HEATERS

PROPERTY OF

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2nd Edition

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HANDBOOK
of
OIL BURNERS
and
WATER HEATERS

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Published September 1966

FOREWORD

The original edition of the Carlin "Handbook," published in 1959, has proved so popular that we have prepared a second edition completely updated to include the numerous changes which have occurred in the interim.

Again we have collected in one handy place a wealth of information for oil burner men—particularly installers and service personnel—to assist in obtaining the best possible performance from Carlin heating equipment.

We suggest that you carry this handbook on every job; it will save you hours and hours of valuable time by giving you the facts and figures you need—when you need them!

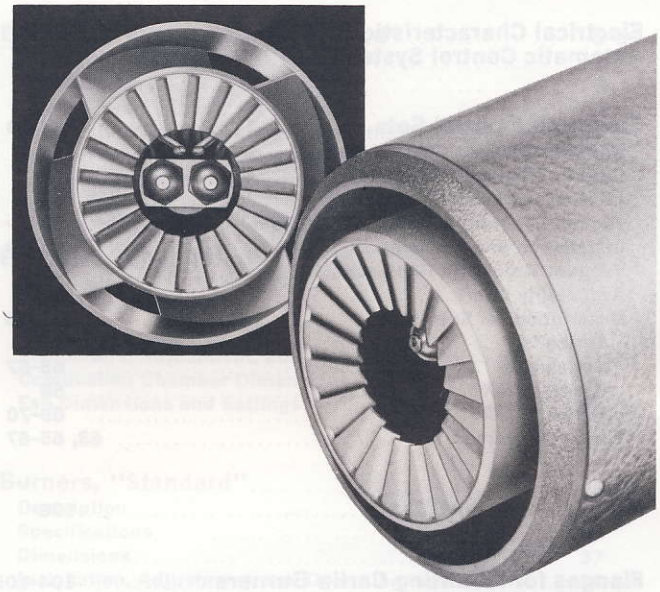
Although every effort has been made to include all important data, it is impossible to cover every need for information in a publication of this size. This is particularly true with reference to replacement parts. Although we have included at the back of the book a listing of major components and their interchangeable use, we wish to remind our readers of the availability of a complete parts list (PL-60) which illustrates and numbers every part for every Carlin model. If you don't have this helpful reference, request a copy today from your wholesaler or directly from us.

If the answers to your questions are not found in this "Handbook," feel free to call on us. The experience of Carlin engineers, representing a lifetime of specialization in heating equipment, is yours to draw on. Our aim always is to give careful, prompt, and courteous attention to every request.

Also, may we suggest to you that your ideas for improving the Carlin "Little Red Handbook" are always welcome.

B. C. Lindberg

B. C. Lindberg, *President*



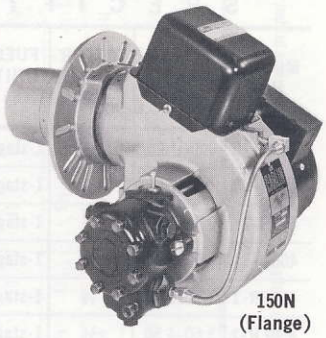
Carlin "Flame Retention Head" burners, in combination with well-known Carlin advanced-design features, produce a quiet, high-temperature flame that is also quick-starting, free of pulsation and of proper shape for clean firing in frequently encountered low and narrow combustion areas as well as in low-base and Scotch Marine-type boilers.

Exceptionally favorable CO_2 readings (in relation to burner firing rate), with low stack temperatures and zero smoke, indicate the high combustion efficiency regularly obtained, even in restricted combustion areas and under subnormal draft conditions.

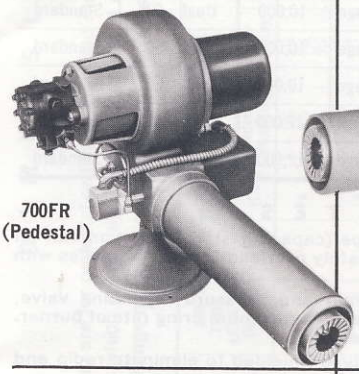
The many outstanding features of these burners together with their simplified, functional construction, assure dependable performance with the utmost economy—both in operation and maintenance.

All models except 1200FR available for either pedestal or flange mounting. Model 1200FR available for pedestal mounting only. For information on flanges, refer to pages 104-105.

400N
(Pedestal)

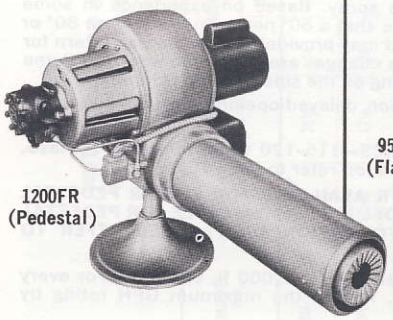


150N
(Flange)

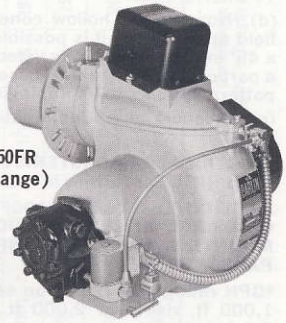


700FR
(Pedestal)

450FR
(Pedestal)



1200FR
(Pedestal)



950FR
(Flange)

CARLIN *"Flame Retention Head"* BURNERS

SPECIFICATIONS

MODEL NO.	FIRING RANGE* (GPH)	MOTOR (HP) (a)	FUEL UNIT (b)	TRANS-FORMER (volts) (c)	NOZZLE(S) (d)	DELAYED OIL VALVE (e)
150N-2R	0.65–1.25	⅛	1-stage	10,000	Single 80°	Optional
150N-3R	1.00–1.65	⅛	1-stage	10,000	Single 80°	Optional
400N-2	0.65–2.00	⅛	1-stage	10,000	Single 60°	Optional
400N-3	1.50–3.00	⅛	1-stage	10,000	Single 60°	Optional
450FR-1	1.50–3.00	⅛	1-stage	10,000	Dual 60°	Standard
450FR-2	3.00–4.50	⅛	1-stage	10,000	Dual 60°	Standard
700FR	3.50–6.50	⅙	2-stage	10,000	Dual 60°	Standard
950FR-1	3.50–7.00	⅙	2-stage	10,000	Dual 60°	Standard
950FR-2	6.00–9.30	⅙	2-stage	10,000	Dual 60°	Standard
1200FR-1	6.00–9.50	¼	2-stage	12,000	Dual 60°	Standard
1200FR-2	9.00–12.00	¼	2-stage	12,000	Dual 60°	Standard

NOTES

(a) Motor is long-hour duty type (capacitor start, induction run on Models 1200FR-1 and -2) with safety overload control. Complies with NEMA specifications.

(b) Fuel unit has built-in strainer and pressure regulating valve. Capacity of strainer equals or exceeds maximum firing rate of burner. Equipped with easy-flow bleed valve.

(c) Transformer is heavy-duty type shielded to eliminate radio and TV interference.

(d) Nozzles are hollow cone spray. Based on experience in some field applications, it is possible that a 60° nozzle in place of an 80° or a 45° in place of a 60° as listed may provide a better flame pattern for a particular installation. These changes are suggested when the flame pattern appears to be impinging on the side walls of a chamber.

(e) Solenoid type. Combination delayed-opening and instantaneous cut-off.

ELECTRICAL CHARACTERISTICS—115–120 volts, 60-cycle, 1-phase. 1725 RPM. For further information refer to page 107.

ALL MODELS EXCEPT 1200FR AVAILABLE FOR EITHER PEDESTAL OR FLANGE MOUNTING. MODEL 1200FR AVAILABLE FOR PEDESTAL MOUNTING ONLY. FOR INFORMATION ON FLANGES REFER TO PAGES 104–105.

*GPH ratings are based on sea level to 2,000 ft. elevation. For every 1,000 ft. rise over 2,000 ft., reduce the maximum GPH rating by 4 percent.

DIMENSIONS

NOTE: Dimensions given are for pedestal or flange mounted models except "Height" and "Floor to Nozzle" dimensions which apply only to pedestal mounted models. Note "Effective Air Tube Length" is shorter on flange-mounted models due to thickness of mounting flange and gasket.

MODEL NO.	LENGTH (over-all)	WIDTH (over-all)	HEIGHT (Min.)	HEIGHT (Max.)	AIR TUBE LENGTH (Nom.)	AIR TUBE (O.D.)	AIR TUBE (I.D.)	EFFECTIVE AIR TUBE LENGTH* (Max.) Pedestal Mounting	EFFECTIVE AIR TUBE LENGTH* (Max.) Flange Mounting	FLOOR TO NOZZLE(S) (Min.)	FLOOR TO NOZZLE(S) (Max.)	TOP OF BURNER TO C/L OF AIR TUBE	C/L OF AIR TUBE TO BOTTOM OF HOUSING	AIR CONE (O.D.)	AIR CONE (I.D.)
150N-2R, -3R	15⅝ 17⅝ 19⅝	15⅞	14	17	7, 9, 11	4⅛	4	6¾ 8¾ 10¾	5¼ 7¼ 9¼	8¼	11¼	5¾	7¾	4⅛	2⅝ (-2R) 2⅞ (-3R)
400N-2, -3	18¾ 20¾ 28¾	17⅛	18	21	8, 10, 18	4⅛	4	8¾ 10¾ 18¾	7¼ 9¼ 17¼	7	10	11	3 1/16	4⅛	2 1/16 (-2) 3⅛ (-3)
450FR-1, -2	19¾ 21¾	17½	15¾	19¾	8, 10	4⅛	4	8⅛ 10⅛	6⅝ 8⅝	9⅝	13	6½	9 5/16	4⅛	3⅛ (-1) 3⅝ (-2)
700FR	23¾ 28¾	19½	22¾	25¾	10, 15	4¾	4½	10⅜ 15⅜	8¼ 13¼	10¼	13¾	12½	4 15/16	4¾	3⅞
950FR-1, -2	21¼ 23¼ 28¼	21	18¼	21	8, 10, 15	5¼	5	8 10 15	5⅞ 7⅞ 12⅞	11⅛	13¾	7¼	11	5¼	4½ (-1) 4¾ (-2)
1200FR-1, -2	31	24	24	27	15	5¼	5	15	—	11½	14½	12½	4⅝	5¼	4½ (-1) 4¾ (-2)

All dimensions in inches. Dimensions are approximate.
*"Effective Air Tube Length" is length available for insertion in heating boiler or furnace and includes length of air cone as well as air tube proper.

INSTALLATION, ADJUSTMENT, AND OPERATING INSTRUCTIONS

Combustion Chambers

The combustion chamber dimensions (see opposite page) are offered as guides which are applicable in general to field installations. Designed boiler units with chambers not sized to the chart can often be fired with "Flame Retention Head" models at the firing rate specified by the manufacturer. A corbel across the chamber at the back wall (opposite the burner air tube) will usually benefit the process of combustion.

Although the general shape of the "FR Head" fire lends itself to rectangular or oval shaped chambers, this does not eliminate the use of round chambers. While round chambers are not shown in the chart, many installations where round chambers exist are being fired efficiently with "FR Head" models, especially in the lower ranges of 0.65 to 2.00 GPH.

Inspection shows that in many of these cases the ends of the flame appear to "mushroom" back into the main body of the fire with no evidence of dirt or smoke. Actually the condition to be avoided is the accumulation of carbon on any part of the chamber due to impingement of the flame.

In burner replacement work, it may be found that the existing chamber is in good condition but its dimensions are larger than shown on the chart for "FR Head" models (page 11). It is suggested that the burner be installed without making changes in the chamber until a combustion efficiency test has been made. It has been found that the efficiency test often shows it is not necessary to alter the chamber, thereby saving material and labor.

Combustion Chamber Material

The higher flame temperature developed by "FR Head" burners requires the use of a good refractory capable of withstanding heat as follows: 0.65 to 1.20 GPH, 2000°F (1100°C); 1.20 to 3.00 GPH, 2300°F (1260°C); 3.00 to 5.00 GPH, 2600°F (1425°C); 5.00 to 12.00 GPH, 3000°F (1650°C). Insulating refractory is recommended up to 5.00 GPH.

During the past few years, new combustion chamber materials have been introduced to the industry. The "blanket" styles such as Johns-Manville's "Cera Felt" and "Cera Form," Carborundum's "Fiberfrax" and more recently Babcock &

Wilcox's "Kaowool" have proved very satisfactory from a performance angle in domestic-size installations. The availability of these materials enables the industry to provide (1) linings for damaged chambers, (2) more actual combustion area within the same unit due to reduced wall thickness of the chamber, and (3) a replacement chamber that may be installed in units where it is a major service problem to replace a damaged chamber with a precast type as originally supplied.

COMBUSTION CHAMBER DIMENSIONS AND FIREBRICK REQUIREMENTS FOR "FR HEAD" BURNERS

GPH	COMBUSTION CHAMBER INSIDE DIMENSIONS				NUMBER FIREBRICK REQUIRED*		
	RECTANGULAR				WALLS		FLOOR
	W	L	H	C	Brick, Flat	Brick on Edge	Brick, Flat
0.65	8.5	9	12	5	28	16	14
0.75	9	10	12	5	30	17	16
0.85	9.5	11	13	5	35	20	17
1.00	9.5	12	13	5	36	20	18
1.25	10	13	14	5	40	23	19
1.35	10	14	14	5	42	24	20
1.50	10	15	14	5	43	24	21
1.65	10	16	15	5	47	27	22
2.00	11	18	16	5.5	55	31	24
2.50	12	18	17	6	60	34	26
3.00	14	19	18	7	68	39	29
4.00	15	20	18	8	71	40	31
5.00	16	21	18	8.5	74	42	34
6.00	17	23	18	9	79	45	37
7.00	18	25	18	9.5	84	47	41
8.00	19	28	18	9.5	90	51	45
9.00	19	31	18	9.5	95	54	50
10.00	20	34	20	10	112	63	56
11.00	22	37	20	11	121	68	64
12.00	24	40	20	12	130	73	72

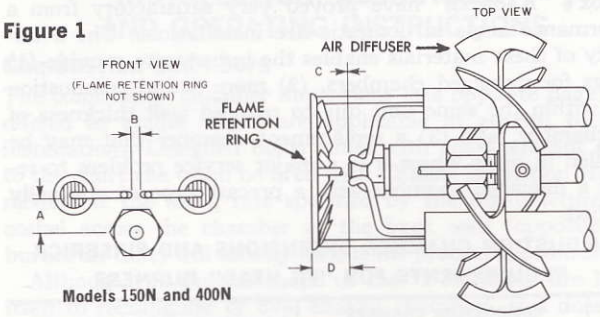
W = WIDTH L = LENGTH H = HEIGHT
C = DISTANCE FROM CHAMBER FLOOR TO CENTER OF NOZZLE

Brick requirements are based on 9-inch "straight" brick (9" x 4½" x 2½").

*To determine total firebrick requirements, add number for "WALLS" (either flat or on edge) and number for "FLOOR."

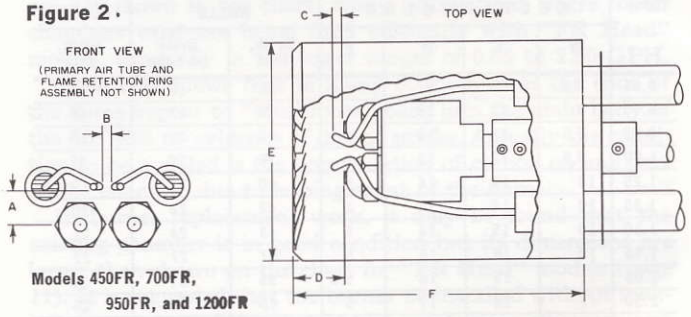
No extras are allowed for in the above quantities. A prominent manufacturer of firebrick states that usually 5–10% extras are added to take care of cutting and breakage.

Figure 1



Models 150N and 400N

Figure 2



Models 450FR, 700FR, 950FR, and 1200FR

BURNER POSITIONING AND INSTALLATION

Flange mounted models 150N, 400N, 450FR, 700FR, and 950FR.

1. Remove combustion head assembly to avoid damage.
2. Mount flange with gasket to boiler front. Be sure set screws are *at the top*.
3. Measure distance from inside front wall of combustion chamber to outer face of flange.
4. From end of air cone, mark the air tube at a point equal to measurement determined in step 3.
5. With set screws of flange collar loosened, position burner so that marking on tube aligns with outer face of flange.
6. Hold burner up as far as possible and firmly tighten two set screws in flange collar. This will insure a slight downward pitch of the air tube to the combustion chamber and prevent any after-drip of oil from the nozzle working back to the fan housing. (On Models 150N, 400N, and 450FR the set screws bring the pressure shoe into contact with the air tube; on Models 700FR and 950FR the set screws bear directly against the air tube.)
7. Inspect with flame mirror to make sure end of air cone is flush with inside surface of combustion chamber. UNDER NO CONDITION SHOULD THE AIR CONE EXTEND INTO THE COMBUSTION CHAMBER.
8. Install combustion head assembly using proper nozzle(s).
9. Complete oil piping and electrical connections.
10. Set air shutter and adjust combustion head assembly as per instructions following.

DIMENSIONS FOR COMBUSTION HEAD SETTINGS

(See drawing, opposite page)

MODEL NO.	A	B	C	D	PRIMARY AIR TUBE AND FLAME RETENTION RING ASSEMBLY	
					E	F
	Bottom of electrode wires to orifice of nozzle(s)	Spark gap at bends of electrode wires	Relation of electrode wire tips to face of nozzle(s)	Nozzle face to outside rim of flame retention ring	Outside Diameter	Overall Length
150N-2R	½	⅛	Flush	⅝	—	—
150N-3R	½	⅛	Flush	⅝	—	—
400N-2	½	⅛	Flush	⅝	—	—
400N-3	½	⅛	Flush	⅝	—	—
450FR-1	7/16	⅛	⅛ ahead	½	2¾	4
450FR-2	7/16	⅛	⅛ ahead	½	2¾	4
700FR	7/16	⅛	⅛ ahead	⅝	3⅛	4
950FR-1	7/16	⅛	⅛ ahead	¾	3½	4
950FR-2	7/16	⅛	⅛ ahead	¾	3½	4
1200FR-1	7/16	⅛	⅛ ahead	¾	3½	4
1200FR-2	7/16	⅛	⅛ ahead	¾	3½	4

NOTE: Models 150N and 400N have single nozzle. Models 450FR, 700FR, 950FR, and 1200FR have dual nozzles. All dimensions in inches.

Pedestal mounted models 150N, 400N, 450FR, 700FR, 950FR, and 1200FR.

1. Remove combustion head assembly to avoid damage.
2. Adjust pedestal height so that burner air tube fits into opening provided in combustion chamber wall.
3. Position burner so that face of air cone is flush with inner wall surface of combustion chamber. UNDER NO CONDITION SHOULD THE AIR CONE EXTEND INTO THE COMBUSTION CHAMBER. A slight downward pitch of the air tube to the combustion chamber will prevent any after-drip of oil from the nozzle running back to the fan housing.
4. Seal around the air tube with insulating material. Make certain no particles of cement become lodged on the inner surfaces of the air cone as such particles will distort the flame.
5. Replace combustion head assembly using proper nozzle(s). Distance from combustion chamber floor to center of nozzle should correspond with dimension "C" in table on page 11.
6. Complete oil piping and electrical connections.
7. Set air shutter and adjust combustion head assembly as per instructions following.

IGNITION: Intermittent (UL interrupted) ignition or constant (UL intermittent) ignition is applicable to all "FR Head" models.

AIR SHUTTER ADJUSTMENT

All models have an air shutter to admit and control the volume of air required to support combustion. On models except 450FR and 950FR, the shutter is adjusted by loosening the air shutter retention screw and rotating the shutter forward or backward to regulate the air supply. On Models 450FR and 950FR, the air shutter is adjusted by loosening the locknut at lower left corner of housing and turning adjusting screw (or lever-indicator used on earlier models) to open or close air shutter.

Model 150N requires an air shutter adjustment *only*. The shutter should be set to provide the minimum amount of air required to produce a smoke reading of zero to a trace on the Bacharach or similar smoke scale.

COMBUSTION HEAD ADJUSTMENT

The adjustment of the combustion head assembly serves two purposes:

1. It provides a means of setting the flame retention ring more than the normal distance ahead of the air cone as may be required should abnormal conditions be encountered on a particular installation.
2. It offers a simple means of drawing the combustion head assembly back into the air tube for protection against possible damage in transit or handling.

CAUTION: THE FLAME RETENTION RING MUST NOT BE DRAWN BACK INTO THE AIR TUBE WHEN FIRING. WHEN SHIPPED FROM THE FACTORY, THE COMBUSTION HEAD IS PURPOSELY DRAWN BACK INTO THE AIR TUBE TO PROTECT AGAINST DAMAGE IN TRANSIT.

Model 150N requires no adjustment of the flame retention ring-air diffuser assembly which has been properly set at the

FLAME RETENTION RING ADJUSTMENT

MODEL NO.	FIRING RANGE (GPH)	APPROXIMATE DISTANCE OF FLAME RETENTION RING AHEAD OF FACE OF AIR CONE
400N-2	0.65–1.00	FLUSH
400N-2	1.10–1.50	1/8"
400N-2	1.65–2.00	3/16"
400N-3	1.50–1.75	3/16"
400N-3	2.00–2.25	1/4"
400N-3	2.50–3.00	3/8"
450FR-1	2.00–3.00	1/4"
450FR-2	3.00–4.50	1/4"
700FR	3.50–6.50	1/4"
950FR-1	3.50–7.00	1/4"
950FR-2	6.00–9.30	1/4"
1200FR-1	6.00–9.50	1/4"
1200FR-2	9.00–12.00	1/4"

factory. Do not change the angle of the blades of the air diffuser. Should the set screw holding the air diffuser-flame retention ring assembly require tightening, make certain that no part of the assembly touches the electrode porcelains and that the distance from nozzle face to outside rim of flame retention ring is in accordance with dimension "D" given in table on page 13.

On all other models an adjustment can be made in accordance with the procedures as described in the following pages.

The actual distance that the flame retention ring extends beyond the face of the air cone will vary with the installation. Draft, flue travel through the unit, and air supply in the vicinity of the burner are conditions which affect the settings. Note also that the settings for Model 400N vary with the firing rate. Refer to table on page 15.

FIRING THE BURNER

Models 400N, 700FR, and 1200FR

With the proper nozzle(s) installed, the combustion head assembly in place, and the back plate assembled, the following steps should be taken to fire the burner:

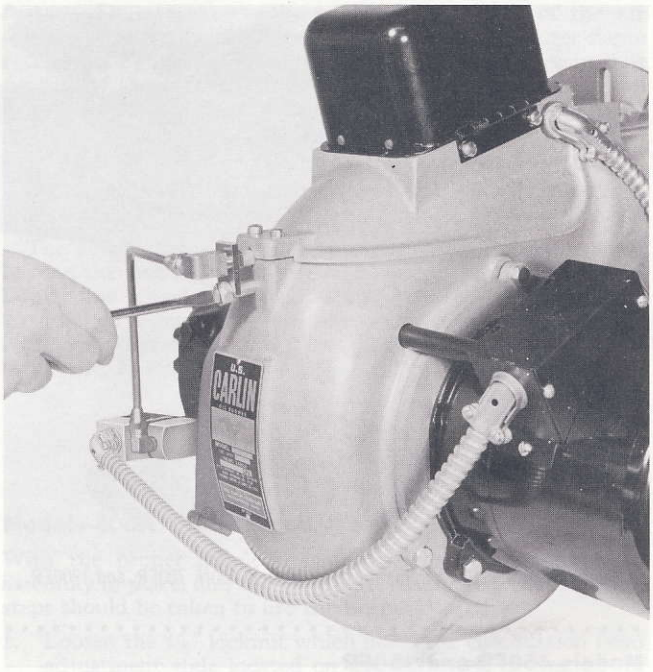
1. Loosen the 9/16" locknut which holds the combustion head adjustment slide located on the right side of the burner housing at the rear.
2. Turn 9/16" adjusting bolt (which passes through back plate and engages with slide) clockwise until flame retention ring is flush with or extends beyond the face of the air cone. Follow the settings given in table on page 15.
3. Open air shutter in accordance with size of nozzle(s).
4. Be sure all oil lines are connected and tightened.
5. Start the burner.
6. Adjust air shutter for smoke-free fire. Avoid sharpness or "sparks" escaping through main body of flame, an indication of excessive air.
7. After final adjustments have been made, lock the combustion head assembly in place by tightening the 9/16" adjustment slide locknut. Also secure the air shutter.

Flame Retention Head adjustment for Models 400N, 700FR, and 1200FR.

Models 450FR and 950FR

The combustion head adjustment mechanism on Models 450FR and 950FR differs slightly from other "FR Head" models. Instead of steps 1 and 2 above, proceed as follows: Loosen the two screws which hold the burner housing cover. Using a screwdriver, turn the cap screw (located directly under the nozzle line) clockwise to move the combustion head forward, counterclockwise to retract it. Tighten all screws after proper adjustments have been made. Steps 3 through 6 above apply to Models 450FR and 950FR as well as to Models 400N, 700FR, and 1200FR.

The flame, when adjusted for maximum efficiency, will burn in a complete and even circle of fire approximately 1/8" ahead of the flame retention ring on Models 150N and 400N, and approximately 3/16" ahead on Models 450FR, 700FR, 950FR, and 1200FR.



Flame Retention Head adjustment for Models 450FR and 950FR.

It should be emphasized that these measurements are not exact. It may appear at first glance that the fire is actually burning against the flame retention ring. Close inspection will show, however, that there is an air wall between the ring and flame. The air wall is created by the high velocity air directed through the vanes of the flame retention ring.

If the combustion head assembly is drawn back into the air tube, the flame will leave the ring and control of the fire will be lost.

A final test of the fire for cleanliness should be made by taking a smoke reading with doors and observation ports closed. If excess smoke is noted, a further adjustment of the air shutter may be necessary.

General Information and Check List:

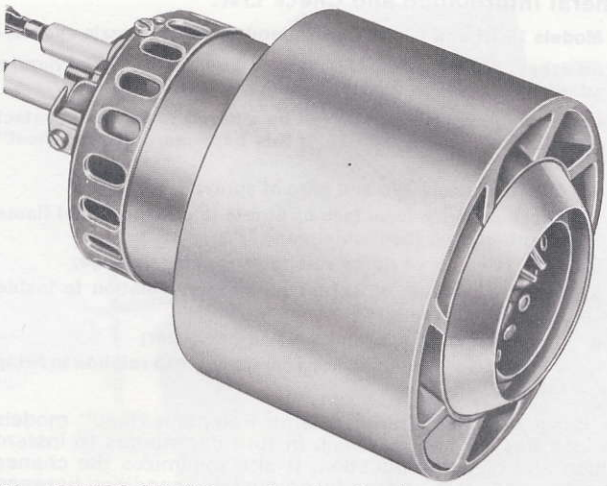
1. **Models 150N and 400N have a standard single nozzle adapter.**
2. **All other "FR Head" models have a nonstandard dual nozzle adapter (#822) with nozzle tappings ¾" center to center.**
3. **Under no conditions should oil be allowed to come in contact with the flame retention ring. If this happens, "trouble shoot" as follows:**
   a. **Check nozzle angle and type of spray;**
   b. **Check distance from face of nozzle to outside rim of flame retention ring. (See table, page 13);**
   c. **Inspect vanes of flame retention ring for damage;**
   d. **Observe position of burner air cone in relation to inside front wall of combustion chamber;**
   e. **Check for excessive back pressure in boiler;**
   f. **Recalculate combustion chamber size with relation to firing rate.**

The basic design of Carlin "Flame Retention Head" models provides fine air control which in turn contributes to instant ignition and clean combustion. It also minimizes the chance of "pulsation" often caused by an unstable condition between the flame front and the burner air cone.

FAN DIMENSIONS AND SETTINGS

MODEL NO.	FAN				
	DIAM.	WIDTH	LENGTH OF HUB	BORE	BACK OF FAN TO FACE OF MOTOR
150N-2R	5¾	4	⅝	½	7/16
150N-3R	5¾	4	⅝	½	7/16
400N-2	5¾	4	⅝	½	½
400N-3	6 5/16	4	⅝	½	7/16
450FR-1	6 5/16	4	⅝	½	5/16
450FR-2	6 5/16	4	⅝	½	5/16
700FR	7⅜	4⅛	1¾	½	¼
950FR-1	7⅜	5	1¾	½	3/16
950FR-2	7⅜	5	1¾	½	3/16
1200FR-1	8¼	5 11/16	3¾*	⅝	7/16
1200FR-2	8¼	5 11/16	3¾*	⅝	7/16

*With keyway to accommodate capacitor start motor. All dimensions in inches.



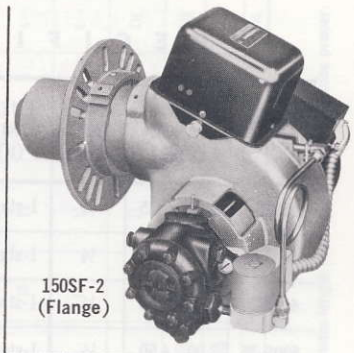
The SHELL HEAD combustion head operates on a unique "dual-action" principle which assures top performance in combustion areas where there is sufficient height and width to accommodate the relatively wide fire.

First, SHELL HEAD mixes oil and air in exactly the right proportions *within the combustion head.* Second, this mixture is distributed *outside the combustion head* immediately in front of the burner . . . SHELL HEAD extracts maximum heat from every drop of fuel, generates flame temperatures 400°–600° higher than conventional burners, cuts fuel consumption as much as 36%, and keeps the heating plant clean longer.

Tried and proven in thousands of installations over a 16-year period of Carlin manufacture, SHELL HEAD is foolproof in design, has no complicated parts to get out of order and is easily adjusted to develop the proper flame pattern.

All models except 2000-5 available for either pedestal or flange mounting. Model 2000S-5 available for pedestal mounting only. For information on flanges, refer to pages 104–105.

400S
(Pedestal)

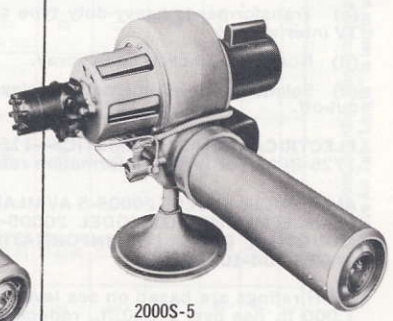


150SF-2
(Flange)

500S-35
(Pedestal)

700S-35
(Pedestal)

800S-4
(Pedestal)



2000S-5
(Pedestal)

CARLIN *"Shell-Head"* BURNERS

S P E C I F I C A T I O N S

MODEL NO.	FIRING RANGE* (GPH)	MOTOR (HP) (a)	FUEL UNIT (b)	TRANS-FORMER (volts) (c)	NOZZLE(S) (d)	DELAYED OIL VALVE (e)
150SF-2	0.65– 1.35	⅛	1-stage	10,000	80° Single	Standard
400S-2	0.75– 1.75	⅛	1-stage	10,000	80° Single	Standard
400S-3	1.75– 3.00	⅛	1-stage	10,000	60° Single	Standard
500S-35	3.00– 4.50	⅛	1-stage	10,000	60° Dual	Standard
700S-35	3.50– 7.00	⅙	2-stage	10,000	60° Dual	Standard
800S-4	4.00– 8.00	⅙	2-stage	10,000	60° Dual	Standard
2000S-5	7.00–12.00	⅓	2-stage	12,000	60° Dual	Standard

N O T E S

(a) Motor is long-hour duty type (capacitor start induction run on Model 2000S-5) with safety overload control. Complies with NEMA specifications.

(b) Fuel unit has built-in strainer and pressure regulating valve. Capacity of strainer equals or exceeds maximum firing rate of burner. Equipped with easy-flow bleed valve.

(c) Transformer is heavy-duty type shielded to eliminate radio and TV interference.

(d) Nozzles are hollow cone spray.

(e) Solenoid type. Combination delayed-opening and instantaneous cut-off.

ELECTRICAL CHARACTERISTICS—115-120 volts, 60-cycle, 1-phase. 1725 RPM. For further information refer to page 107.

ALL MODELS EXCEPT 2000S-5 AVAILABLE FOR EITHER PEDESTAL OR FLANGE MOUNTING. MODEL 2000S-5 AVAILABLE FOR PEDESTAL MOUNTING ONLY. FOR INFORMATION ON FLANGES REFER TO PAGES 104–105.

*GPH ratings are based on sea level to 2,000 ft. elevation. For every 1,000 ft. rise over 2,000 ft., reduce the maximum GPH rating by 4 percent.

D I M E N S I O N S

NOTE: Dimensions given are for pedestal or flange mounted models except "Height" and "Floor to Nozzle" dimensions which apply only to pedestal mounted models. Note "Effective Air Tube Length" is shorter on flange-mounted models due to thickness of mounting flange and gasket.

MODEL NO.	LENGTH (over-all)	WIDTH (over-all)	HEIGHT (Min.)	HEIGHT (Max.)	AIR TUBE LENGTH (Nom.)	AIR TUBE (O.D.)	AIR TUBE (I.D.)	EFFECTIVE AIR TUBE LENGTH* (Max.) Pedestal Mounting	EFFECTIVE AIR TUBE LENGTH* (Max.) Flange Mounting	FLOOR TO NOZZLE(S) (Min.)	FLOOR TO NOZZLE(S) (Max.)	TOP OF BURNER TO C/L OF AIR TUBE	C/L OF AIR TUBE TO BOTTOM OF HOUSING	AIR CONE (O.D.)	AIR CONE (I.D.)
150SF-2	16½ 18½ 20½	15⅜	14	17	7 9 11	4⅛	4	7 9 11	5½ 7½ 9½	8¼	11¼	5¾	7¾	4	2⅜
400S-2	18¾ 20¾ 28¾	17⅞	18	21	8 10 18	4⅛	4	8¾ 10¾ 18¾	7¼ 9¼ 17¼	7	10	11	3 11/16	4	2⅜
400S-3	18¼ 20¼ 28¼	17⅞	18	21	8 10 18	4⅛	4	8¼ 10¼ 18¼	6¾ 8¾ 16¾	7	10	11	3 11/16	4	3¼
500S-35	20⅞ 22⅞ 28⅜	18¾	18	21	10 12 18	4¾	4½	10¼ 12¼ 18¼	8⅛ 10⅛ 16⅛	7	10	11	3 11/16	4¾	3⅜
700S-35	23¾ 28¾	19½	22¼	25¾	10 15	4¾	4½	10⅜ 15⅜	8¼ 13¼	10¼	13¼	12½	4 15/16	4¾	3⅝
800S-4	23¾ 28¾	19½	22¾	25¾	10 15	5¼	5	11 16	8⅞ 13⅞	10¼	13¼	12½	4 15/16	5¼	4
2000S-5	34½	25½	24	27	18	6¼	6	18½	—	11½	14½	12½	4⅝	6¼	5

All dimensions in inches. Dimensions are approximate.
*"Effective Air Tube Length" is length available for insertion in heating boiler or furnace and includes length of air cone as well as air tube proper.

INSTALLATION, ADJUSTMENT, AND OPERATING INSTRUCTIONS

Combustion Chambers

"Shell Head" combustion chambers must be of rectangular or round shape and should conform to the dimensions given on the opposite page. Chambers of unconventional design, such as pear-shaped, are entirely unsatisfactory as the fire will impinge on the angled walls. Round chambers are preferable for firing rates up to 3.00 GPH. When rectangular chambers are used, it is advisable to round the inside corners, particularly the corners nearest the burner, to avoid eddies and currents which may be present.

Stainless Steel Combustion Chambers

Several manufacturers of oil-fired furnaces and boilers equip their units with stainless steel combustion chambers. Care should be taken to avoid any impingement of oil on the chamber walls; also the size of nozzle should be determined in accordance with the area within the chamber.

Combustion Chamber Material

The higher flame temperature developed by "Shell Head" burners requires the use of a good refractory capable of withstanding heat as follows:

0.65 to 1.20 GPH	2000°F (1100°C)
1.20 to 3.00 GPH	2300°F (1260°C)
3.00 to 5.00 GPH	2600°F (1425°C)
5.00 to 12.00 GPH	3000°F (1650°C)

Insulating refractory is recommended up to 5.00 GPH.

During the past few years, new combustion chamber materials have been introduced to the industry. The "blanket" styles such as Johns-Manville "Cera Felt" and "Cera Form," Carborundum's "Fiberfrax" and more recently Babcock & Wilcox's "Kaowool" have proved very satisfactory from a performance angle in domestic-size installations. The availability of these materials enables the industry to provide (1) linings for damaged chambers, (2) more actual combustion area within the same unit due to reduced wall thickness of the chamber, and (3) a replacement chamber that may be installed in units where it is a major service problem to replace a damaged chamber with a precast type as originally supplied.

COMBUSTION CHAMBER DIMENSIONS AND FIREBRICK REQUIREMENTS FOR "SHELL HEAD" BURNERS

GPH	COMBUSTION CHAMBER INSIDE DIMENSIONS					NUMBER FIREBRICK REQUIRED*		
	RECTANGULAR				Round Diam.	WALLS		FLOOR
	W	L	H	C		Brick, Flat	Brick on Edge	Brick, Flat
0.65	9	9	15	5	9	37	21	15
0.75–0.85	11	11	15	5.5	11.5	42	24	18
1.00–1.20	12	12	15	6	13	44	25	20
1.35–1.50	13	13	16	6.5	14	50	28	22
1.65–1.75	14	14	17	7	15	56	32	24
2.00	16	16	20	8	17	73	41	28
2.25	16	18	21	8	17	81	46	30
2.50	17	19	22	8.5	18	88	50	33
3.00	18	20	23	9	19	96	55	35
3.50–4.00	19	21	24	9.5		105	59	38
4.50–5.00	20	22	25	10		114	64	40
5.50–6.00	21	23	26	10.5		123	69	43
6.50–7.00	22	24	27	11		132	75	46
7.50–8.00	23	25	28	11.5		142	80	49
8.50–9.00	24	26	29	12		152	86	52
9.50–10.00	25	27	30	12.5		163	92	55
10.50–11.00	26	28	31	13		174	98	58
11.50–12.00	27	29	32	13.5		185	104	61

W = WIDTH L = LENGTH H = HEIGHT
C = DISTANCE FROM CHAMBER FLOOR TO CENTER OF NOZZLE

A reduction of 10% from any of the measurements (except "C") given in this table is permissible when the space within the combustion area of the boiler or furnace is limited. Reduce only the dimension required, allowing the other dimensions to remain at full size.

Brick requirements are based on 9-inch "straight" brick (9" x 4½" x 2½").

*To determine total firebrick requirements, add number for "WALLS" (either flat or on edge) and number for "FLOOR."

No extras are allowed for in the above quantities. A prominent manufacturer of firebrick states that usually 5–10% extras are added to take care of cutting and breakage.

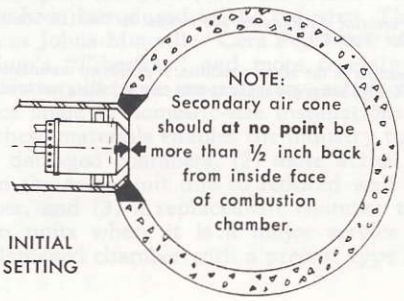
Positioning of Air Cone

Allow a clearance of ½" to ¾" between the burner air tube and the combustion chamber burner tube opening. Set burner so that the secondary air cone at no point is more than ½" back from the inside face of the combustion chamber. However, under no conditions should the secondary air cone extend into the combustion chamber. Fill in the space around the air tube and air cone with refractory cement. An excellent mixture for this purpose is dry asbestos with about 20% Portland cement plus enough water to make the mixture workable. See Figure 3 below.

It is absolutely essential that no particles of cement become lodged on the inner surfaces of the air cone or finned collar as such particles will distort the air pattern which in turn will distort the flame and result in lower efficiency. Before applying the insulating material at this point, remove the electrode and combustion assembly and block up the inside of the end of the air tube and air cone with a rag, pulling it out into the chamber after the insulating material has set up.

Until recently, it has been our recommendation that the air cone also be protected with insulation. With the development of high-temperature resistant alloys which are now being used in Carlin air cones, this procedure is no longer essential. However, an application of insulating material will offer additional protection against the high temperatures generated by "S" series burners. If used, be sure that no particles of the insulation obstruct the air cone opening. Apply so that, when viewing the inside of the front wall of the combustion chamber with a flame mirror, no part of the air tube or air cone is visible. One should see only the air cone opening with nozzle and electrode wires inside.

Figure 3



Preliminary Adjustment of Primary Air Supply

(See Figures 4 and 5, page 28.)

Air is supplied to the Primary Air Tube (5) through holes in the Primary Air Tube Holder (6) and the Primary Air Control Ring (7). The air supply can be varied over a considerable range by varying the degree of register of the holes in the Primary Air Tube Holder and the Primary Air Control Ring by rotation of the latter. The amount of primary air required will vary with the size of the fuel oil nozzle. Excessive primary air will result in the flame burning too far from the secondary air cone and will tend to produce a noisy fire, whereas a deficiency in the supply of primary air will result in the flame "striking back" and burning in a bright ring just in front of the Outer Primary Air Cone (3) which may eventually cause carbonization of the oil nozzle.

The following table will serve as a guide for adjusting the primary air hole openings before firing the burner.

Model	Firing Range	Approximate Opening
150SF-2	0.65 to 0.85	half open
	1.00 to 1.35	fully open
400S-2	0.75 to 1.20	half open
	1.25 to 1.75	fully open
400S-3	1.75 to 3.00	fully open
500S-35	3.00 to 3.50	half open
	4.00 to 4.50	fully open
700S-35	3.50 to 4.50	one-third open
	5.00 to 5.50	half open
	6.00 to 7.00	fully open
800S-4	4.00 to 4.50	one-third open
	5.00 to 5.50	half open
	6.00 to 8.00	fully open
2000S-5	7.00 to 8.00	one-third open
	8.50 to 9.00	half open
	10.00 to 12.00	fully open

The purpose of the primary air holes is to position the fire from the end of the air cone. It does not shape the fire. The shaping of the fire is controlled by the position of the primary air tube (Part No. 5—see Figs. 4 and 5, page 28) in relationship to the secondary air cone.

"SHELL HEAD"

MODELS 150SF-2, 400S-2, 400S-3

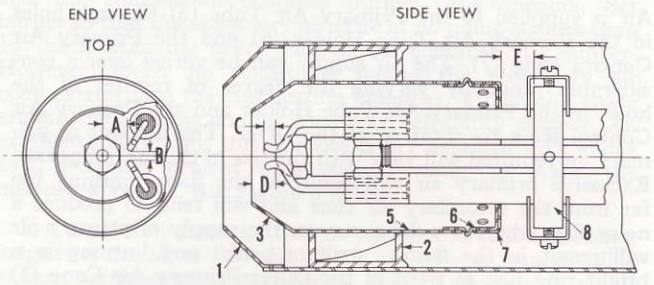


Figure 4

"SHELL HEAD"

MODELS 500S-35, 700S-35, 800S-4, 2000S-5

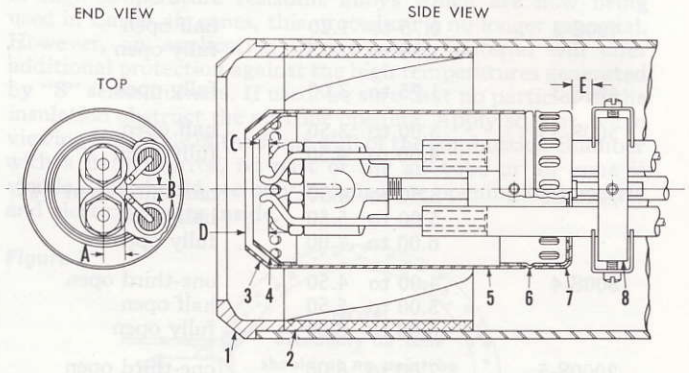


Figure 5

PART NUMBERS

1. Secondary Air Cone
2. Finned Collar
3. Outer Primary Air Cone
4. Inner Primary Air Cone
5. Primary Air Tube
6. Primary Air Tube Holder
7. Primary Air Control Ring
8. Electrode Bracket

DIMENSIONS FOR COMBUSTION HEAD SETTINGS

(See drawings, opposite page)

MODEL NUMBER	A Electrode wires from point nearest nozzle(s) to orifice of nozzle(s)	B Spark gap at bends of electrode wires	C Face of nozzle(s) to tips of electrode wires	D Face of nozzle(s) to front edge of primary air tube	E Back of primary air control ring to electrode bracket
150SF-2	7/16	1/8	3/16	3/8	1/4
400S	7/16	1/8	3/16	3/8	3/8
500S-35	3/8	1/8	3/16	3/8	3/8
700S-35	3/8	1/8	3/16	3/8	3/8
800S-4	3/8	1/8	3/16	3/8	3/8
2000S-5	3/8	1/8	3/16	3/8	3/8

NOTE: Models 150SF-2 and 400S have single nozzle. Models 500S-35, 700S-35, 800S-4, and 2000S-5 have dual nozzles.

All dimensions in inches.

Flame Adjustment

Set fan air shutter tentatively 1/4 to 3/4 open, depending upon nozzle size. Fire burner. After ignition has gone off, loosen combustion head and nozzle line locknut and turn adjusting screw (usually clockwise) until flame becomes blow torch in shape as in Fig. 6, page 31. (Control of flame has been lost at this point and adjustment to this condition is utilized only for a reference point from which to adjust to the proper operating condition.) Using a flame mirror to observe distance of fire from the secondary air cone and also its shape, turn adjusting screw counterclockwise until flame assumes hollow cone form. Directly before the most efficient cone-shaped fire is obtained a slight amount of feathering will occur as in Fig. 7, page 31. From this point the adjusting screw should be turned counterclockwise very slowly until the feathering disappears as in Fig. 8, page 31.

With ignition off, the distance of the flame from the secondary air cone as illustrated in Fig. 8, according to model of burner, should be as follows:

Model Number	Approximate Distance from Secondary Air Cone
150SF-2	1″ to 1.5″
400S-2 and 400S-3	1.5″ to 2″
500S-35	2″ to 2.5″
700S-35	2″ to 3″
800S-4	2″ to 3″
2000S-5	3″ to 4″

If flame burns closer than dimensions given above, open primary air holes slightly. If flame burns further away, close holes slightly. The exact adjustment of the primary air holes may vary from one installation to another (even though the same firing rate is used) due to difference in velocity and volume of draft.

Tighten combustion head and nozzle line locknut after flame has been properly shaped and positioned.

After the burner has been running for a sufficient time to reach normal operating combustion chamber temperatures, the draft reading over the fire should be set at the minimum requirement to provide clean combustion.

The "S" series burners operate on a low draft reading due to the static pressure constantly maintained at the burner head. The static pressure further provides a "push" which assists the normal "pull" created by the draft in moving the gases through the flue passes of the heating unit.

Under normal conditions draft readings should range from .01″ w.g. over fire for the small firing rates on the 150SF-2 burner to .08″ w.g. for the largest firing rates on the 2000S-5. Draft readings indicate velocity only. Where restrictions do not permit the movement of a sufficient volume of gases, the draft readings must be increased.

Close fan air shutter until slight smoke appears and then open slowly just enough to clean fire. Conduct test with smoke testing equipment to insure operation with minimum smoke.

Figure 6

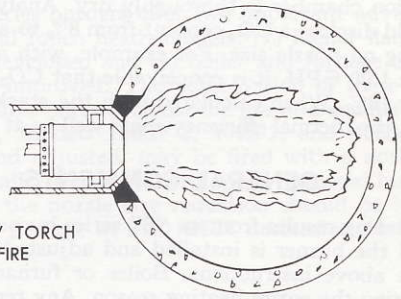
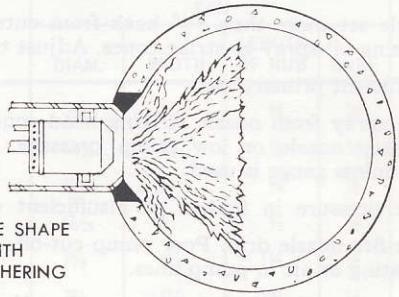
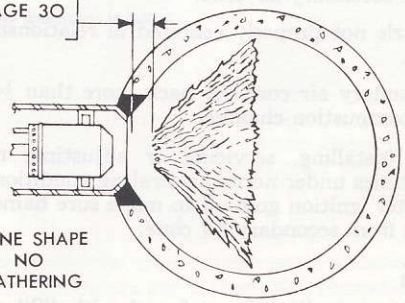


Figure 7



REFER TO PAGE 30

Figure 8



Final readings and adjustments should be made after the combustion chamber is thoroughly dry. Analysis of the flue gas should disclose a CO_2 content from 8% to as high as 12% depending on nozzle size. For example, with a firing rate of less than 1.00 GPH, it is conceivable that CO_2 reading could be under 10%. When calculated with the stack temperature, however, the thermal efficiency could well be at 80% or above.

GENERAL COMMENTS

The operating results from an "S" series burner are excellent provided the burner is installed and adjusted in accordance with the above instructions. Boiler or furnace will remain clean during the entire heating season. Any tendency toward carbon formation on the combustion head is due to one or more of the following causes:

1. Nozzle set more than $\frac{3}{8}$" back from outer primary air cone causing oil spray to strike cones. Adjust to $\frac{3}{8}$".
2. Insufficient primary air.
3. Wild spray from nozzle striking head cones, poor spray shape, dirty nozzle or low pump pressure. Do not alter pressure unless gauge is used.
4. Back pressure in firebox or insufficient overfire draft.
5. After-fire nozzle drip. Poor pump cut-off, solenoid valve not operating or air in pump lines.
6. Delayed ignition. Points not properly adjusted.
7. Primary air tube adjusted back too far causing oil spray to strike secondary air cone.
8. Nozzle not properly centered in relationship to primary air tube.
9. Secondary air cone set back more than $\frac{1}{2}$" from inside face of combustion chamber.

After installing, servicing or adjusting, recycle burner several times under normal operating conditions and observe flame after ignition goes off to make sure flame burns proper distance from secondary air cone.

Ignition

Intermittent ignition is preferred with "S" series burners.

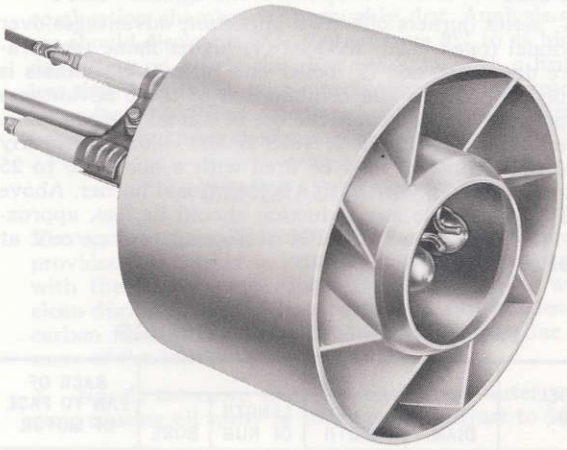
Nozzle Size

The "S" series burners offer two important advantages over conventional (open head) models: (1) higher flame temperatures are developed and (2) boiler and furnace cleanliness is noticeably improved. The combination of these advantages makes possible and advisable the use of a smaller size nozzle. In general, Models 150SF-2, 400S-2, and 400S-3, properly installed and adjusted, may be fired with a nozzle 20 to 25 percent smaller than used with a conventional burner. Above 3.00 GPH the nozzle size reduction should be less, approximately 15 percent at 3.50 GPH decreasing to 5 percent at 12.00 GPH.

FAN DIMENSIONS and SETTINGS

MODEL NO.	FAN				BACK OF FAN TO FACE OF MOTOR
	DIAM.	WIDTH	LENGTH OF HUB	BORE	
150SF-2	5¾	4	⅝	½	⅜
400S-2	6 5/16	4	⅝	½	7/16
400S-3	6 5/16	4	⅝	½	⅜
500S-35	6 5/16	4	⅝	½	⅜
700S-35	7⅝	4⅛	1¾	½	¼
800S-4	7⅝	4⅛	1¾	½	¼
2000S-5	8¼	5 11/16	3¾*	⅝	7/16

*With keyway. All dimensions in inches.

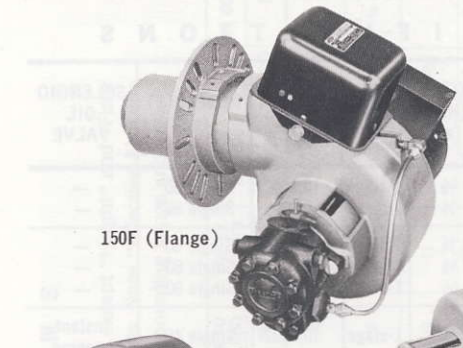


Carlin's line of "Standard" burners currently consists of Models 400 and 2000. Model 400 (available in two capacities) and its larger version, Model 400-4, are basically for conversion work and are designed for efficient air handling and quiet operation. Model 2000, highest capacity burner in the line (10.00–20.00 GPH), features the "High-temperature Combustion Head" which produces a clean fire of extremely high temperature.

Due to the popularity of the "FR Head" models, several models in the "Standard" category have been discontinued—Model 1200N as of June 1963 and Models 400 (in the 0.65 to 1.00 GPH range only), 150F, 650, and 1200 as of November 1965. Replacement parts are and will continue to be available.

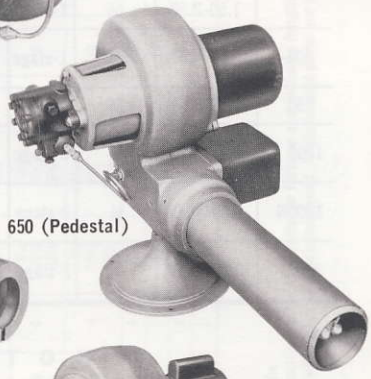
Because of the large numbers of these burners in use, they have been included in this "Handbook" for the convenience of the service man. It should also be mentioned that all of the discontinued models may be readily converted to "FR Head." Consult Carlin for full details.

Models 150F, 400 (0.65–1.00 GPH), 650, 1200, and 1200N have been discontinued. Dimensional data and other information on these burners are included for the assistance of the service man who frequently encounters these models in the field.



150F (Flange)

400 (Pedestal)



650 (Pedestal)

2000 (Pedestal)

1200 (Pedestal)

Model 400 available for either pedestal or flange mounting. Model 2000 is available for pedestal mounting only. For information on flanges, refer to pages 104–105.

SPECIFICATIONS

MODEL NO.	FIRING RANGE* (GPH)	MOTOR (HP) (a)	FUEL UNIT (b)	TRANS-FORMER (volts) (c)	NOZZLE(S) (d)	SOLENOID OIL VALVE
150F	0.65–1.35 1.35–2.00	⅛ ⅛	1-stage 1-stage	10,000 10,000	Single 80° Single 60°	— —
400	0.65–1.00 1.00–1.65 1.50–2.50	⅛ ⅛ ⅛	1-stage 1-stage 1-stage	10,000 10,000 10,000	Single 60° Single 60° Single 60°	— — —
400-4	2.50–4.00	⅛	1-stage	10,000	Single 45°	Instant opening
650	3.50–6.50	⅙	1-stage	10,000	Dual 60°	—
1200	6.00–12.00	¼	2-stage	12,000	Dual 45°	Delayed opening
1200N	6.00–10.00	¼	2-stage	12,000	Dual 45°	Delayed opening
2000	10.00–20.00	⅓	2-stage	12,000	Dual 45°	Delayed opening

NOTES

(a) Motor is long-hour duty type (capacitor start induction run on Models 1200, 1200N and 2000) with safety overload control. Complies with NEMA specifications.

(b) Fuel unit has built-in strainer and pressure regulating valve. Capacity of strainer equals or exceeds maximum firing rate of burner. Equipped with easy-flow bleed valve.

(c) Transformer is heavy-duty type shielded to eliminate radio and TV interference.

(d) Nozzles are hollow cone spray.

ELECTRICAL CHARACTERISTICS—115–120 volts, 60-cycle, 1-phase. 1725 RPM. For further information refer to page 107.

Model 400 is available for either pedestal or flange mounting. Model 2000 available for pedestal mounting only. For information on flanges, refer to pages 104–105.

Models 150F, 400 (0.65–1.00 PGH), 650, 1200, and 1200N have been discontinued. Replacement parts are available.

*GPH ratings are based on sea level to 2,000 ft. elevation. For every 1,000 ft. rise over 2,000 ft., reduce the maximum GPH rating by 4 percent.

DIMENSIONS

NOTE: Dimensions given are for pedestal or flange mounted models except "Height" and "Floor to Nozzle" dimensions which apply only to pedestal mounted models. Note "Effective Air Tube Length" is shorter on flange-mounted models due to thickness of mounting flange and gasket.

MODEL NO.	LENGTH (over-all)	WIDTH (over-all)	HEIGHT (Min.)	HEIGHT (Max.)	AIR TUBE LENGTH (Nom.)	AIR TUBE (O.D.)	AIR TUBE (I.D.)	EFFECTIVE AIR TUBE LENGTH* (Max.) Pedestal Mounting	EFFECTIVE AIR TUBE LENGTH* (Max.) Flange Mounting	FLOOR TO NOZZLE(S) (Min.)	FLOOR TO NOZZLE(S) (Max.)	TOP OF BURNER TO C/L OF AIR TUBE	C/L OF AIR TUBE TO BOTTOM OF HOUSING	AIR CONE (O.D.)	AIR CONE (I.D.)
150F	15⅞ 17⅞ 19⅞	15⅞	14	17	7 9 11	4⅛	4	7 9 11	5½ 7½ 9½	8¼	11¼	5¾	7¾	4	2⅜ (0.65–1.35) 2⅝ (1.35–2.00)
400	18⅛ 20⅛ 28⅛	17⅛	18	21	8 10 18	4⅛	4	8⅛ 10⅛ 18⅛	6⅝ 8⅝ 16⅝	7	10	11	3 1⁵⁄₁₆	4⅛	2⅜ (0.65–1.00) 2 1⁄₁₆ (1.00–1.65) 3 (1.50–2.50)
400-4	18⅛ 20⅛ 28⅛	17⅛	18	21	8 10 18	4⅛	4	8⅛ 10⅛ 18⅛	6⅝ 8⅝ 16⅝	7	10	11	3 1⁵⁄₁₆	4⅛	3¼
650	28	19½	22¾	25¾	13	4⅛	4	13⅛	11⅞	10¼	13¼	12½	4 1⁵⁄₁₆	4	3½
1200	31⅛	24⅜	24	27	15	5¼	5	15⅛	—	11½	14½	12½	4⅝	5¼	4⅜
1200N	31⅛	25⅞	24	27	15	5¼	5	15⅛	—	11½	14½	12½	4⅝	5¼	4⁵⁄₁₆
2000	34½	26½	24	27	18	6¼	6	18½	—	11½	14½	12½	4⅝	6¼	5¼

All dimensions in inches. Dimensions are approximate.
*"Effective Air Tube Length" is length available for insertion in heating boiler or furnace and includes length of air cone as well as air tube proper.
Models 150F, 400 (0.65—1.00 GPH), 650, 1200, and 1200N have been discontinued. Replacement parts are available.

INSTALLATION, ADJUSTMENT, AND OPERATING INSTRUCTIONS

Combustion Chambers

For Models 150F, 400, and 650, round or rectangular chambers are satisfactory provided the dimensions given in the table on the opposite page are followed. When rectangular chambers are used it is advisable to round the inside corners, particularly the corners nearest the burner, to avoid eddies and currents which may be present. Pear-shaped chambers should not be used as the fire will impinge on the angled walls. See note, page 24, regarding stainless steel combustion chambers.

When Models 1200 and 2000 were introduced, it was recommended that rectangular combustion chambers be designed with "wing walls" to aid the process of combustion. At that time, most installations of these models were in the older commercial-sized boilers which offered considerable combustion area with relatively few restrictions. In recent years, with the trend toward more compact units and more restrictions, it has been determinded that the performance of the burner is often improved by omitting the wing walls. There is no objection, however, to slightly rounding the inside corners of the combustion chamber to provide a smooth flow of air.

If conditions require the use of wing walls the dimensions are determined as follows:

Working on the end of the chamber at which the burner air tube is located, measure in from each side ¼ of the total width of the combustion chamber. Next, measure along each side from the front of the chamber to a point equal to ½ the width of the chamber. This will then define two triangular areas that are to be filled in with fire brick to form the "wing walls".

Example: For 14.00 gal. chamber with width of 28″:

1. Measure in from each side 7″;
2. Measure along each side from front of chamber 14″;
3. Connect these two points with straight line forming triangles;
4. Fill in these areas, thus forming "wing walls".

(Continued on page 40)

COMBUSTION CHAMBER DIMENSIONS AND FIREBRICK REQUIREMENTS FOR STANDARD BURNERS

GPH	COMBUSTION CHAMBER INSIDE DIMENSIONS					NUMBER FIREBRICK REQUIRED*		
	RECTANGULAR				Round Diam.	WALLS		FLOOR
	W	L	H	C		Brick, Flat	Brick on Edge	Brick, Flat
0.65	8.5	8.5	14	5	9	33	19	14
0.75	9	9	14	5	10	34	19	15
0.85	9.5	9.5	15	5	11	38	21	16
1.00	9.5	10.5	15	5	12	39	22	16
1.25-1.35	11	13	16	6	14	47	27	20
1.50-1.65	12	14	17	6	15	53	30	22
1.75	12.5	15	18.5	6.5	16	60	34	23
2.00	13	16	20	6.5	17	68	38	25
2.50	14	17	22	7	18	79	44	27
3.00	16	19	23	8	20	90	51	32
3.50	16.5	21	24	8	20	100	56	34
4.00-4.50	17.5	23	24	8	24	106	60	38
5.00-5.50	19	24.5	24	9.5		112	63	42
6.00	21	26	24	10.5		120	68	47
7.00	22	29	25	11		134	75	53
8.00	24	30	27	12		152	85	58
9.00	25	32	28	12.5		165	93	62
10.00	26	33	29	13		176	99	66
11.00	26	36	29	13		183	103	70
12.00	27	38	30	13.5		198	111	76
13.00	27	41	30	13.5		206	116	80
14.00	28	42	32	14		225	127	84
15.00	28	43	32	14		228	128	86
16.00	29	45	33	14.5		244	137	92
17.00	29	47	33	14.5		250	140	95
18.00	30	48	34	15		263	148	99
19.00	30	51	34	15		272	153	104
20.00	31	52	35	15.5		287	161	109

W = WIDTH L = LENGTH H = HEIGHT
C = DISTANCE FROM CHAMBER FLOOR TO CENTER OF NOZZLE

A reduction of 10% from any of the measurements (except "C") given in this table is permissible when the space within the combustion area of the boiler or furnace is limited. Reduce only the dimension required, allowing the other dimensions to remain at full size.

Brick requirements are based on 9-inch "straight" brick (9″ x 4½″ x 2½″).

*To determine total firebrick requirements, add number for "WALLS" (either flat or on edge) and number for "FLOOR."

No extras are allowed for in the above quantities. A prominent manufacturer of firebrick states that usually 5–10% extras are added to take care of cutting and breakage.

When using Models 1200 and 2000, the number of bricks given for the various gallonages is adequate to build the angled corners of the "wing wall" style of construction recommended.

Protecting Air Tube and Air Cone

Approximately ½" clearance between the air tube and combustion chamber air tube opening should be allowed in order that this area may be carefully packed with insulating material. An excellent mixture is dry asbestos with about 20% Portland cement plus enough water to make the mixture workable. It is most important that no particles of the mixture become lodged on the inner surfaces of the air cone to distort the flame and lower its efficiency. Formerly, we recommended protection of the air cone itself with insulation but the use of high temperature-resistant alloys makes this procedure no longer essential.

Positioning of Air Cone

Standard models installed in refractory-type chambers should have the air cone positioned ½" to ¾" back from the inside front surface of the combustion chamber. Under no conditions should the air tube or air cone extend into the chamber; neither should the air cone ever be more than ¾" back from the inside front surface of the combustion chamber.

Air Diffuser and Combustion Head Adjustments

Models 150F, 400, and 650 have an air diffuser with blades formed at a fixed angle to establish the air pattern of the burner. The diffuser is positioned in the proper location at the factory—see dimensions, pages 42–43—and, normally, no further adjustment is needed. It is, however, possible to move the diffuser forward or backward to tailor the flame when unusual conditions are encountered. In general, if the diffuser is moved forward toward the nozzle body, the flame is drawn closer to the air cone. Moving the diffuser back toward the electrode bracket may tend to move the fire away from the air cone. Extreme care should be exercised if either of these adjustments is made as other conditions may arise such as "coking" on the air cone or ignition problems due to an excess of air at the electrodes.

Model 150F (0.65 to 1.35 GPH range)

Models in this range have an air diffuser baffle with a series of 6 holes and a disc with a corresponding series of 6 holes. The disc is held against the baffle by a spring washer. By rotating the disc, the holes in the air diffuser baffle can be increased or decreased in size.

The 0.65 to 1.35 GPH range is shipped with the center holes fully open which is normally the proper position. The holes should be partially or fully closed only when less air is required directly at the nozzle.

Model 150F (1.35 to 2.00 GPH range)

The air diffuser in this range consists of larger blades and a 2¾" stationary baffle disc.

Model 400 (0.65 to 1.00 GPH range)

This model uses the same air diffuser baffle as Model 150F (0.65 to 1.35 GPH range) described on page 40.

Model 400 (1.00 to 1.65, 1.50 to 2.50 GPH range) and Model 400-4

The air diffuser baffle on models in the above firing ranges consists of a six-bladed diffuser and 2¼" diameter disc fabricated as a unit.

Model 650

The combustion head (consisting of the nozzle line, nozzle body, air diffuser and baffle, electrode bracket, electrode assemblies and adjusting slide) has a ½" adjustment for varying the distance from the face of the nozzles to the outer end of the air cone.

Adjustment is accomplished by turning the combustion head adjusting screw located at the rear of the burner. Turning this adjusting screw clockwise moves the head forward; counterclockwise pulls the head back.

When the head is moved forward to its extreme position, the distance from the nozzle faces to the end of the air cone is approximately ½". When completely drawn back, the distance is 1". Under normal conditions, a distance of ¾" has been found most satisfactory.

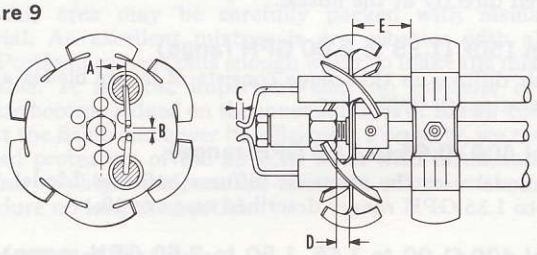
CAUTION

The angle of the blades on the air diffuser is fixed at the factory and should not be changed. If the set screw holding the air diffuser in proper position is loosened, make certain when tightening this set screw that the metal diffuser does not touch the electrode porcelains.

(Continued on page 44)

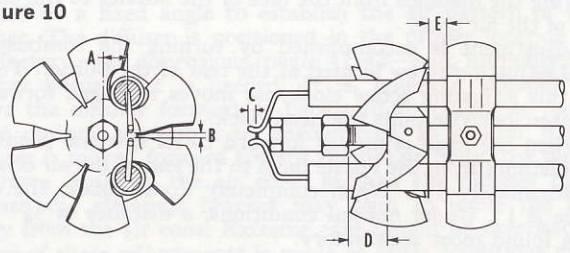
DIMENSIONS FOR COMBUSTION HEAD SETTINGS

Figure 9



MODEL NO.	FIRING RANGE (GPH)	A ELECTRODE WIRES FROM POINT NEAREST NOZZLE TO ORIFICE OF NOZZLE	B SPARK GAP AT BENDS OF ELECTRODE WIRES	C FACE OF NOZZLE TO TIPS OF ELECTRODE WIRES	D BACK OF NOZZLE ADAPTER TO AIR DIFFUSER	E AIR DIFFUSER TO FRONT EDGE OF ELECTRODE BRACKET
150F	0.65–1.35	½	⅛	3/16	3/16	1¼
400	0.65–1.00	½	⅛	3/16	3/16	1¾

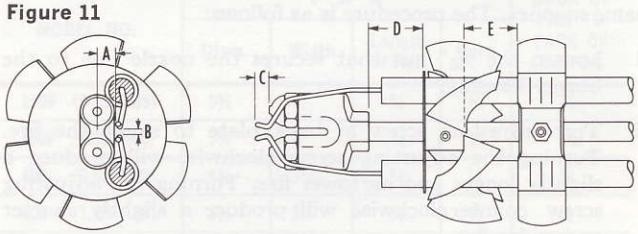
Figure 10



MODEL NO.	FIRING RANGE (GPH)	A ELECTRODE WIRES FROM POINT NEAREST NOZZLE TO ORIFICE OF NOZZLE	B SPARK GAP AT BENDS OF ELECTRODE WIRES	C FACE OF NOZZLE TO TIPS OF ELECTRODE WIRES	D BACK OF NOZZLE ADAPTER TO AIR DIFFUSER	E BAFFLE DISC TO FRONT EDGE OF ELECTRODE BRACKET
150F	1.35–2.00	½	⅛	3/16	3/16	½
400	1.00–1.65	½	⅛	3/16	¾	½
400	1.50–2.50	½	⅛	3/16	¾	½
400-4	2.50–4.00	½	⅛	3/16	¾	½

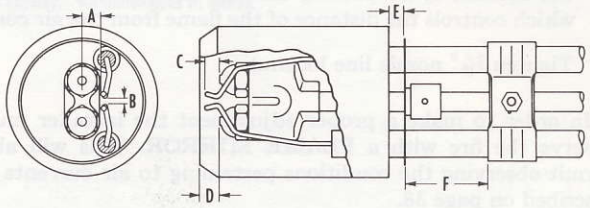
DIMENSIONS FOR COMBUSTION HEAD SETTINGS

Figure 11



MODEL NO.	FIRING RANGE (GPH)	A ELECTRODE WIRES FROM POINT NEAREST NOZZLES TO ORIFICE OF NOZZLES	B SPARK GAP AT BENDS OF ELECTRODE WIRES	C FACE OF NOZZLE TO TIPS OF ELECTRODE WIRES	D BACK OF NOZZLE ADAPTER TO BAFFLE DISC	E AIR DIFFUSER TO FRONT EDGE OF ELECTRODE BRACKET
650	3.50–6.50	⅜	⅛	3/16	1⅛	1 1/16

Figure 12



MODEL NO.	FIRING RANGE (GPH)	A ELECTRODE WIRES FROM POINT NEAREST NOZZLES TO ORIFICE OF NOZZLES	B SPARK GAP AT BENDS OF ELECTRODE WIRES	C FACE OF NOZZLE TO TIPS OF ELECTRODE WIRES	D FACE OF NOZZLES TO FRONT EDGE OF PRIMARY AIR TUBE	E BACK OF PRIMARY AIR TUBE TO BAFFLE DISC	F BAFFLE DISC TO FRONT EDG OF ELECTROD BRACKET
1200	6.00–12.00	⅜	⅛	¼	⅜	¼	1¾*
1200N	6.00–10.00	½	⅛	⅜	⅜	¼	1¾*
2000	10.00–20.00	⅜	⅛	¼	⅜	¼	1¾*

NOTE: Models 150F and 400 have single nozzle. Models 650, 1200, 1200N, and 2000 hav dual nozzles.

*With photocell, increase to 2¼". All dimensions in inches.

Models 1200, 1200N, and 2000

The combustion heads on these models are adjusted in the same manner. The procedure is as follows:

1. Loosen the 9/16" nut that secures the nozzle line to the burner housing.
2. Turn adjusting screw at back plate to shape the fire. Turning the adjusting screw clockwise will produce a slightly longer and narrower fire. Turning the adjusting screw counterclockwise will produce a slightly shorter and wider fire.
3. Adjust or position nozzle line baffle disc so that the flame is stable and not wavering from the burner air cone. Normally, the flame should be 3" to 4" away from the air cone on Models 1200 and 1200N and 4" to 5" away on Model 2000. If the flame burns at a greater distance, the nozzle line disc should be moved forward toward the primary air tube. This will reduce the amount of air admitted through the rear of the primary air tube. It is the amount of air passing through the primary air tube which controls the distance of the flame from the air cone.
4. Tighten 9/16" nozzle line locknut.

In order to make a proper adjustment the installer must observe the fire with a FLAME MIRROR. This will also permit observing the conditions pertaining to air currents as described on page 38.

After the burner has been firing for sufficient time to reach normal operating combustion chamber temperatures, adjust draft from .03" w.g. over fire for small nozzle sizes to .06" for large nozzle sizes. Close fan air shutter until slight smoke appears and then open slowly just enough to clean fire.

Final readings and adjustments should be made after combustion chamber is thoroughly dry. Analysis of the flue gas should disclose a CO_2 content greater than 10%, probably 12%. Higher CO_2 content can be obtained but may prove too critical for practical burner operation.

FAN DIMENSIONS AND SETTINGS

MODEL NO.	FAN				BACK OF FAN TO FACE OF MOTOR
	Diam.	Width	Length of Hub	Bore	
150F (0.65–1.35)	5¾	4	⅝	½	7/16
150F (1.35–2.00)	5¾	4	⅝	½	7/16
400 (0.65–1.00)	4¾	3 7/16	⅝	½	½
400 (1.00–1.65)	5¼	3¾	⅝	½	½
400 (1.50–2.50)	5¾	4	⅝	½	½
400-4	6 5/16	4	⅝	½	7/16
650	7⅝	4⅛	1¾	½	¼
1200	7⅝	5⅝	3¾*	⅝	7/16
1200N	7⅝ 8¼	5⅝ 5 11/16	3¾* 3¾*	⅝	7/16
2000	8¼	5 11/16	3¾*	⅝	7/16

*With keyway. All dimensions in inches.

MODEL 950FRD-1 (3450 RPM)

The "FRD" models are designed for and equipped with motors having a speed of 3450 RPM—double the normal 1725 RPM regularly used on high pressure gun-type burners.

There are three principal advantages offered by the 3450 RPM models, namely:

1. Elimination of the combustion chamber.
2. Less dependence on natural draft.
3. Smaller flame pattern with high combustion efficiency.

In most applications, complete combustion chambers as used with 1725 RPM models are no longer necessary. Certain types of heating units may require an insulated floor, a refractory ring at the burner head, or a target wall for maximum efficiency and protection of the heating surfaces.

Equipped with the time-tested "Flame Retention Head," Carlin high-speed burners produce a concentrated, intense fire. Rapid and complete burning of the oil with high-velocity air provides a normally smaller flame pattern which, in turn, permits firing in a smaller combustion area.

The need for natural draft is minimized due to the completeness of the process of combustion at the burner head. Also, improved performance can be expected under conditions of low chimney height or location near tall buildings or other obstructions.

Because of their peak combustion efficiency in boilers and furnaces of reduced dimensions, the "FRD" models provide many opportunities for the installation of larger capacity heating systems in laundries, motels, restaurants, apartment houses, and other structures where space is at a premium.

INSTALLATION INSTRUCTIONS

The design of the 3450 RPM models is such that complete combustion chambers are no longer necessary in most applications. An insulated floor is required and in some cases a refractory ring at the burner head. Wherever there is the possibility of flame impingement on the rear heating surfaces of a boiler, it is recommended that a refractory target wall be built.

Flame Impingement Must Be Avoided

The rapid and complete burning of the oil due to the design of the combustion head and the amount of high velocity air provides a normally smaller flame pattern. This automatically allows the use of a higher capacity fire in a smaller area than has been required in the past. It is a requirement, however, that the flame does not impinge directly on any of the heating surfaces. This is a precaution that must be carefully observed. Due to the high flame temperature, the lack of refractory protection and the "cold" heating surfaces of the cast iron or steel, "burn outs" could occur thereby resulting in extremely costly repairs or complete replacement.

When 3450 RPM models are adapted to a boiler or furnace for firing through fire doors, extreme caution must be used to prevent flame impingement on the crown sheet. There will be occasions when it will be necessary to tilt the burner downward to avoid impingement.

Natural Draft Need Minimized

The need of natural draft is minimized due to the completeness of the process of combustion at the burner head. This is extremely helpful especially in applications where chimneys are low or located in positions where they are affected by surrounding buildings. The chimney flue must be equal to or greater than the boiler breeching. The 3450 RPM models can fire with no natural draft and to some extent against a back pressure. However, when the condition of back pressure exists, there are other factors that must be carefully considered and recognized.

SPECIFICATIONS

MODEL NO.	FIRING RANGE* (GPH) (a)	MOTOR (HP) (b)	FUEL UNIT (100 PSI Pressure) (c)	TRANSFORMER (volts) (d)	NOZZLES (e)	DELAYED OIL VALVE (f)
150FRD-1	2.00–4.50	¼	2-stage	10,000	Dual 60°	Standard
450FRD-1	4.00–7.00	¼	2-stage	10,000	Dual 60°	Standard
450FRD-1A	4.00–8.00	¼	2-stage	10,000	Dual 60°	Standard
950FRD-1	7.00–13.00	½	2-stage	10,000	Dual 60°	Standard

NOTES

(a) Ratings for Models 150FRD-1 and 450FRD-1 based on .02 inches water, natural draft; for Models 450FRD-1A and 950FRD-1 on .04 inches water, natural draft.

(b) Motor is 3450 RPM capacitor start, induction run with safety overload control. Complies with NEMA specifications.

(c) Fuel unit has built-in strainer and pressure regulating valve. Capacity of strainer equals or exceeds maximum firing rate of burner. Equipped with easy-flow bleed valve. See "Fuel Unit Data," p. 50-51.

(d) Transformer is heavy-duty type shielded to eliminate radio and TV interference.

(e) Nozzles are hollow cone spray.

(f) Solenoid type. Combination delayed-opening and instantaneous cut-off.

ELECTRICAL CHARACTERISTICS—115–120 volts, 60 cycle,-1-phase, 3450 RPM. For further information refer to page 107.

ALL MODELS AVAILABLE FOR EITHER PEDESTAL OR FLANGE MOUNTING. FOR INFORMATION ON FLANGES REFER TO PAGES 104–105.

*GPH ratings are based on sea level to 2,000 ft. elevation. For every 1,000 ft. rise over 2,000 ft., reduce the maximum GPH rating by 4 percent.

DIMENSIONS

MODEL NO. ▶	150FRD-1	450FRD-1 450FRD-1A	950FRD-1
Length (over-all)	15⅝, 17⅝, 19⅝	19¾, 21¾	21¼, 23¼, 28¼
Width (over-all)	16⅛	18⅝	24⅛
Height (over-all) Flange Mounted	13½	15 11/16	18¼
Height, Pedestal Mounted — Min.	14	15¾	18¼
Height, Pedestal Mounted — Max.	17	19¾	21
Nominal Air Tube-Air Cone Length	7, 9, 11	8, 10	8, 10, 15
Maximum Effective Air Tube-Air Cone Length* — Flange Mounted	5¼, 7¼, 9¼	6, 8	5⅞, 7⅞, 12⅞
Maximum Effective Air Tube-Air Cone Length* — Pedestal Mounted	6¾, 8¾, 10¾	8⅛, 10⅛	8, 10, 15
Floor to Nozzle, Pedestal Mounted — Min.	8¼	9⅝	11⅛
Floor to Nozzle, Pedestal Mounted — Max.	11¼	13	13¾
Top of Transformer to Centerline of Air Tube	5¾	6½	7¼
Centerline of Air Tube to Bottom of Housing, Flange Mounted	7¾	9 3/16	11
Air Tube — O.D.	4⅛	4¾	5¼
Air Tube — I.D.	4	4½	5
Air Cone — O.D.	4⅛	4¾	5¼
Air Cone — I.D.	3½	3⅞	4¾
Fan — Diam.	5¼	5¾	6 5/16
Fan — Width	3¾	4	5
Flange†	1½	2⅛	2⅛

*"Effective Air Tube-Air Cone Length" is length available for insertion in heating boiler or furnace.

†Length through hub including ⅛" gasket.

All dimensions in inches. Dimensions are approximate.

Model 950FRD-1 which has a top firing rate of 13.00 GPH was tested with a .02 draft. Normally a 13-gallon fire would be expected to have from .04 to .06 inches of water over the fire. It is conceivable that a plus reading (back pressure) on the fire would reduce the maximum firing rate of the burner; but laboratory tests to date indicate that the reduction in firing is at a minimum, at least up to a back pressure of .02.

Generally speaking, back pressures are undesirable. Consequently boilers and furnaces are designed with a draft requirement. The problems of insufficient draft are created by the location, construction or poor planning of the chimney necessary to provide the required draft. It is under these conditions that the 3450 RPM models may perform correctly whereas the normal 1725 RPM models could not.

Tight Boiler Needed

Tight and well-sealed boilers are a must with the new 3450 RPM models. With a questionable draft condition, the creation of a positive pressure in the combustion chamber could cause gases to be expelled in the area. This condition must be avoided; therefore a careful survey and recognition of the possible boiler "leakage" relative to gases is required before recommending the installation of the "double speed" models.

Important Considerations

In summary, there are three conditions that must be considered before the installation of 3450 RPM models:

1. The firing rate of the burner must be capable of providing the maximum BTU input in accordance with the boiler nameplate.
2. The installation must be made in such a manner that there is access to the combustion area.
3. Under no conditions must there be impingement on the heating surfaces of the boiler or furnace.

FUEL UNIT DATA

Carlin "FRD" models are equipped with a Sundstrand H2 "P" 2-stage fuel unit having a standard spring. At 3450 RPM, this unit is rated as follows: 16 GPH at 100 PSI max. and 11 GPH at 150 PSI max.

The H2 "P" fuel unit has a standard gear set consisting of a larger rotor gear with a smaller roller gear within. The latter is always hardened but, contrary to a popular opinion, hardening of the rotor gear is not necessary as long as pressures do not go above the 150 PSI limit recommended by Sundstrand.

Fuel line hook-up for 3450 RPM burners is the same as for 1725 RPM.

COMBUSTION HEAD DIMENSIONS AND SETTINGS

	MODEL NO. ▶	150FRD-1	450FRD-1 450FRD-1A	950FRD-1
A	Bottom of electrode wires to orifice of nozzles	7/16	7/16	7/16
B	Spark gap at bends of electrode wires	1/8	1/8	1/8
C	Relation of electrode wire tips to face of nozzles	1/8 ahead	1/8 ahead	1/8 ahead
D	Face of nozzles to outside rim of flame retention ring	1/2	5/8	3/4
E	Outside diameter, primary air tube and flame retention ring assembly	2 3/4	3 1/8	3 1/2
F	Over-all length, primary air tube and flame retention ring assembly	4	4	4

All dimensions in inches.

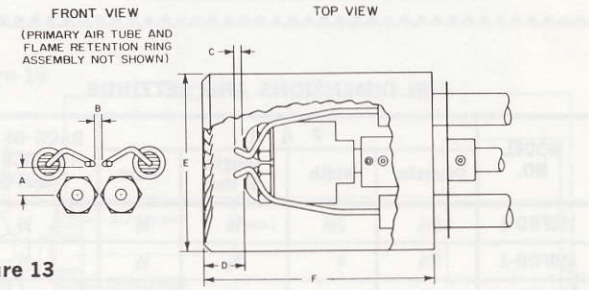


Figure 13

"FRD" burners **MUST** be fired with the flame retention ring ahead of the face of the air cone. The recommended distance is ¼-inch minimum.

COMBUSTION AREA DIMENSIONS

(Refer to drawings on opposite page.)

FIRING RATE (GPH)	C	D (Min.)	L*	H	WIDTH OR DIAMETER (Min.)
2.00	5.5	5.5	18	11	11
2.50	6	6	18	12	12
3.00	7	7	19	14	14
4.00	8	8	20	16	15
5.00	8.5	8.5	21	17	16
6.00	9	9	23	18	17
7.00	9.5	9.5	25	19	18
8.00	9.5	9.5	28	19	19
9.00	9.5	9.5	31	19	19
10.00	10	10	34	20	20
11.00	11	11	37	22	22
12.00	12	12	40	24	24
13.00	13	13	43	26	26

*A target wall with corbel is recommended on boilers of the "uptake" design. If, however, a target wall is not used, a minimum of 5" additional length (L) is required in the combustion area.

All dimensions in inches.

FAN DIMENSIONS AND SETTINGS

MODEL NO.	F A N				BACK OF FAN TO FACE OF MOTOR
	Diameter	Width	Length of Hub	Bore	
150FRD-1	5¼	3¾	⅝	½	½
450FRD-1	5¾	4	⅝	½	½
450FRD-1A	5¾	4	⅝	½	½
950FRD-1	6 5/16	5	1¾	½	3/16

All dimensions in inches.

Figure 14

CAST IRON BOILER

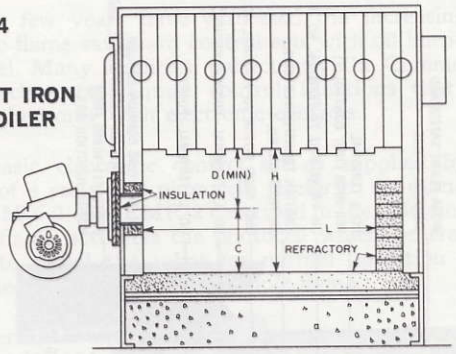


Figure 15

STEEL BOILER

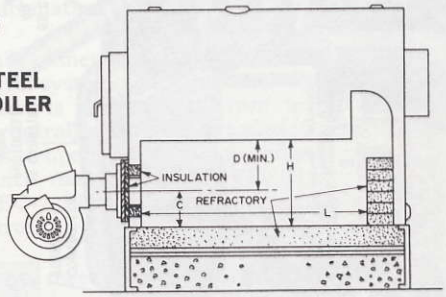
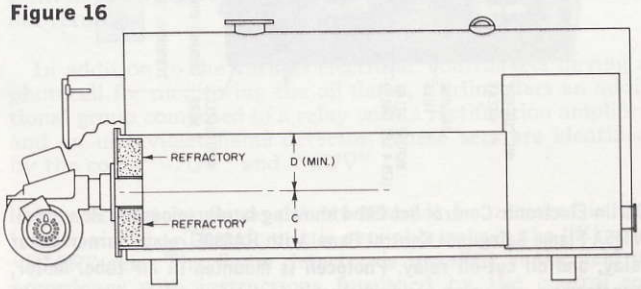
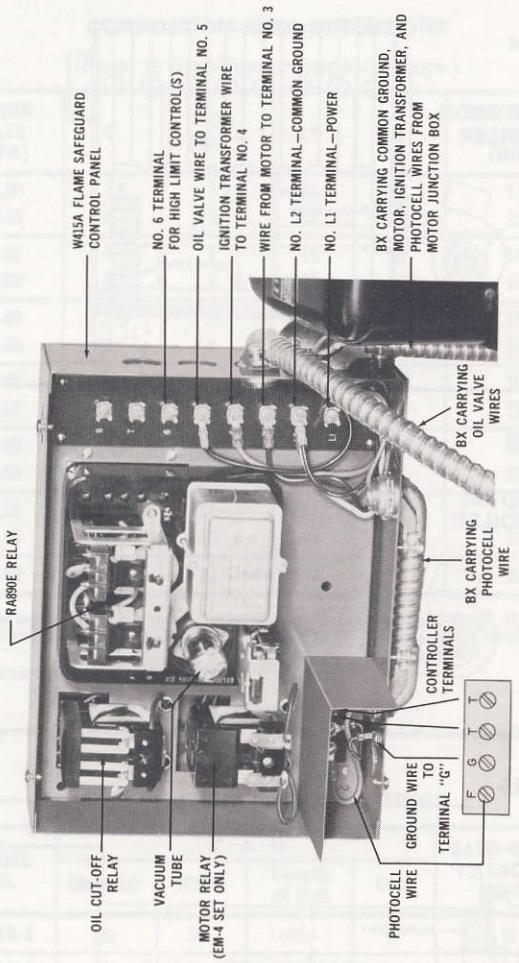


Figure 16



SCOTCH MARINE BOILER



Carlin Electronic Control Set EM-4 showing burner-mounted Honeywell W415A Flame Safeguard Control Panel with RA890E relay, burner motor relay, and oil cut-off relay. Photocell is mounted in air tube. Motor, transformer, oil valve, and photocell factory-wired to sub-base of W415A panel.

The past few years have witnessed the increasing use of electronic flame safeguard control sets with oil burners using No. 2 fuel. Many localities, particularly the Commonwealth of Massachusetts, require control functions that can be accomplished only with electronic controls.

The basic electronic control set as supplied by Carlin consists of a relay and photocell. (Refer to set numbers E-2, EM-2, EMX-2, and EMR-2 described in the following pages.) The oil flame activates the photocell which generates D.C. current to signal the relay for normal operation which is maintained as long as there is ample flame.

Further "policing" of burner operation is achieved by the use of the W415A Flame Safeguard Control Panel as in the control sets ending in "-35" and "-4". See pages 56-57 for further information on the W415A panel.

A further refinement in electronic controls is the programming control system which provides a prepurge period before the oil valve is permitted to open and a postpurge period after the controller has been satisfied. This system also closes the oil valve upon loss of flame and will not again start the burner until manually reset. The Honeywell R4150A and Fireye TFC-2 Flame Safeguard Controls are programming-type controls.

In order to meet the requirements of Factory Mutual (FM) as well as Underwriters' Laboratories (UL), sets that include the Honeywell W415A and R4150A, and Fireye 24CJ5 controls are wired so that, upon loss of flame, the ignition does not return.

In addition to the various electronic control sets having a photocell for monitoring the oil flame, Carlin offers an additional group composed of a relay with a rectification amplifier and an ultraviolet flame detector. These sets are identified by the codes "-7UV" and "-8UV"

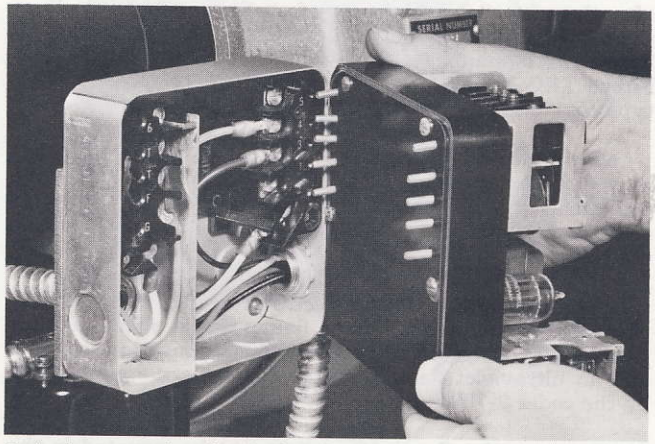
The ultraviolet flame detector cannot be mounted in the burner air tube. Therefore it is available only in the "E" and "EMR" sets. The flame detector is installed in the field in accordance with instructions furnished by the control set manufacturer.

HONEYWELL RA890E "PROTECTORELAY" used with W415A FLAME SAFEGUARD CONTROL PANEL

The RA890E Relay, used with the W415A Panel, provides an electronic control system which goes beyond the requirements of Underwriters' Laboratories for oil burners within the firing range of Carlin models. This control arrangement, as offered in the EM-35 and EM-4 sets, meets the requirements of states and municipalities which have codes calling for a shut-down faster than normal in the event of flame failure.

An oil cut-off relay is incorporated in the W415A panel and is pre-wired to the sub-base which is also a part of the panel. In the event of flame failure, the oil cut-off relay closes the oil valve—also required in the system—within 2 to 4 seconds. The oil valve cannot be re-energized until the control is manually reset. (Before the introduction of the W415A panel, the above sequence of control action was accomplished with the combination of the RA890E and R482D relays described in the first edition (1959) of the Carlin Handbook.)

The W415A panel as used in Carlin electronic control set



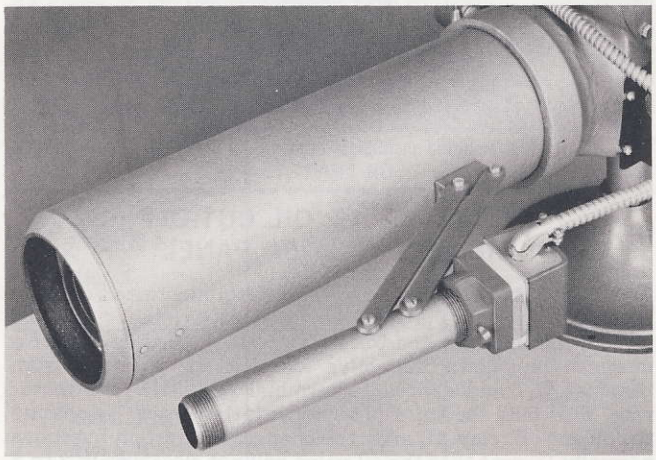
Carlin burners equipped with the RA890E Relay, factory-mounted on the burner housing (Sets EM-2, EMX-2 and EMR-2), are shipped with all wiring connections on the Q270A Base completed. Field installation is readily accomplished by aligning relay and base as illustrated, then turning down the captive mounting screws in the relay.

EM-4 incorporates a motor relay in addition to the oil cut-off relay. The motor relay provides protection for the contacts of the RA890E when motors of higher horsepower are used. The latter in most instances have a higher amperage rating than the RA890E. Carlin Models 2000S-5, 2000, and 950FRD-1 are furnished with the EM-4 set when electronic control sets are specified.

C7010A PHOTOCELL MOUNT

The C7010A is a miniaturized external industrial photocell holder designed for burners of the Carlin type. It is used where an external photocell mounting is required or desired and, with Carlin oil burners, performs the same functions as the larger and more costly C7003A designed primarily for industrial burners.

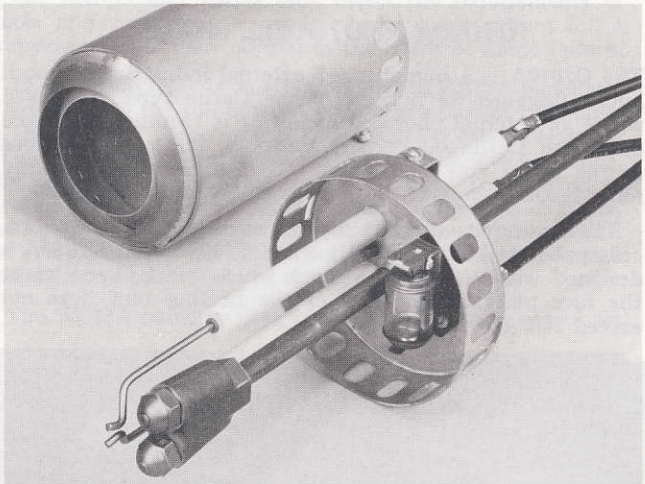
The maximum ambient temperature of 165° F at the photocell applies to both the C7010A and C7003A. The C7010A is designed with a mounting block which can be used where the face plate temperature of the heating unit does not exceed 200° F.



C7010A Photocell Mount attached to Model 2000S-5. The arms extending to the mounting bracket on the tube are adjustable, permitting variations in positioning but at all times maintaining a proper angle for sighting the flame.

INTERNAL PHOTOCELL MOUNT

When the photocell is mounted in the air tube, the C7014A mount is used on Carlin "S" series (Shell Head) models and the C7013A mount on all other models having electronic control sets with photocell internally mounted. Both mounts use the same photocell (Honeywell No. 38316).



Photocell C7014A mounted inside air tube of Carlin "Shell Head" burner.

FIELD TEST OF OIL CUT-OFF RELAY ON W415A PANEL

The standard wiring of the W415A panel illustrated on page 54 calls for the oil valve to be wired to terminal "5." The ground wire is connected to terminal "L2." In the event of a nuisance shut-down the valve wire can be removed from terminal "5" and shifted to terminal "3" with the motor wire. This puts the valve in series with the motor, by-passing the oil cut-off relay. If, after the change, the system functions normally (except that the oil valve will not close within 2 to 4 seconds after flame failure), it is evident that the malfunction is in the oil cut-off relay. The complete W415A panel must then be replaced.

THE INSTALLATION AND SERVICING OF ELECTRONIC CONTROLS

Meter is a "Must"

A meter designed to measure the microamperes being generated by the light through the photocell and the RA890E "Protectorelay" is a "must" in the serviceman's tool kit if he is to be expected to analyze trouble. The job *cannot be done* without a meter. When the meter is not in use it is well to attach the clips to each other to complete the circuit and avoid unnecessary wear.

Vacuum Tubes and Photocells

It is strongly recommended that replacement vacuum tubes for use in Honeywell Safeguard Equipment be M-H factory tested tubes purchased through Honeywell suppliers. To obtain maximum safety from the equipment, vacuum tubes with series heaters or filaments are necessary. M-H tubes are purchased from two manufacturers, RCA and Sylvania, who provide series filaments which are given a minimum of 32 hours of operational check. The tubes are marked with the proper M-H part number. Honeywell recommends annual replacement of vacuum tubes and photocells to insure trouble-free, uninterrupted service.

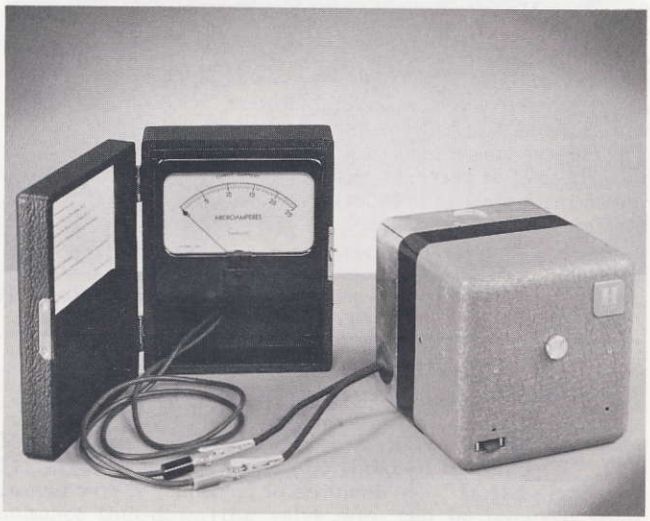
The following is a cross reference of M-H tube numbers:

RELAY	M-H PART NO.	RCA OR SYLVANIA
R478A or B R4074B	102988 105608 100668 107303	12AU7 12AV7 12AX7 6X4
R187A, R887A R190B, R890B R890C, R7023A R178A, B	38305	12SN7
RA890B RA890C or E	102988	12AU7

Position of Photocell for Testing

The position of the photocell with reference to the fire must be correct. The microamperes generated by the light through the photocell signal the RA890E relay for normal operation. The normal operating range is 2–5 microamperes per the meter. Although some installations are working normally with as little as 1.5 microamperes, it is best to obtain a reading of at least 2 microamperes.

If a meter test fails to show a steady reading of at least 1 microampere, another photocell should be substituted to see if the desired microamperes can be read on the meter. If the substitute photocell fails to improve the reading, it is likely that the trouble is in the position of the photocell or in the flame condition. Variations will occur and the serviceman properly trained will be able to cope with these conditions.



The knockout on the RA890E base has been removed in order that the wire from "F" on the photocell and "F" wire from the "Protectorelay" can be connected externally. In this way, tests can be conducted easily and the external mounting does not interfere with normal operation. (Current models of RA890E include a "jack" marked "FLAME CUR." for this purpose.) These wires should be protected with an insulated wire nut. It is a simple matter with this hookup to connect the meter in "series" with the circuit in order to conduct tests for microampere readings. If meter reads backwards, reverse wires.

ELECTRONIC CONTROL SET AVAILABILITY CHART

"A" INDICATES SET IS AVAILABLE

ELECTRONIC CONTROL SET SERIES AND NUMBER		BURNER MODEL					
		400 400-4 150N 400N	150SF-2 400S 150FRD-1 450FR-1	500S-35 700S-35 800S-4 700FR 1200FR-1 1200FR-2	450FR-2 950FR-1 950FR-2 450FRD-1 450FRD-1A	950FRD-1	2000S-5 2000
"E" Series	E-2	A	A	A	A	—	A
	E-35	A	A	A	A	—	—
	E-4	—	—	—	—	A	A
	E-6	A	A	A	A	A	A
	E-7	A	A	A	A	A	A
	E-7UV	A	A	A	A	A	A
	E-8UV	A	A	A	A	A	A
"EM" Series	EM-2	—	A	A	A	—	A
	EM-35	—	A	A	A	—	—
	EM-4	—	—	—	—	A	A
	EM-6	—	A	A	A	A	A
	EM-7	—	A	A	A	A	A
"EMX" Series	EMX-2	—	—	A	—	—	A
	EMX-35	—	—	A	—	—	—
	EMX-4	—	—	—	—	—	A
	EMX-6	—	—	A	—	—	A
	EMX-7	—	—	A	—	—	A
"EMR" Series	EMR-2	A	A	A	A	—	A
	EMR-35	A	A	A	A	—	—
	EMR-4	—	—	—	—	A	A
	EMR-6	A	A	A	A	A	A
	EMR-7	A	A	A	A	A	A
	EMR-7UV	A	A	A	A	A	A
	EMR-8UV	A	A	A	A	A	A

"SERIES E"
(NOT MOUNTED—NOT WIRED)

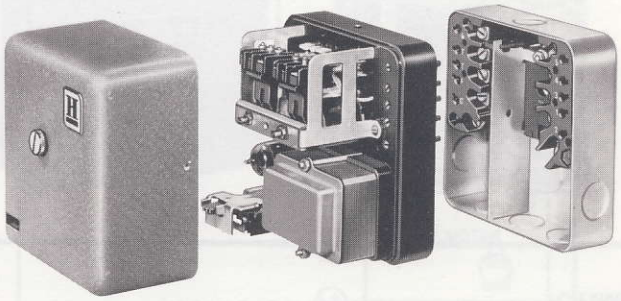
CONTROL SET NO.	DESCRIPTION
E-2	Honeywell RA890E Relay, Q270A Base, C7010A Photocell Mount and 190 Sighting Tube. Photocell mount machined for sighting tube.
E-35	Honeywell W415A Flame Safeguard Control Panel with oil cut-off relay only, cabinet and cover, RA890E Relay, C7010A Photocell Mount, and 190 Sighting Tube. Photocell mount machined for sighting tube. Burner must be equipped with either V4046A or V4046B Oil Valve.
E-4	Honeywell W415A Flame Safeguard Control Panel with both burner motor relay and oil cut-off relay, cabinet and cover. RA890E Relay, C7010A Photocell Mount, and 190 Sighting Tube. Photocell mount machined for sighting tube. Burner must be equipped with either V4046A or V4046B Oil Valve.
E-6*	Fireye TFC-2 system consisting of Type 24CJ5 Model 3000 Flame Safeguard and Programming Control, Type 45AM1 Photocell Mount for external mounting, and 190 Sighting Tube. Photocell mount machined for sighting tube. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.
E-7*	Honeywell R4150A Flame Safeguard Control, Q520A Base, C7010A Photocell Mount and 190 Sighting Tube. Photocell mount machined for sighting tube. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.
E-7UV*	Honeywell R4150A Flame Safeguard Control, Q520A Base, and C7012A Ultraviolet-sensitive Flame Detector. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.
E-8UV*	Fireye UVC-2 System consisting of Type 25CU6 Model 1050 Flame Safeguard and Programming Control, sub-base, and Type 45UV3 Ultraviolet-sensitive Scanner (Photocell). Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.

Note: The 190 Sighting Tube is 8″ long and has 2″ I.D. Sets may be ordered with the standard C7010A Photocell Mount which is tapped for 1¼″ pipe (NPT).

***Control system provides automatic sequencing of burner motor, transformer, and oil valve. Sequencing consists of a prepurge, trial-for-ignition, and postpurge period.**

"SERIES EM"
(BURNER-MOUNTED WITH PHOTOCELL LOCATED IN AIR TUBE)

CONTROL SET NO.	DESCRIPTION
EM-2	Honeywell RA890E Relay for use with Q270A Base mounted on burner housing and photocell mounted in air tube. Motor, transformer, oil valve, and photocell factory-wired to base.



WIRING DIAGRAM FOR ELECTRONIC CONTROL SET EM-2

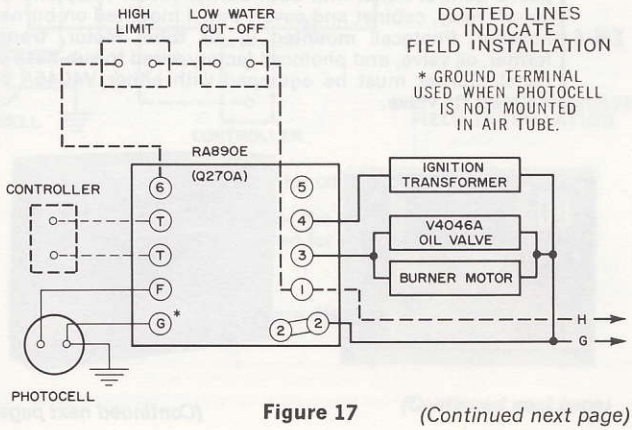
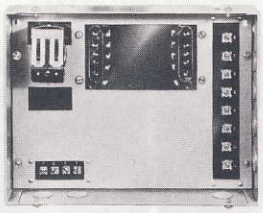


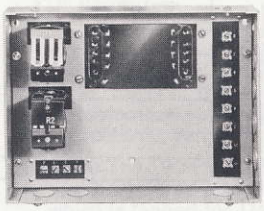
Figure 17

(Continued next page)

CONTROL SET NO.	DESCRIPTION
EM-35	Honeywell RA890E Relay for use with W415A Flame Safeguard Control Panel with oil cut-off relay only, cabinet and cover. Panel mounted on burner housing. Photocell mounted in air tube. Motor, transformer, oil valve, and photocell factory-wired to sub-base of panel. Burner must be equipped with either V4046A or V4046B Oil Valve.

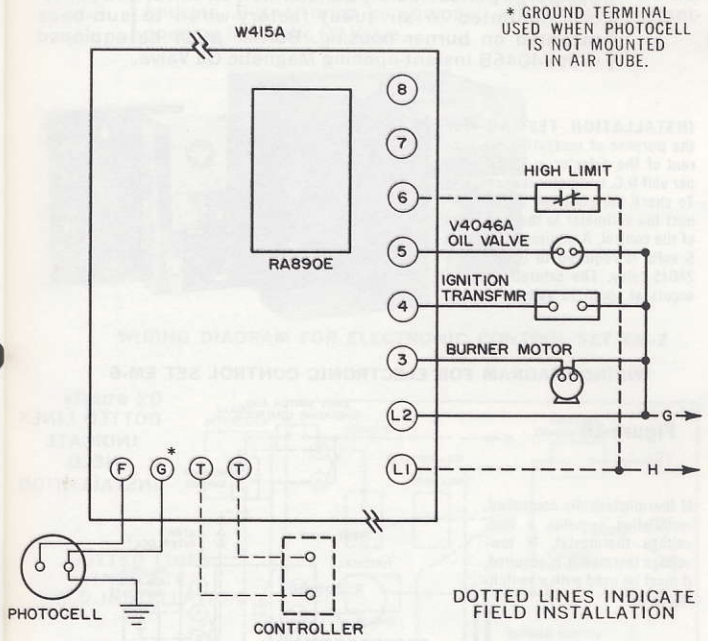


CONTROL SET NO.	DESCRIPTION
EM-4	Honeywell RA890E Relay for use with W415A Flame Safeguard Control Panel with both burner motor relay and oil cut-off relay, cabinet and cover. Panel mounted on burner housing. Photocell mounted in air tube. Motor, transformer, oil valve, and photocell factory-wired to sub-base of panel. Burner must be equipped with either V4046A or V4046B Oil Valve.



(Continued next page)

WIRING DIAGRAM FOR ELECTRONIC CONTROL SETS EM-35 AND EM-4



Set EM-35 is pre-wired for oil cut-off relay only.

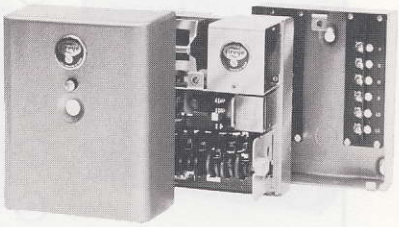
EM-4 set is pre-wired for the burner motor relay in addition to being wired for the oil cut-off relay.

Figure 18

(Continued next page)

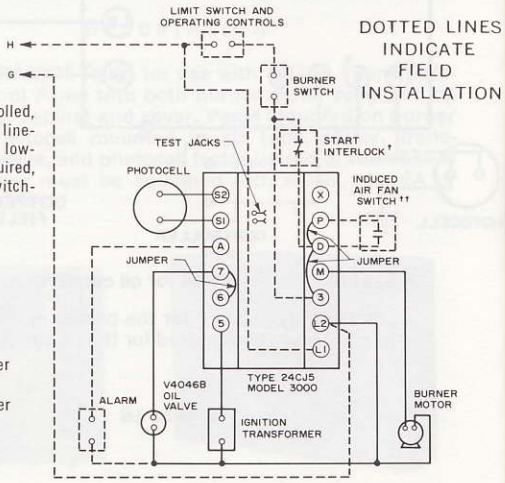
CONTROL SET NO.	DESCRIPTION
EM-6	Fireye TFC-2 System consisting of Type 24CJ5 Model 3000 Flame Safeguard and Programming Control, sub-base, and Type 45CM1 Photocell. Control system provides automatic sequencing of burner motor, transformer, and oil valve. Sequencing consists of a prepurge, trial-for-ignition, and postpurge period. Motor, transformer, oil valve, and photocell (mounted in air tube) factory-wired to sub-base mounted on burner housing. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.

INSTALLATION TESTING—For the purpose of measuring the current of the detector, a 20,000 ohm per volt D.C. voltmeter is necessary. To check the photocell signal, connect the voltmeter to the test jacks of the control. A minimum signal of 5 volts is required to operate the 24CJ5 relay. The saturation signal occurs at about 15 volts.



WIRING DIAGRAM FOR ELECTRONIC CONTROL SET EM-6

Figure 19



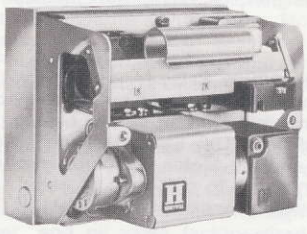
If thermostatically controlled, installation requires a line-voltage thermostat. If low-voltage thermostat is required, it must be used with a switching relay.

†If used, remove jumper between D and P.

††If used, remove jumper between 3 and D.

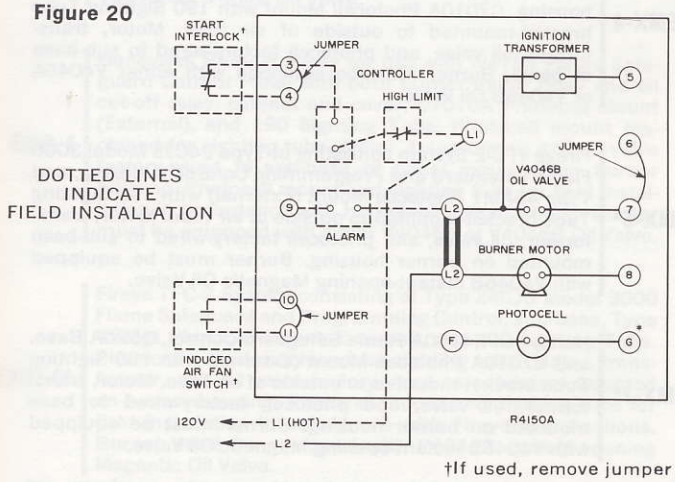
(Continued next page)

CONTROL SET NO.	DESCRIPTION
EM-7	Honeywell R4150A Flame Safeguard Control, Q520A Base, and Photocell. Control system provides automatic sequencing of burner motor, transformer, and oil valve. Sequencing consists of a prepurge, trial-for-ignition, and postpurge period. Motor, transformer, oil valve, and photocell (mounted in air tube) factory-wired to base mounted on burner housing. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.



WIRING DIAGRAM FOR ELECTRONIC CONTROL SET EM-7

Figure 20



†If used, remove jumper

*Ground terminal used when photocell is not mounted in air tube.

"SERIES EMX"
(BURNER-MOUNTED WITH PHOTOCELL MOUNT BRACKET-MOUNTED TO OUTSIDE OF AIR TUBE)

CONTROL SET NO.	DESCRIPTION
EMX-2	Honeywell RA890E Relay for use with Q270A Base mounted on burner housing. C7010A Photocell Mount with 190 Sighting Tube bracket-mounted to outside of air tube. Motor, transformer, oil valve, and photocell factory-wired to base.
EMX-35	Honeywell RA890E Relay for use with W415A Flame Safeguard Control Panel with oil cut-off relay only, cabinet and cover. Panel mounted on burner housing. C7010A Photocell Mount with 190 Sighting Tube bracket-mounted to outside of air tube. Motor, transformer, oil valve, and photocell factory-wired to sub-base of panel. Burner must be equipped with either V4046A or V4046B Oil Valve.
EMX-4	Honeywell RA890E Relay for use with W415A Flame Safeguard Control Panel with both burner motor relay and oil cut-off relay, cabinet and cover. Panel mounted on burner housing. C7010A Photocell Mount with 190 Sighting Tube bracket-mounted to outside of air tube. Motor, transformer, oil valve, and photocell factory-wired to sub-base of panel. Burner must be equipped with either V4046A or V4046B Oil Valve.
EMX-6*	Fireye TFC-2 System consisting of Type 24CJ5 Model 3000 Flame Safeguard and Programming Control, sub-base, and Type 45AM1 Photocell Mount (External) with 190 Sighting Tube bracket-mounted to outside of air tube. Motor, transformer, oil valve, and photocell factory-wired to sub-base mounted on burner housing. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.
EMX-7*	Honeywell R4150A Flame Safeguard Control, Q520A Base, and C7010A Photocell Mount (External) with 190 Sighting Tube bracket-mounted to outside of air tube. Motor, transformer, oil valve, and photocell factory-wired to base mounted on burner housing. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.

***Control system provides automatic sequencing of burner motor, transformer, and oil valve. Sequencing consists of a prepurge, trial-for-ignition, and postpurge period.**

"SERIES EMR"
(BURNER-MOUNTED WITH PHOTOCELL LOCATED OUTSIDE OF AIR TUBE BUT NOT ATTACHED TO AIR TUBE)

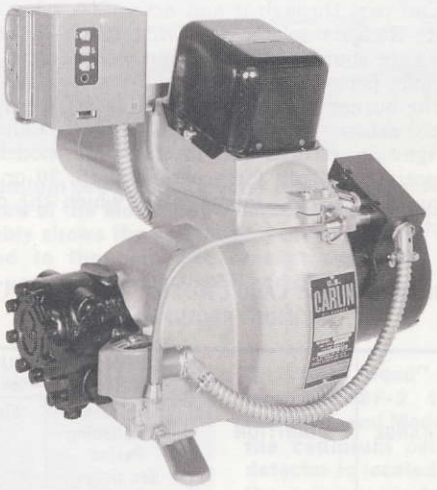
CONTROL SET NO.	DESCRIPTION
EMR-2	Honeywell RA890E Relay for use with Q270A Base, C7010A Photocell Mount (External), and 190 Sighting Tube. Photocell mount machined for sighting tube. Motor, transformer, and oil valve factory-wired to base mounted on burner housing. Photocell mount and sighting tube for field installation in accordance with Honeywell specifications.
EMR-35	Honeywell RA890E Relay for use with W415A Flame Safeguard Control Panel with oil cut-off relay only, cabinet and cover, C7010A Photocell Mount (External), and 190 Sighting Tube. Photocell mount machined for sighting tube. Motor, transformer, and oil valve factory-wired to sub-base of panel mounted on burner housing. Photocell mount and sighting tube for field installation in accordance with Honeywell specifications. Burner must be equipped with either V4046A or V406B Oil Valve.
EMR-4	Honeywell RA890E Relay for use with W415A Flame Safeguard Control Panel with both burner motor relay and oil cut-off relay, cabinet and cover, C7010A Photocell Mount (External), and 190 Sighting Tube. Photocell mount machined for sighting tube. Motor, transformer, and oil valve factory-wired to sub-base of panel mounted on burner housing. Photocell mount and sighting tube for field installation in accordance with Honeywell specifications. Burner must be equipped with either V4046A or V4046B Oil Valve.
EMR-6*	Fireye TFC-2 System consisting of Type 24CJ5 Model 3000 Flame Safeguard and Programming Control, sub-base, Type 45AM1 Photocell Mount (External), and 190 Sighting Tube. Photocell mount machined for sighting tube. Motor, transformer, and oil valve factory-wired to sub-base mounted on burner housing. Photocell mount and sighting tube for field installation in accordance with Fireye specifications. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.

(Continued next page)

CONTROL SET NO.	DESCRIPTION
EMR-7*	Honeywell R4150A Flame Safeguard Control, Q520A Base, C7010A Photocell Mount (External), and 190 Sighting Tube. Photocell mount machined for sighting tube. Motor, transformer, and oil valve factory-wired to base mounted on burner housing. Photocell mount and sighting tube for field installation in accordance with Honeywell specifications. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.
EMR-7UV*	Honeywell R4150A Flame Safeguard Control, Q520A Base, and C7012A Ultraviolet-sensitive Flame Detector. Motor, transformer, and oil valve factory-wired to base mounted on burner housing. Ultraviolet-sensitive flame detector for field installation in accordance with Honeywell specifications. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.
EMR-8UV*	Fireye UVC-2 System consisting of Type 25CU6 Model 1050 Flame Safeguard and Programming Control, sub-base, and Type 45UV3 Ultraviolet-sensitive Scanner (Photocell). Motor, transformer, and oil valve factory-wired to sub-base mounted on burner housing. Scanner for field installation in accordance with Fireye specifications. Burner must be equipped with V4046B instant-opening Magnetic Oil Valve.

Note: The 190 Sighting Tube is 8″ long and has 2″ I.D. Sets may be ordered with the standard C7010A Photocell Mount which is tapped for 1¼″ pipe (NPT).

***Control system provides automatic sequencing of burner motor, transformer, and oil valve. Sequencing consists of a prepurge, trial-for-ignition, and postpurge period.**



Typical bracket-mounting of primary relay (Honeywell "Protectorelay" R8184 or R8185D) for use with cadmium cell flame detector. Burner illustrated is Model 450FR-2. Bracket accommodates either Honeywell or White-Rodgers controls. The primary control is so mounted that it is well within the over-all width of the burner and back far enough to permit use of the total effective air tube length.

Cadmium Cell Flame Detectors offer positive protection against flame or power failure

The cadmium cell control offers greater sensitivity than the conventional stack switch since the photoconductive flame-sensing device reacts to light rather than to a change in temperature as is the case with the helix of the stack control. Underwriters' Laboratories regulations now in effect require the use of either the cadmium cell-type primary relay or electronic control set on all oil burners firing over 3.00 GPH.

The sensing element is cadmium sulfide, the resistance

of which decreases in the presence of light. An oil flame lowers the cell resistance to the point where an electric current can pass through it and activate a relay component. On White-Rodgers relays, following flame failure, there is an immediate shut-down of the burner, followed by a scavenger timing period after which ignition is again attempted. Should the burner fail to ignite on this attempt, the control goes into safety. On Honeywell relays, following flame failure, ignition returns (on intermittent models) and the motor continues to run for a period of 70, 30 or 15 seconds depending on the relay model, after which the control goes into safety.

UNDERWRITERS' LABORATORIES SAFETY CONTROL TIMING REQUIREMENTS

FIRING RANGE	IGNITION	NOMINAL MAXIMUM TIMINGS IN SECONDS—See Note (a)	
		Main-Flame Establishing Period See Notes (b), (c)	Flame-Failure Reaction Time See Note (d)
3 Gallons or less	Unproved igniter	90	90
7 Gallons or less	Unproved igniter	30	3 See Note (e)
20 Gallons or less	Unproved igniter	15	3 See Note (f)

NOTES

(a) The nominal timing is the designed duration of the period determined at rated voltage of the control in a room temperature of 70° F. Allowable factory tolerance may be in addition thereto.

(b) The maximum input for determining the main-flame establishing period for a burner not equipped as indicated in "c" below is to be the maximum input of the burner.

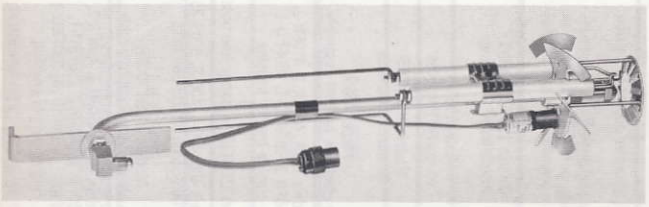
(c) The maximum input for determining the main-flame establishing period and for determining if a proved igniter is required for a burner equipped to start on low fire only is to be the input to the largest fire that can be initially ignited, provided the input to that fire cannot be increased until ignition of the low fire is established and proved.

(d) The flame-failure reaction timing is to be based on the burner's maximum input. The flame-failure reaction time is the interval between the occurrence of flame extinguishment and the time the safety shutoff is de-energized. For burners having an hourly input of 400,000 Btu or less, the timing may be the interval measured from the time the sensing device first detects loss of flame to the time the safety shutoff device is de-energized.

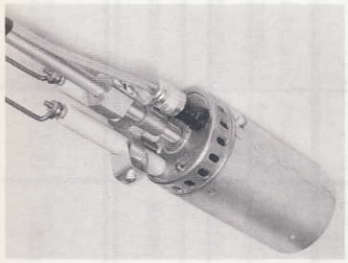
(e) A flame-failure reaction time of more than 3 seconds, but not more than 30 seconds, is permitted if intermittent ignition* is employed, or if the ignition system is re-energized in not more than 0.8 seconds after flame extinguishment occurs.

(f) A flame-failure reaction time of more than 3 seconds, but not more than 15 seconds, is permitted if intermittent ignition* is employed, or if the ignition system is re-energized in not more than 0.8 seconds after flame extinguishment occurs.

***Intermittent ignition as used here denotes spark throughout period of burner operation.**



A typical cadmium cell flame detector mounting inside the air tube. This view of the Model 400N combustion head and electrode assembly shows the cell located behind the air diffuser and attached to the electrode bracket assembly. Similar mounting is used on Models 700FR and 1200FR.



On "Shell Head" models from 150SF-2 through 2000S-5, and Model 2000, the cadmium cell flame detector is located behind the primary air tube and attached to a hex boss on the nozzle line. On Models 400 and 400-4, the detector is mounted on the electrode bracket assembly.

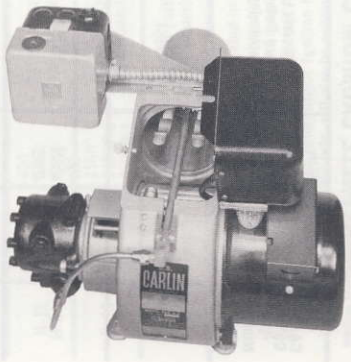


Photo shows cadmium cell flame detector as mounted inside burner housing on Model 150N. Cell is located for constant viewing of the flame but does not interfere with removal of combustion head assembly. This method of mounting is also used on Models:

450FR-1 150FRD-1
450FR-2 450FRD-1
950FR-1 450FRD-1A
950FR-2 950FRD-1

HONEYWELL CADMIUM CELL CONTROL SETS FOR USE WITH CARLIN OIL BURNERS

CARLIN Control Set Number	For Use With CARLIN BURNER MODELS		HONEYWELL Primary Relay * ("Protectorelay")	Type of Ignition**	Primary Relay Timing Cycle	Primary Relay Mounting	HONEYWELL Cadmium Cell Flame Detector	Flame Detector Mounting
	Required	Optional (At extra cost)						
H-1		150N 150SF-2 450FR-1	R8184	Constant	70-second	Bracket-mounted, with junction box, to burner housing	C554A	Models 150N, 450FR-1 inside burner housing Model 150SF-2 on nozzle line boss
H-2		400 400N 400S	R8184	Constant	70-second	Same as H-1	C554A	Models 400, 400S on nozzle line boss Model 400N on electrode bracket assembly
H-5	150FRD-1 450FR-2 450FRD-1 950FR-1	150N 150SF-2 450FR-1	R8184	Constant	30-second	Same as H-1	C554A	Models 150N, 450FR-1, 450FR-2, 950FR-1, 150FRD-1, 450FRD-1 inside burner housing Model 150SF-2 on nozzle line boss
H-6	400-4 500S-35 700S-35 700FR	400 400N 400S	R8184	Constant	30-second	Same as H-1	C554A	Models 400, 400-4, 400-S, 500S-35, 700S-35 on nozzle line boss Models 400N, 700FR on electrode bracket assembly
H-7	450FRD-1A 950FR-2 950FRD-1	150N 150SF-2 450FR-1 450FR-2 150FRD-1 450FRD-1	R8184	Constant	15-second	Same as H-1	C554A	Models 150N, 450FR-1, 450FR-2, 950FR-1, 950FR-2, 150FRD-1, 450FRD-1, 450FRD-1A, 950FRD-1 inside burner housing Model 150SF-2
H-8	800S-4 2000S-5 1200FR-1 1200FR-2 2000	400 400-4 400N 400S 500S-35 700S-35 700FR	R8184	Constant	15-second	Same as H-1	C554A	Models 400, 400-4, 400-S, 500S-35, 700S-35, 800S-4, 2000 and 2000S-5 on nozzle line boss Models 400N, 700FR, 1200FR-1, 1200FR-2 on electrode bracket assembly
H-9		150N 150SF-2 450FR-1	R8184	Constant	70-second	Not burner-mounted	C554A	Same as H-1
H-10		400 400N 400S	R8184	Constant	70-second	Not burner-mounted	C554A	Same as H-2
H-11		150N 150SF-2 450FR-1	R8182A (with Triple Aquastat)	Constant	70-second	Not burner-mounted	C554A	Same as H-1
H-12		400 400N 400S	R8182A (with Triple Aquastat)	Constant	70-second	Not burner-mounted	C554A	Same as H-2
H-13		150N 150SF-2 450FR-1	R8182B (with Single Aquastat)	Constant	70-second	Not burner-mounted	C554A	Same as H-1
H-14		400 400N 400S	R8182B (with Single Aquastat)	Constant	70-second	Not burner-mounted	C554A	Same as H-2

*At press time, design changes are anticipated in the Honeywell R8185D Intermittent Ignition Control. When the re-design is accomplished the control will be re-submitted to Underwriters' Laboratories, Inc. for listing with Carlin burners. It is expected that the control will be offered and listed in timing cycles of 70, 30 and 15 seconds. As soon as the new version of the R8185D becomes available, all Carlin cadmium cell control sets will automatically include intermittent ignition controls in place of the constant ignition type, as listed.

The White-Rodgers 669 Intermittent Ignition Control, as shown in Sets WR-1 and WR-2, is available. The 668 Constant Ignition Control, as listed in the balance of the WR sets, will also be automatically changed to the 669 control following complete submittals and listings.

**See footnotes, page 77.

CARLIN Cadmium Cell Control SETS

WHITE-RODGERS CADMIUM CELL CONTROL SETS FOR USE WITH CARLIN OIL BURNERS

CARLIN Control Set Number	For Use With CARLIN BURNER MODELS		WHITE-RODGERS Primary Relay ("Kwik-Sensor")*	Type of Ignition**	Primary Relay Timing Cycle	Primary Relay Mounting	WHITE-RODGERS Cadmium Cell Flame Detector	Flame Detector Mounting
	Required	Optional (At extra cost)						
WR-1		150N 150SF-2 450FR-1	669	Intermittent	45-second	Bracket-mounted, with junction box, to burner housing	956	Models 150N, 450FR-1 inside burner housing Model 150SF-2 on nozzle line boss
WR-2		400 400N 400S	669	Intermittent	45-second	Same as WR-1	956	Models 400, 400S on nozzle line boss Model 400N on electrode bracket assembly
WR-3		150N 150SF-2 450FR-1	6L68 (Line Voltage)	Constant	45-second	Same as WR-1	956	Same as WR-1
WR-4		400 400N 400S	6L68 (Line Voltage)	Constant	45-second	Same as WR-1	956	Same as WR-2
WR-5	150FRD-1 450FR-2 450FRD-1 950FR-1	150N 150SF-2 450FR-1	668	Constant	30-second	Same as WR-1	956	Models 150N, 450FR-1, 450FR-2, 950FR-1, 150FRD-1, 450FRD-1 inside burner housing Model 150SF-2 on nozzle line boss
WR-6	400-4 500S-35 700S-35 700FR	400 400N 400S	668	Constant	30-second	Same as WR-1	956	Models 400, 400-4, 400S, 500S-35, 700S-35 on nozzle line boss Models 400N, 700FR on electrode bracket assembly
WR-7	450FRD-1A 950FR-2 950FRD-1	150N 150SF-2 450FR-1 450FR-2 150FRD-1 450FRD-1 950FR-1	668	Constant	15-second	Same as WR-1	956	Models 150N, 450FR-1, 450FR-2, 950FR-1, 950FR-2, 150FRD-1, 450FRD-1, 450FRD-1A, 950FRD-1 inside burner housing Model 150SF-2 on nozzle line boss
WR-8	800S-4 2000S-5 1200FR-1 1200FR-2 2000	400 400N 400S 400-4 500S-35 700S-35 700FR	668	Constant	15-second	Same as WR-1	956	Models 400, 400-4, 400-S, 500S-35, 700S-35, 800S-4, 2000 and 2000S-5 on nozzle line boss Models 400N, 700FR, 1200FR-1, 1200FR-2 on electrode bracket assembly
WR-9		150N 150SF-2 450FR-1	669	Intermittent	45-second	Not burner-mounted	956	Same as WR-1
WR-10		400 400N 400S	669	Intermittent	45-second	Not burner-mounted	956	Same as WR-2

*At press time, design changes are anticipated in the Honeywell R8185D Intermittent Ignition Control. When the re-design is accomplished the control will be re-submitted to Underwriters' Laboratories, Inc. for listing with Carlin burners. It is expected that the control will be offered and listed in timing cycles of 70, 30 and 15 seconds. As soon as the new version of the R8185D becomes available, all Carlin cadmium cell control sets will automatically include intermittent ignition controls in place of the constant ignition type, as listed.

The White-Rodgers 669 Intermittent Ignition Control, as shown in Sets WR-1 and WR-2, is available. The 668 Constant Ignition Control, as listed in the balance of the WR sets, will also be automatically changed to the 669 control following complete submittals and listings.

** **IGNITION**—Intermittent ignition (spark only on burner start-up) is employed on Carlin oil burners firing at a rate of 3.00 GPH or less. On all other gallonages, constant ignition (spark during the entire running cycle of burner) is used in compliance with Underwriters Laboratories regulations for listing of burners requiring cadmium cell controls, namely burners firing over 3.00 GPH. When The Carlin Company submitted burners with cadmium cell controls for listing, intermittent ignition-type controls for burners firing over 3.00 GPH were not recognized by UL. Burners may now, however, be submitted with this type of control for listing.

FACTORY WIRING—Carlin Honeywell Control Set Numbers H-1 through H-8 and White-Rodgers Control Set Numbers WR-1 through WR-8 have motor, transformer, oil valve (if used), primary relay, and flame detector factory-wired to junction box. Other control sets listed are not factory-wired.

CARLIN Cadmium Cell Control SETS

WIRING DIAGRAMS

(Dotted lines indicate field installation)

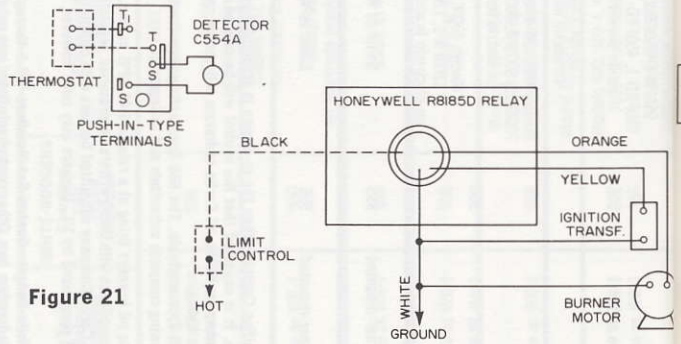


Figure 21

Wiring Diagram for Honeywell R8185D Primary Relay and C554 Cadmium Cell Flame Detector

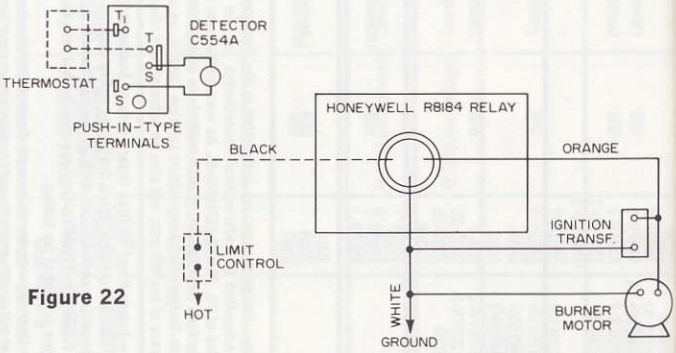


Figure 22

Wiring Diagram for Honeywell R8184 Primary Relay and C554 Cadmium Cell Flame Detector

WIRING DIAGRAMS

(Dotted lines indicate field installation)

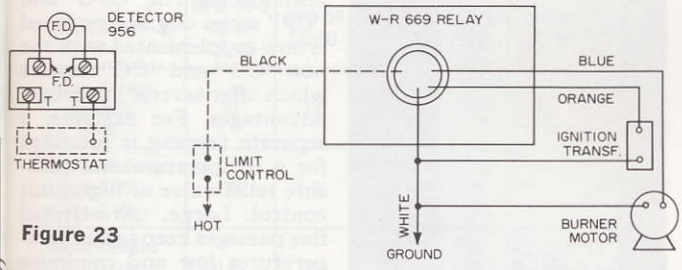


Figure 23

Wiring Diagram for White-Rodgers 669 Primary Relay and 956 Cadmium Cell Flame Detector

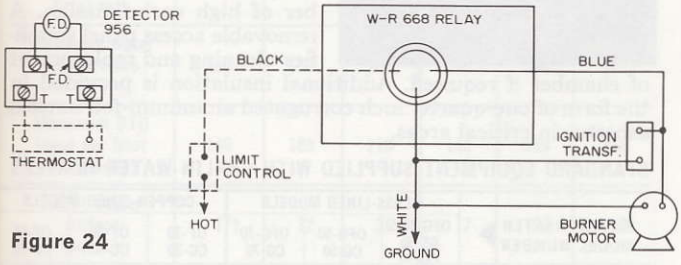
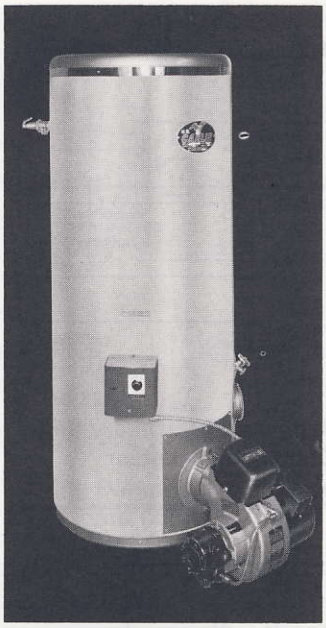


Figure 24

Wiring Diagram for White-Rodgers 668 Primary Relay and 956 Cadmium Cell Flame Detector

Honeywell "Protectorelay" R8185D (70-second timing cycle) replaced model R8185B. The R8185D control permits the use of a jumper between terminals T1 and T on systems where the thermostat is **not** wired directly to the "Protectorelay."



Carlin offers two standard lines of storage-type water heaters, each line featuring glass-lined models and copper-lined models. The "OFG" and "OF" series originally offered is now supplemented with the new "CG" and "CC" heaters which offer several important advantages. For example, a separate tapping is provided for a temperature and pressure relief valve or high limit control. Large, unrestricted flue passages keep jacket temperatures low and minimize combustion problems resulting from inadequate draft conditions. 30-gallon models have a formed fiber combustion chamber and 50- and 70 gallon models have a high-temperature refractory chamber of high corbel design. A removable access panel simplifies cleaning and replacement of chamber if required. Additional insulation is provided in the form of one-quarter inch corrugated aluminum-foil backed asbestos in critical areas.

STANDARD EQUIPMENT SUPPLIED WITH CARLIN WATER HEATERS

WATER HEATER MODEL NUMBER ▶	GLASS-LINED MODELS			COPPER-LINED MODELS		
	OFG-30-S GS-30 CG-30	OFG-50 CG-50	OFG-70 CG-70	OF-30 CC-30	OF-50 CC-50	OF-65 CC-70
Burner model	150N-2R*	150N-3R*	150N-3R†	150N-2R*	150N-3R*	150N-3R†
Air tube length (nom.)	7"**	7"	9"	7"	7"	9"
Nozzle size†‡	0.85-80°HC	1.20-80°HC	1.35-80°HC	0.85-80°HC	1.20-80°HC	1.35-80°H
Flange assembly (see page 96)	No. 20§	No. 20	No. 21	No. 20	No. 20	No. 21

*Also available at additional cost with "Shell Head" Model 150SF-2. Flange assemblies as above.

†Also available at additional cost with "Shell Head" Model 400S-2 with 10" air tube (nominal length) and flange assembly No. 31. See page 96.

** 11" air tube (nominal length) supplied on Model GS-30 (Com-pac).

††Unless otherwise specified, nozzle sizes furnished are in accordance with recommended firing rate.

§Flange assembly No. 30 supplied on Model GS-30 (Com-Pac).

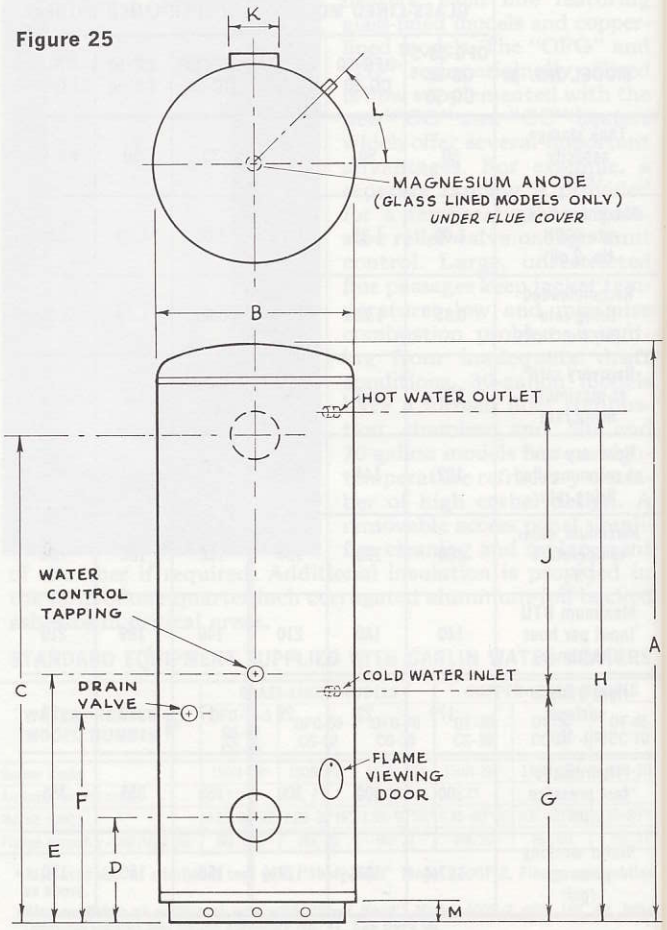
CAPACITIES

MODEL NO. ▶	GLASS-LINED MODELS			COPPER-LINED MODELS		
	OFG-30-S GS-30 CG-30	OFG-50 CG-50	OFG-70 CG-70	OF-30 CC-30	OF-50 CC-50	OF-65 CC-70
Tank storage capacity (gals.)	30	50	70	30	50	65, 70
Maximum firing rate (GPH, No. 2 oil)	1.00	1.35	1.50	1.00	1.35	1.50
Recommended firing rate (GPH, No. 2 oil)	0.85	1.20	1.35	0.85	1.20	1.35
Recovery rate* at maximum firing rate	120	162	180	120	162	180
Recovery rate* at recommended firing rate	102	144	162	102	144	162
Maximum water temperature (°F)	160	160	160	180	180	180
Maximum BTU input per hour (thousands)	140	189	210	140	189	210
Heat transfer surface (sq. ft.)	17†	22	28	17	22	28
Hydrostatic test pressure (psi)	300	300	300	355	355	355
Water working pressure (psi)	127½	127½	127½	150	150	150

*Recovery rates in gallons per hour are based on a 100°F temperature rise. A constant draw of water at a rate greater than the recovery rate will result in inadequate hot water if the total volume of water drawn exceeds 70 percent of the storage capacity of the tank.

†15 sq. ft. on Model GS-30 (Com-Pac).

Figure 25



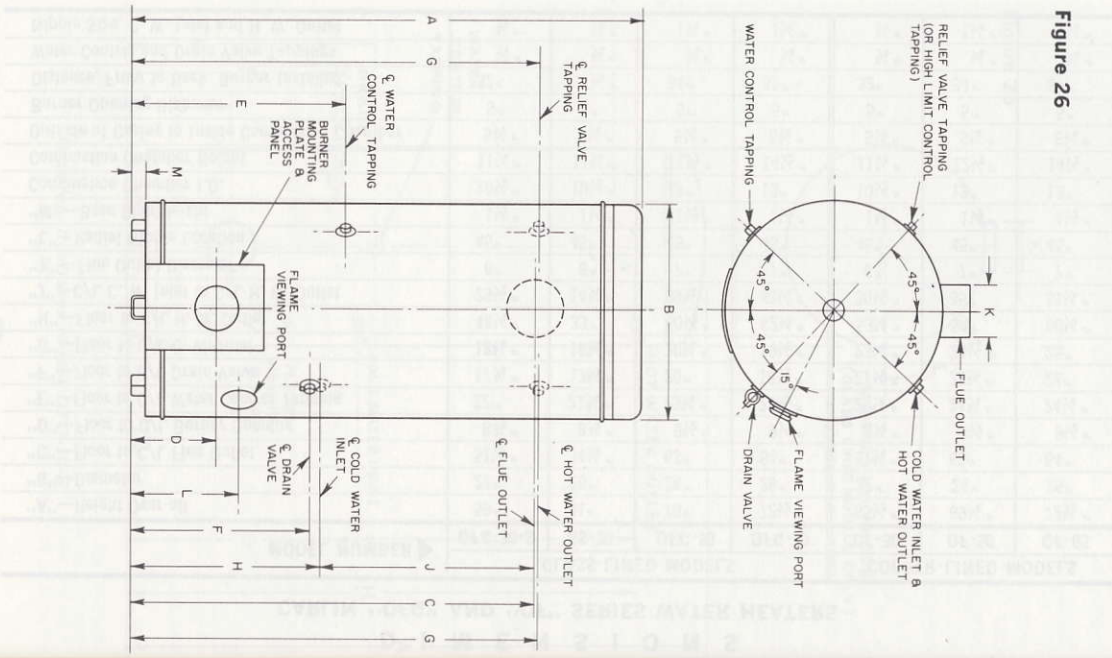
Drawing illustrates Model OFG-30-S

DIMENSIONS

CARLIN "OFG" AND "OF" SERIES WATER HEATERS

MODEL NUMBER ▶	GLASS-LINED MODELS				COPPER-LINED MODELS		
	OFG-30-S	GS-30	OFG-50	OFG-70	OF-30	OF-50	OF-65
"A"—Height Over-all	59″	41″	70″	72½″	65½″	69¾″	72½″
"B"—Diameter	22″	26″	24″	26″	22″	24″	26″
"C"—Floor to C/L Flue Outlet	51½″	34¾″	63″	64″	57¾″	63″	64″
"D"—Floor to C/L Burner Opening	8⅜″	8¾″	9½″	9½″	8¾″	9½″	9½″
"E"—Floor to C/L Water Control Tapping	22″	21¾″	23¾″	22½″	23¾″	24¾″	24¼″
"F"—Floor to C/L Drain Valve	17⅛″	17¾″	20″	18½″	27⅜″	28¼″	28″
"G"—Floor to C/L C. W. Inlet	18¾″	18⅝″	20¾″	19½″	23⅝″	24½″	25″
"H"—Floor to C/L H. W. Outlet	48¼″	33″	60½″	62¾″	53¾″	54″	60¼″
"J"—C/L C. W. Inlet to C/L H. W. Outlet	29½″	14⅜″	39¾″	43¼″	30⅛″	35″	35¼″
"K"—Flue Outlet Diameter	6″	6″	7″	7″	6″	7″	7″
"L"—Radial Nipple Location	45°	45°	45°	45°	45°	45°	45°
"M"—Base Ring Height	1½″	1½″	1½″	1½″	1½″	1½″	1½″
Combustion Chamber I.D.	10½″	10½″	13″	13″	10½″	13″	13″
Combustion Chamber Height	11¾″	11¾″	12½″	14½″	11¾″	12½″	14½″
Outside of Casing to Inside Combustion Chamber	5¾″	7¾″	5¾″	6¾″	5¾″	5¾″	6¾″
Burner Opening Diameter	5″	5″	5″	5″	5″	5″	5″
Distance, Front to Back, Burner Installed	32″	37⅝″	34″	37″	32″	34″	37″
Water Control and Drain Valve Tappings	¾″	¾″	¾″	¾″	¾″	¾″	¾″
Nipple Size, C. W. Inlet and H. W. Outlet	¾″	¾″	1¼″	1¼″	¾″	1¼″	1¼″

Figure 26



DIMENSIONS

CARLIN "CG" AND "CC" SERIES WATER HEATERS

MODEL NUMBER ▶	GLASS-LINED MODELS			COPPER-LINED MODELS		
	CG-30	CG-50	CG-70	CC-30	CC-50	CC-70
"A"—Height Over-all	56⅝"	69"	73"	66 5/16"	69"	73"
"B"—Diameter	22"	24"	26"	20"	24"	26"
"C"—Floor to C/L Flue Outlet	48⅛"	60 3/16"	64¾"	57 1/16"	60 3/16"	64¾"
"D"—Floor to C/L Burner Opening	7¾"	8¾"	8¾"	7¾"	8¾"	8¾"
"E"—Floor to C/L Water Control Tapping	22"	24¼"	24¼"	22"	24¼"	24¼"
"F"—Floor to C/L Drain Valve	18"	20¼"	20¼"	18⅜"	20¼"	20¼"
"G"—Floor to C/L H. W. Outlet and Relief Valve Tapping	48⅛"	60 3/16"	64¾"	58 3/16"	60 3/16"	64¾"
"H"—Floor to C/L C. W. Inlet	18¾"	21"	21"	19¼"	21"	21"
"J"—C/L C. W. Inlet to C/L H. W. Outlet	29⅜"	39 3/16"	43¾"	38 15/16"	39 3/16"	43¾"
"K"—Flue Outlet Diameter	6"	7"	7"	6"	7"	7"
"L"—Floor to C/L Flame Viewing Port	12½"	12½"	12½"	12½"	12½"	12½"
"M"—Leg Height	1½"	1½"	1½"	1½"	1½"	1½"
Combustion Chamber I.D.	10½"	13"	13"	10½"	13"	13"
Combustion Chamber Height	12½"	15"	15"	12½"	15"	15"
Outside of Casing to Inside Combustion Chamber	5¾"	5½"	6½"	4¾"	5½"	6½"
Burner Opening Diameter	4½"	4½"	4½"	4½"	4½"	4½"
Distance, Front to Back, Burner Installed	32"	34"	37"	31"	34"	37"
Valve and Control Tappings (IPS)	¾"	¾"	¾"	¾"	¾"	¾"
Nipple Size (IPS) C. W. Inlet and H. W. Outlet	¾"	1¼"	1¼"	¾"	1¼"	1¼"

INSTALLATION INSTRUCTIONS

1. Remove black iron nipples located in top of water heater tank and in combination primary relay and water control tapping. These are used for shipping purposes only. Remove control, immersion well, and flange packed in the burner carton.

2. Locate unit in proximity to chimney to simplify piping. (See Figure 27). Position heater to allow for inspection of fire through observation port and for service to burner.

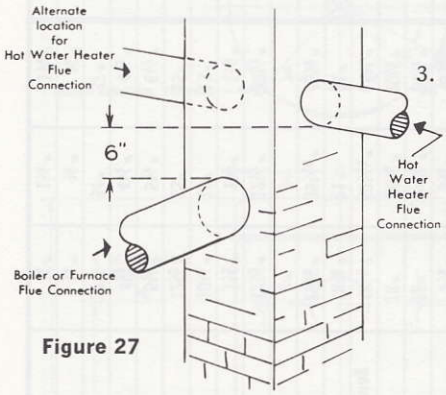


Figure 27

3. Place heater on firm, level floor. If floor is of combustible material, provide fireproofing between water heater base and floor. On "OFG" and "OF" series, do not obstruct holes in heater base ring as air must be admitted for cooling area between lower part of flue liner and casing.

4. Install water piping as required. Be sure T&P relief valve is installed.

5. Connect water heater flue outlet to chimney. As with a heating plant, an oil-fired water heater requires draft for clean, efficient operation. The design of Carlin units is such that the heated gases rise from the combustion chamber, encircle the storage tank and move upward to the outlet. Since there is nothing to interfere with the travel of the gases, the pulsation noise often encountered in heating units with built-in restrictions, baffles, etc. is eliminated as long as there is sufficient draft to carry off the products of combustion.

Three methods of venting the heater are, in order of preference, as follows:

A. Connect water heater flue outlet to separate flue in chimney. Separate flue means a chimney flue which is

used for no other equipment such as a boiler, furnace, fireplace, etc. Install a draft regulator.

B. Connect water heater flue to a chimney flue already being used for a boiler or furnace. In this case, preferred location of the opening into the chimney for the water heater flue is on a side adjacent to the boiler or furnace flue connection. The bottom of the water heater flue connection should be 6″ above the boiler or furnace flue connection. See Figure 27. This hook-up may not require a draft regulator in the water heater flue provided a draft regulator is installed in the boiler or furnace flue. It should be adjusted with both the burner for the boiler or furnace and the burner for the water heater operating simultaneously. If draft cannot be controlled in both units while operating simultaneously, a draft regulator should be installed in the water heater flue.

C. Where neither of the above methods can be utilized, it is satisfactory to "Y" the water heater flue into the boiler or furnace flue. The outlet cross-sectional area of the "Y" should approximately equal the combined cross-sectional areas of the two flues which it joins.

Examples:

If boiler or furnace flue diameter is now	and	water heater is added having flue diameter of	then	"Y" diameter should be
6″		6″		8″
6″		7″		9″
7″		6″		9″
7″		7″		10″
8″		6″		10″
8″		7″		11″

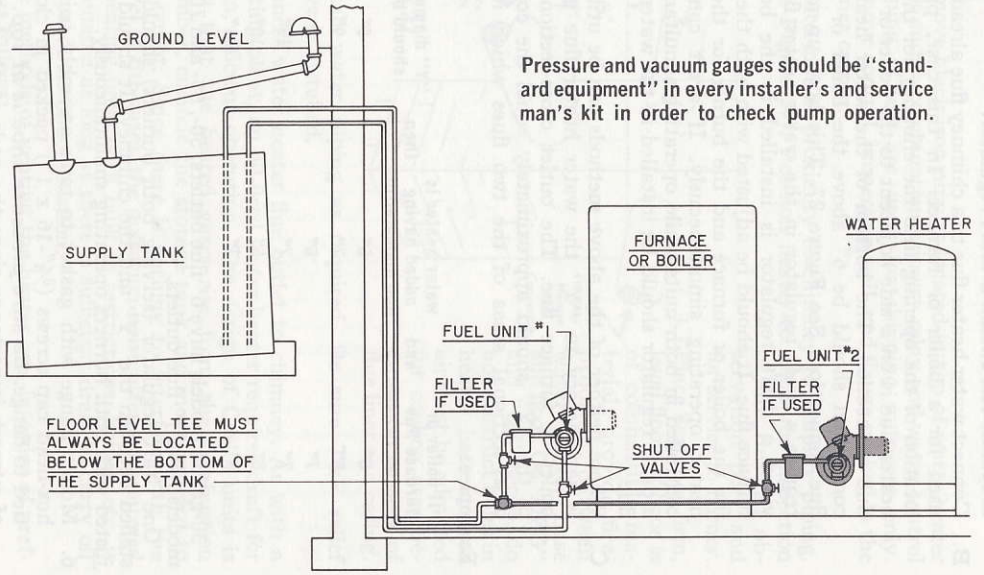
30-gallon models have 6″ flue outlets. 50-, 65- and 70-gallon models have 7″ flue outlets.

One draft regulator (serving both burners) should be installed between the "Y" and the chimney. It should be adjusted with both burners operating simultaneously.

6. Mount flange with gasket to tank assembly using two hex-head cap screws (⅜″-16 x 1″) packed in cloth bag tied to flange. *Be sure pressure shoe is at top*. This is of utmost importance since the pads at the bottom of the flange are bored at a 2° angle to insure a slight down-

(Continued on page 92)

HOW TO HOOK-UP A WATER HEATER TO AN EXISTING OIL-FIRED SYSTEM



Pressure and vacuum gauges should be "standard equipment" in every installer's and service man's kit in order to check pump operation.

Figure 28

The rapid acceptance and greatly expanded use of oil-fired water heaters have created the need for information about the proper way to hook up the water heater burner on the same line as the burner serving a boiler or furnace.

Carlin engineers, in cooperation with Sundstrand Hydraulics, manufacturers of Sundstrand fuel units, have made a thorough investigation of all possible methods of hooking to existing supply tanks and oil lines. The latter company has been most helpful in carrying out an experimental program and in developing the drawings shown below. We are indebted to Sundstrand for much of the information given here.

EXAMPLE NO. 1 (Refer to Figure 28)

OUTSIDE TANK INSTALLATION—BURNERS LOCATED BELOW TANK

The feed is actually by gravity; however, a two-pipe system may be required with the original furnace or boiler installation because of lift within the tank and distance of run. To add water heater burner, the suction line is teed below the bottom of the tank. Unless local regulations require, no return line from the water heater burner is necessary since the "floor level" tee is under head pressure due to siphon effect from tank. **Caution: Be sure By-pass Plug has NOT been inserted in water heater burner pump.** Also, see that ALL VALVES ARE OPEN when starting burners. A closed valve on the return line will cause pump to build pressure and blow seals.

(Continued on Page 91)

HOW TO HOOK-UP A WATER HEATER TO AN EXISTING OIL-FIRED SYSTEM (Continued)

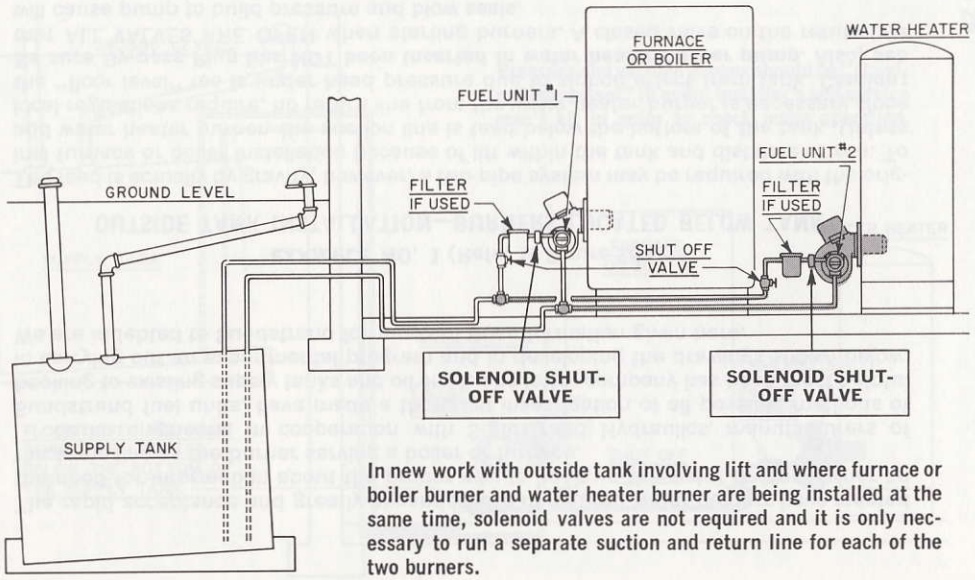


Figure 29

In new work with outside tank involving lift and where furnace or boiler burner and water heater burner are being installed at the same time, solenoid valves are not required and it is only necessary to run a separate suction and return line for each of the two burners.

EXAMPLE NO. 2 (Refer to Figure 29)

EXISTING OUTSIDE TANK INSTALLATION INVOLVING LIFT

This type of installation where a water heater is being added to an existing furnace or boiler line has produced the most inquiries since it is seldom possible to install a separate suction line for the water heater burner. By using a solenoid shut-off valve on the inlet side of each fuel unit, the suction line can be teed and the return line also teed, making them common to both burners. **Make sure the By-pass Plug IS inserted in the water heater burner pump.** Solenoid valves must be of the two-way normally closed type with orifice diameter of ¼". The valves are to be wired in parallel with burner motors. Locate as shown, that is between the line filter and pump inlet. Equip installations with shut-off valves for service work. Be sure, however, that ALL VALVES ARE OPEN when starting burners.

EXAMPLE NO. 3—INSIDE TANK INSTALLATION

On a gravity-fed inside tank installation, where ordinarily no return line is needed unless required by local regulations, it is only necessary to tee into the existing suction line. Be sure to have the tee located LOWER THAN THE BOTTOM OF THE FUEL SUPPLY TANK.

If the system requires a return line, even though gravity-fed, the return line from the newly installed water heater would be teed into the original return line.

Although an existing oil burner installation may have a return line, it is not necessary to add a return line for a water heater unless required by local regulations. Therefore, since a return line is NOT to be used for the additional equipment, **be sure that the By-pass Plug has NOT been inserted in the water heater burner pump.**

ward pitch of the burner air tube to the combustion chamber, thereby preventing any after-drip of oil from working back to housing. See page 96 for flange data.

7. Check electrode settings; also check for proper nozzle size. Factory electrode settings are as follows: Spark gap at bends of electrode wires—⅛″; electrode wire tips flush with nozzle face; bottom of electrode wires to orifice of nozzle—½″; nozzle face to outside rim of flame retention ring—⅝″.
8. Insert burner into air tube opening until it is tight against flange (or stop pins where used). Hold housing up as far as possible. Tighten two set screws against pressure shoe.

   To avoid the possibility of any products of combustion escaping through the opening around the burner air tube, especially on burner starts, it is recommended that asbestos or other sealing material be used to fill the space. Reach through observation port to pack sealer firmly.
9. Inspect front end of burner air cone with flame mirror making sure that the air cone does not extend beyond the inside wall of the combustion chamber.
10. Install oil burner controls and wiring. Hook up oil lines in accordance with standard practice. For oil supply tank location refer to pages 88–91, "How to Hook Up a Water Heater to an Existing Oil-fired System."
11. Fill heater tank with water and check for leaks.
12. Fire the burner. Adjust for draft, maintaining a minimum .02″ WG over the fire. Adjust the air shutter for a clean fire. Observe flame with mirror by viewing through observation port. Close observation port and check in chimney breeching for smoke.

    It is essential that an oil-fired water heater be operated with a clean-burning fire. Any soot accumulation on the heating surface of the glass- or copper-lined steel tank will decrease the efficiency of the unit as well as cause malfunction of the oil burner and controls. It is recommended that the fire be set to burn within a range of a trace to No. 1 smoke. Although the cleanliness of a fire may be judged to a degree through the observation port, it is recommended that the final adjustment be made with smoke testing equipment.
13. Hang up the Warranty (included in envelope attached to outside of heater carton) and return the Warranty Registration Card for your customer's protection.

CONTROLS for CARLIN STORAGE-TYPE WATER HEATERS

Standard controls furnished with each heater are either (1) the White-Rodgers Type 6L80, or (2) Honeywell R4166A constant ignition, non-recycling combination oil burner primary relay (cadmium cell type) and single water control. In localities where a dual control is required by local heating and plumbing codes either (1) the White-Rodgers Type 6L81 or (2) Honeywell R4166B is available in place of the standard controls.

On the "CG" and "CC" series, an extra tapping is provided in the top six inches of the tank for installation of the temperature and pressure relief valve or a high limit control.

All controls are furnished with a 4″ extended shank to pass through the extra-heavy insulation blanket common to Carlin heaters.

The combination constant ignition primary relay (cadmium cell type) and single water control is supplied as standard because of the many cases where it is necessary to tie the breeching pipe into a chimney flue already being used for a boiler or furnace. The constant ignition control is preferred since a continuous spark is maintained across the electrodes. This insures ignition in the event that, during the start-up or operating cycle of the second unit, the water heater burner flame may be momentarily drawn out of the combustion chamber.

Installation of Water Control

Install control in the ¾″ tapping provided. Wire control in accordance with the proper wiring diagram given on page 94. Both the White-Rodgers 956 Flame Detector (cadmium cell) and the Honeywell C554A Flame Detector are properly located and mounted to the burner housing in compliance with Underwriters' Laboratories requirements. All electrical wiring and plumbing should be done in conformance with local codes. When installing controls, the manufacturer's directions included in each carton should be followed closely.

Other Water Heater Controls

Other controls include (1) a required temperature and pressure relief valve, (2) optional pressure-reducing valve, and (3) optional vacuum relief valve.

(Continued on page 95)

Figure 30

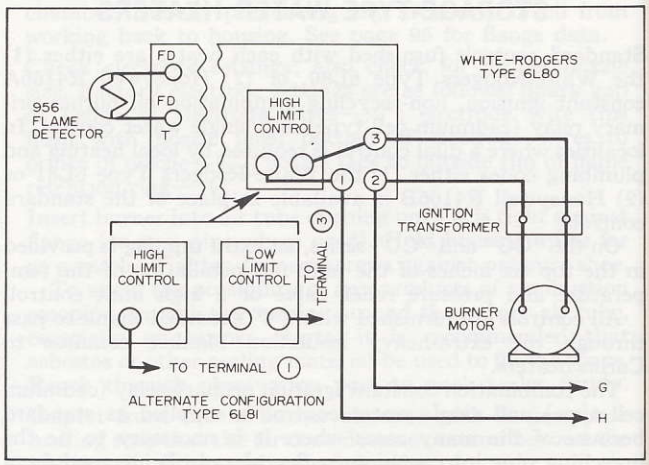
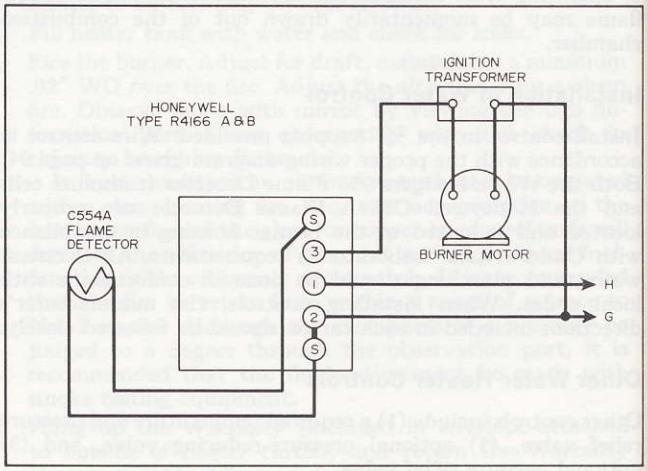


Figure 31



All direct-fired water heaters should be provided with a temperature relief valve and a pressure relief valve, or the more commonly used combination temperature and pressure relief valve. We favor the extension thermostat type for Carlin heaters in order that the tube may extend into the storage tank, which is a requirement in most localities. On the OFG and OF series the T & P valve is installed through a "T" at the hot water supply outlet. On the CG and CC series it is installed through a $\frac{3}{4}$" tapping in the upper section of the tank.

The relief valve should be piped to discharge into a laundry trap, sink, or drain. This is especially advisable when the installation is made in an area with finished flooring as is the case in many of today's homes with recreation or family rooms located in the vicinity of the water heater.

Water Pressure Reducing Valve

This valve is recommended when water pressure exceeds 100 psi.

The Watts built-in "By-pass" model controls system pressure and reduces the frequency of relief valve dropping caused by thermal expansion*. The by-pass operates on the principle of a check valve in reverse. Normally the check is held closed by the street main pressure, preventing any flow of water through it into the system. However, when thermal expansion pressure increases to slightly higher than the main pressure, the check valve opens, passing the expanding water back into the supply main at the rate it is expanded. Thus, the expanding water is dissipated as in an open system and the relief valve is not affected.

*Thermal expansion is caused by heating water in a closed system. The pressure thus created may increase to the set pressure of the relief valve causing it to drip, thus releasing the expanding water and protecting the system against excessive pressure.

Vacuum Relief Valve

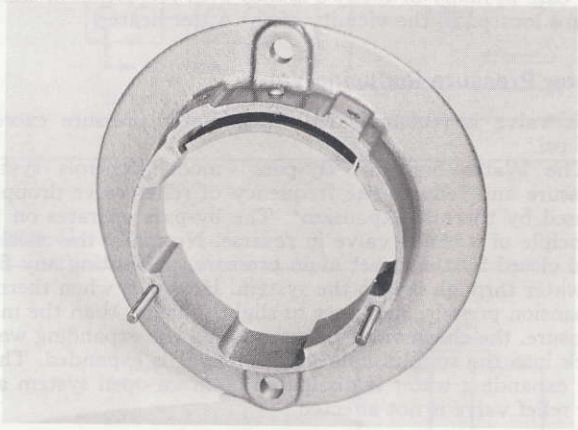
The purpose of a vacuum relief valve is to provide venting of a closed system to atmosphere when a vacuum is created. Air is thereby permitted to enter and prevent vacuum conditions which could siphon the water from the system and burn out a heater or collapse a tank. When copper-lined

models are installed it is doubly important that steps be taken to insure against a vacuum condition as the "copper lining" is subject to collapse under such a condition. Use of this valve should be at the installer's judgment and is dependent largely on the water loss history of the area.

Flow Control Valve

The high draw rates possible with some fixtures can be controlled in a satisfactory manner by installing a flow control valve at the cold water inlet to the heater.

FLANGE ASSEMBLIES for MOUNTING BURNERS to WATER HEATERS



Carlin flange mounting assemblies are curved to fit the contour of the water heater casing. Two $\frac{3}{8}$"-16 x 1" mounting bolts are supplied for attaching the flange which is always installed with pressure shoe at top. By placing the front of the burner housing tight against the flange, or the stop pins built into the flange, the burner air cone is automatically positioned in correct relation to the inside wall of the combustion chamber.

Flange assembly No. 30 with burner-positioning stop pin $1\frac{3}{8}$" long is illustrated. Flange assembly No. 20 is similar but has no stop pins. Assembly No. 21 has $\frac{3}{4}$" stop pins. Flange assembly No. 31 with $\frac{1}{2}$" stop pins is used only when burner Model 400S-2 (Shell Head) is specified.

OPERATING INFORMATION

Temperature Settings

Temperatures over 160°F are not recommended for glass-lined models. In many instances a setting below this temperature will prove adequate for domestic or general use. In restaurant installations where 180°F water is necessary, copper-lined tanks are essential. Restaurant installations should have either a dual water control or two water controls, one as operating, the other as high limit.

The Honeywell R4166A combination "Aquastat" and "Protectorelay" control used on Carlin water heaters has a dial with designations of COOL, WARM, NORMAL and HOT. These designations and the approximate corresponding temperature in degrees Fahrenheit are as follows:

COOL	WARM	NORMAL	HOT
80°	120°	140°	160°

NOTE—Bear in mind that the installation of water heaters must be in accordance with local regulations. Be sure to check with the proper authorities.

Soot Deposits

Failure to provide a satisfactory draft or burner adjustment will result in the formation of a layer of soot on the storage tank. This in turn will block the flue passage, further restricting the draft, and thereby increasing the rate of soot formation. In addition, the layer of carbon acts as an insulator on the tank, thus reducing heat transfer to the water.

Because the flue gases are restricted in entering the flue passages, and due to the lack of good heat transfer to the storage tank, the heat from these gases will be transferred instead to the lower part of the water heater casing resulting in hot spots and possible discoloration of the casing enamel.

Excessive Firing

The 30-gallon size water heater is basically designed to provide domestic hot water for single families. If the unit is used for more than one family, the possibility exists that a

series of draws due to washing dishes, or consecutive showers, may keep it running for hours at a time. This will result in excessive metal temperatures.

The same condition can result from using the unit as a heating boiler and connecting it to copper convectors. In very cold weather, the thermostat may cause the unit to operate continuously. Such applications are not recommended and also void the warranty.

Tank Must be Filled

Immediately upon installation, the water heater tank should be filled with cold water. Operation of the oil burner with an empty tank, even for a very short period of time, will completely burn out the lower portion of the heater.

Stacking

A condition known as "stacking" is often encountered with storage-type water heaters. The condition is usually brought about when short draws are made frequently.

When water is drawn, the burner will start shortly thereafter in order to heat the incoming cold water. A series of short draws will cause the burner to run in short cycles which sometimes creates a "stacking" of the water in layers of different temperatures from the bottom to the top of the tank.

An operating control setting of 140°F, for example, can create a "stacking" which produces 185°F water at the top of the tank.

To prevent this condition, it is advisable for home use to set the control as low as possible but still high enough to provide satisfactory hot water at the faucets.

On restaurant installations (copper-lined tanks), tests should be made to determine the control setting best suited to provide the 180°F water normally required at the dishwasher for rinsing.

Cleaning

When a unit requires cleaning, the following procedure should be followed:

1. Remove the heater top casing cover.
2. Remove the insulation blanket which is under the cover.
3. Remove the flue cover which is held in place by several sheet metal screws.

4. Removal of the flue cover will expose the flue passage which is an annular space about 1″ wide that encircles the tank. A standard flue-cleaning brush can be used to brush the soot downward into the combustion chamber area.
5. The combustion chamber area should then be vacuum cleaned. On "OFG" and "OF" series heaters remove oil burner and clean through the burner tube opening. On "CG" and "CC" models remove oil burner and access panel.

Recently a major oil company and a chemical company have announced a chemical now available for cleaning boilers and water heaters. The procedure calls for the feeding of the chemical through the oil burner pump and into the combustion area. It is recommended that this new product be investigated by servicemen as it could well be a solution to cleaning water heaters, particularly those that have been installed in areas with limited head room.

Magnesium Anodes

Carlin glass-lined water heaters are equipped with a magnesium anode which protects any uncoated steel surfaces (i.e., hot water control well, threaded area of spud tappings, etc.) from corrosion by setting up an electrolytic action between the copper fittings and the anode rather than with the unprotected steel areas.

In maintaining this function, the anode gradually deteriorates. Therefore periodic inspection should be made to determine if a replacement is required. To inspect anode:

(1) Remove metal trim at top of unit.
(2) Remove casing cover.
(3) Remove flue top.
(4) Loosen ¾″ plug and raise anode which is attached. If anode has deteriorated, replace with an approved "sausage link" type which can be fed into the tank even where ceiling clearance is limited. Most replacement anodes are equipped with ¾″ plug fittings. They should not exceed these lengths:

30-gallon models . . . . . 33″
50-gallon models . . . . . 43″
70-gallon models . . . . . 48″

QUANTITIES OF HOT WATER AVAILABLE FROM OIL-FIRED WATER HEATERS

TANK CAPACITY	GALLONS AVAILABLE*	
	IN PEAK HOUR	IN PEAK 2 HOURS
30	150	270
50	210	370
70	250	430

*Based on a temperature rise of 100° F and a draw rate no greater than the recovery rate. See page 81 for recovery rates.

APARTMENT HOUSE SIZING GUIDE

NUMBER OF FAMILIES	HEATER REQUIRED
2	One 30-gallon
5	One 50-gallon
10	One 70-gallon
15	Two 50-gallon
20	Two 70-gallon
25	Two 70-gallon + One 50-gallon
30	Three 70-gallon

TYPICAL RESIDENTIAL HOT WATER REQUIREMENTS ACCORDING TO SPECIFIC USAGE

Shower Bath	10-15 gallons
Tub Bath	10-15 gallons
Automatic Washer per load	15-30 gallons
Dish Washer per load	7-9 gallons
Shave	3½ gallons
Shampoo	5 gallons
Food Preparation	6 gallons
Rinsing Dishes	3-5 gallons
Daily Hand Washing	12-15 gallons

The above tables are intended as guides and are based on average conditions. Hot water usage will, however, vary considerably even in similar establishments. In apartment houses, for example, as income brackets increase so do hot water requirements. Factors such as these should be kept in mind when applying the tables.

UNDERWRITERS' LABORATORIES LABELS AND APPROVAL NUMBERS FOR CARLIN OIL BURNERS

Carlin Oil Burners are listed with Underwriters' Laboratories, Inc. There are two labels that apply to burners within certain firing ranges. The first might be described as a "standard" label which signifies that the oil burner manufacturer has met the requirements as listed by Underwriters' Laboratories, Inc. The second, known as the CS75 Oil Burner label, indicates that the burner manufacturer has met standards more rigid than the normal. The CS75 label is available to manufacturers who can meet the requirements on burners up to and including 8.00 gph.

All Carlin burners having a maximum firing rate of 8.00 GPH carry the CS75 label. All other models have the standard label.

The Commonwealth of Massachusetts requires its own listing. All Carlin burners have been assigned Massachusetts approval numbers. When the burner is recorded as shown in the first column, the Massachusetts approval number as shown in the second column will apply.

DESCRIPTION	MASS. APPROVAL NO.
Carlin	1213
U. S.	1213A
U. S. - Carlin	1213B

New York City also requires its own listing. The Carlin Company approval number is 724-49-SA.

Both the Massachusetts and New York City approval numbers are stamped on every name plate regardless of the area into which the burner is shipped.

Connecticut requires the listing of all burners with the Department of State Police. Connecticut fire marshals have a listing of all makes of burners. All Carlin models are included in this list.

FUEL UNIT PRESSURE AND VACUUM CHECKS

Fuel units should be checked for pressure and vacuum especially if there is an indication of fuel unit trouble.

Even though a fuel unit is capable of high vacuum, this has little bearing on the maximum advisable lift because of the variations in the volatility of different oils under vacuum. There are known installations where the vacuum readings are as high as 15″ to 20″. Such cases, however, are exceptional and 12″ is considered the point at which to limit the readings. Beyond this point it is advisable to consider a booster arrangement.

A reading higher than 12″ indicates excessive restriction in the suction line such as kinked copper tubing, plugged filter, closed tank valve, frozen or undersized oil line, or excessive lift. If the gauge reading is below the calculated vacuum (figured from the fuel unit manufacturer's recommendations) look for air leaks in the lines, valve, fittings, or fuel unit.

On gravity flow installations, the vacuum gauge should read zero except where restrictions are apparent such as closed shutoff valves, clogged filter, kinked line, etc. Any of these restrictions should be removed.

A pressure gauge applied to the pressure gauge port of a fuel unit reveals the pressure to which the fuel unit has been regulated. All fuel units are provided with a means of adjusting pressure with the gauge in position. This should be one of the first check points in service work, particularly if the flame appears to be irregular or unstable.

A pressure gauge applied directly to the nozzle outlet port for cut-off check should hold differential pressure on shut down. For example, with operating pressure of 100 psi, the cut-off should be approximately 85 psi. If the pressure gauge drops below the cut-off point, this would indicate a leak at the cut-off. Therefore the valve assembly should be thoroughly checked for repairs or replacement.

STANDARD FUEL UNITS FOR CARLIN OIL BURNERS

BURNER MODEL	SUNDSTRAND FUEL UNIT MODEL NUMBERS		STRAINER CAPACITY* (GPH)	MAX. NOZZLE CAPACITY* (GPH)	WEBSTER FUEL UNIT MODEL NUMBERS		STRAINER CAPACITY* (GPH)	MAX. NOZZLE CAPACITY* (GPH)
	SINGLE-STAGE	TWO-STAGE			SINGLE-STAGE	TWO-STAGE		
150F	J2CB-100	H2CB-100	4.5	3	1R162D1A5	2R162D1A5	15	3
150N-2R, 3R	J2CB-100	H2CB-100	4.5	3	1R162D1A5	2R162D1A5	15	3
150SF-2	J3CB-100	H3CB-100	4.5	6	1R111D1A3	2R111D1A3	15	10
150FRD-1	—	H2PB-100	16†	15†	—	—	—	—
400	J3CB-100	H3CB-100	4.5	6	1R111D1A3	2R111D1A3	15	10
400-4	J3CB-100	H3CB-100	4.5	6	1R111D1A3	2R111D1A3	15	10
400N-2, 3	J2CB-100	H2CB-100	4.5	3	1R111D1A3	2R111D1A3	15	10
400S-2, 3	J3CB-100	H3CB-100	4.5	6	1R111D1A3	2R111D1A3	15	10
450FR-1, 2	J3CB-100	H3CB-100	4.5	6	1R111D1A3	2R111D1A3	15	10
450FRD-1, 1A	—	H2PB-100	16†	15†	—	—	—	—
500S-35	J3CB-100	H3CB-100	4.5	6	1R111D1A3	2R111D1A3	15	10
650	J4PB-100	H4PB-100	16	10	1R111D1A3	2R111D1A3	15	10
700FR	—	H4PB-100	16	10	—	2R111D1A3	15	10
700S-35	—	H4PB-100	16	10	—	2R111D1A3	15	10
800S-4	—	H4PB-100	16	10	—	2R111D1A3	15	10
950FR-1, 2	—	H4PB-100	16	10	—	2R111D1A3	15	10
950FRD-1	—	H2PB-100	16†	15†	—	—	—	—
1200	—	H5PB-100	16	15	—	2R213D1A3	30	30
1200N	—	H5PB-100	16	15	—	2R213D1A3	30	30
1200FR-1, 2	—	H5PB-100	16	15	—	2R213D1A3	30	30
2000S-5	—	H5PB-100	16	15	—	2R213D1A3	30	30
2000	—	H6KB-100	80	20	—	2R213D1A3	30	30

*Based on 100 PSI pressure. †3450 RPM

All fuel units are flange mounted and have clockwise rotation as viewed from shaft end. Nozzle location on Sundstrand units is in left hand position as viewed from shaft end. On Webster units the nozzle may be positioned in either left or right hand position by turning the unit 180°.

FLANGE MOUNTING OF OIL BURNERS TO BOILERS OR FURNACES

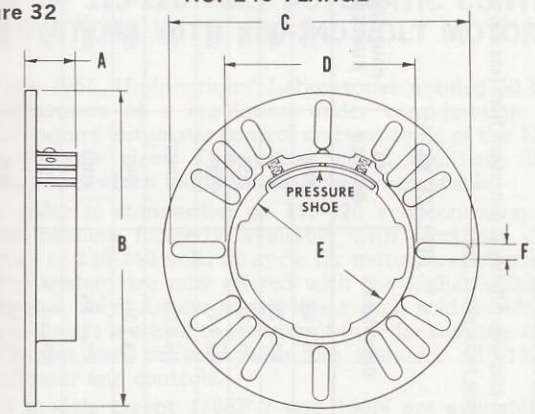
Carlin offers three standard universal flanges for flange mounting oil burners to boilers or furnaces. These flanges are illustrated and dimensioned on page 105. In addition, several non-standard flanges and mounting plate assemblies are available. Carlin engineers will gladly supply full information and assist in the design of special assemblies as may be required.

Instructions for Assembling

1. Mount gasket and flange with set screws at top. It is absolutely essential that the set screws be at the top as the inside of the flange bottom is bored at a 2° angle in order to insure a slight downward pitch of the burner air tube to the combustion chamber.
2. Measure distance from inside front wall of combustion chamber to face of hub of flange.
3. From end of air cone, mark air tube at a point equal to measurement determined in Step 2. *(For all models other than "FR Head" reduce the above measurement by 1/2-inch.)* This will insure that the air cone is ½-inch back from the inside front surface of the combustion chamber as required on models other than "FR Head." (Air cone on "FR Head" models is positioned flush with the inside front surface of the combustion chamber.)
4. With set screws loosened and air tube clearly marked, slide burner through flange until marking on tube and face of hub coincide.
5. Holding the burner up as far as possible, tighten the set screws. This will insure that the air tube pitches downward to the combustion chamber, thereby preventing any after drip of oil from working back to the fan housing.
6. Check position of burner air cone with flame mirror. It is essential for proper firing that the air cone be properly located with respect to the inside front surface of the combustion chamber as described in Step 3.

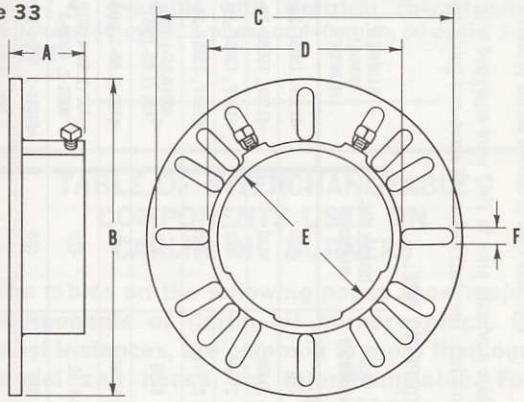
NO. 240 FLANGE

Figure 32



NO. 540 AND NO. 840 FLANGE

Figure 33



FLANGE DIMENSIONS

	A	B	C	D	E	F
No. 240	1⅜	8½	8	5⅛	4 3/16	7/16
No. 540	2	8½	8	5⅝	4⅞	7/16
No. 840	2	8½	8	6	5⅜	7/16

All dimensions in inches

FAN REPLACEMENT CHART

(For fans used in current burner production, see pages 19, 33, 45 and 52)

Burners of Carlin manufacture produced prior to 1962 were equipped with fans and couplings differing in dimensions from fans and couplings supplied on current models. The chart below will serve as a guide when ordering replacement parts.

IF FAN AND COUPLING ARE:			REPLACE WITH:		
DIMENSIONS	FAN NUMBER	COUPLING NUMBER	BURNER MODEL NUMBER	DIMENSIONS	FAN NUMBER	COUPLING NUMBER
5¼ x 3¼	219	420	◀150F, 150SF-2▶	5¾ x 3½	219S	220
5¼ x 3 7/16	219M	420	◀150F, 150SF-2▶	5¾ x 3½	219S	220
5¾ x 3¼	219RL	420	◀150F, 150SF-2▶	5¾ x 3½	219S	220
5 19/32 x 4	219TL	420	◀150F, 150SF-2▶	5¾ x 4	219T	220
4¾ x 3 7/16	419S	420	◀400 (0.65-1.00)▶ ◀400 (1.00-1.65)▶	5¼ x 3¾	419MS	520
5¼ x 3 7/16	419M	420	◀400 (1.50-2.50)▶	5¾ x 3½	219S	520
6 5/16 x 3¾	419L	420	◀400 (2.50-4.00)▶ ◀400S-2, 400S-3▶	6 5/16 x 3¾	419LS	520
6 5/16 x 4⅛	619	420	◀400S-3, 500S-35▶	6 5/16 x 4	519	520
7⅝ x 4⅛ (Hub lgth: 3¾)	819	420	◀650, 700S-35▶ ◀800S-4▶	7⅝ x 4⅛ (Hub lgth: 1¾)	819S	520*

*520-1 shaft extension must be used.

USE OF 115-120 VOLT AUTOMATIC CONTROL SYSTEMS WITH 230-240 VOLT MOTOR

In June 1965, Underwriters' Laboratories notified oil burner manufacturers of a regulation under consideration which would require automatic control systems to be of the 115-120 volt, 60-cycle class. This ruling would eliminate 230-240 volt systems which had previously been acceptable.

In order to standardize on 115-120 volt control systems, Carlin burners formerly available with electrical characteristics of 230-240 volt, 60-cycle for motor, transformer and control system are now offered with the higher voltage for the motor only. An across-the-line switch sold by electrical supply houses is added to the circuit in order that the 230-240 volt motor can be used with the standard 115-120 volt transformer and controls.

All models except 150SF-2 and 150N are available with electrical characteristics of 230-240 volt, 60-cycle, 1-phase, 1725 RPM for applications as explained above. Model 950FRD-1 is available with electrical characteristics of 208-220 volts, 60-cycle, 3-phase or 440 volts, 60-cycle, 3-phase, 3450 RPM.

TABLE OF INTERCHANGEABLE COMPONENTS USED ON CARLIN OIL BURNERS

The tables on the following pages show major components of Carlin oil burners which, in most instances, are common to more than one model and hence are interchangeable. For example, the same motor (No. 216) is used on Models 150F, 150N-2R and 3R, 150SF-2, 450FR-1 and 2. A numeral "2" under the "Electrode Assembly" section indicates that two assemblies of a particular number are required.

PART NUMBER ▼	PART DESCRIPTION ▼ MODEL ▶	150F	150F	150N-2R	150N-3R	150SF-2	150FRD-1	400	400	400	400-4	400N-2	400N-3	400S-2	400S-3	450FR-1	450FR-2	450FRD-1	450FRD-1A	500S-35	650	700FR	700S-35	800S-4	950FR-1	950FR-2	950FRD-1	1200	1200N	1200FR-1	1200FR-2	2000S-5	2000
	FIRING RANGE ▶	0.65–1.35	1.35–2.00	0.65–1.25	1.00–1.65	0.65–1.35	2.00–4.50	0.65–1.00	1.00–1.65	1.50–2.50	2.50–4.00	0.65–2.00	1.50–3.00	0.75–1.75	1.75–3.00	1.50–3.00	3.00–4.50	4.00–7.00	4.00–8.00	3.00–4.50	3.50–6.50	3.50–6.50	3.50–7.00	4.00–8.00	3.50–7.00	6.00–9.30	7.00–13.00	6.00–12.00	6.00–10.00	6.00–9.50	9.00–12.00	7.00–12.00	10.00–20.00
	Motor—1725 RPM, CCW Rotation Facing Shaft																																
216	⅛ HP, 115-120 volt, 60-cycle, 1-phase, ½″ shaft. (For junction box.)	1	1	1	1	1										1	1																
416	⅛ HP, 115-120 volt, 60-cycle, 1-phase, ½″ shaft.							1	1	1	1	1	1	1	1					1													
816	⅙ HP, 115-120 volt, 60-cycle, 1-phase, ½″ shaft.																				1	1	1	1									
9516	⅙ HP, 115-120 volt, 60-cycle, 1-phase, ½″ shaft. (For junction box.)																								1	1							
1216A	¼ HP, Capacitor Start, 115-120 volt, 60-cycle, 1-phase, ⅝″ shaft.																											1	1	1	1		
2016A	⅓ HP, Capacitor Start, 115-120 volt, 60-cycle, 1-phase, ⅝″ shaft.																															1	1
816HV	⅙ HP, 230-240 volt, 60-cycle, 1-phase, ½″ shaft.							1	1	1	1	1	1	1	1					1	1	1	1	1									
2016CS	⅓ HP, Capacitor Start, 230-240 volt, 60-cycle, 1-phase, ⅝″ shaft.																											1	1	1	1	1	1
9516HV	⅙ HP, 230-240 volt, 60-cycle, 1-phase, ½″ shaft. (For junction box.)	1	1	1	1	1										1	1								1	1							
	Motor—3450 RPM, CCW Rotation Facing Shaft																																
4516FRD	¼ HP, 115-120 volt, 60-cycle, 1-phase, ½″ shaft.						1											1	1														
9516FRD	½ HP, 115-120 volt, 60-cycle, 1-phase, ½″ shaft.																										1						
	Transformer																																
218	10,000 volt Secondary, 120 volt, 60-cycle. Hinged base.	1	1	1	1	1	1									1	1	1	1						1	1	1						
418	10,000 volt Secondary, 120 volt, 60-cycle. Clip terminals.							1	1	1	1	1	1	1	1					1		1	1	1									
418EX	10,000 volt Secondary, 120 volt, 60-cycle. Clip terminals. External junction box. For use with burner-mounted electronic controls.							1	1	1	1	1	1	1	1					1		1	1	1									
6518	10,000 volt Secondary, 120 volt, 60-cycle. Thumb nut terminals.																				1												
6518EX	10,000 volt Secondary, 120 volt, 60-cycle. Thumb nut terminals. External junction box. For use with burner-mounted electronic controls.																				1												

Continued next page ▶

CARLIN *Interchangeable Components*

PART NUMBER	PART DESCRIPTION	150F	150F	150N-2R	150N-3R	150SF-2	150FRD-1	400	400	400	400-4	400N-2	400N-3	400S-2	400S-3	450FR-1	450FR-2	450FRD-1	450FRD-1A	500S-35	650	700FR	700S-35	800S-4	950FR-1	950FR-2	950FRD-1	1200	1200N	1200FR-1	1200FR-2	2000S-5	2000
	FIRING RANGE	0.65–1.35	1.35–2.00	0.65–1.25	1.00–1.65	0.65–1.35	2.00–4.50	0.65–1.00	1.00–1.65	1.50–2.50	2.50–4.00	0.65–2.00	1.50–3.00	0.75–1.75	1.75–3.00	1.50–3.00	3.00–4.50	4.00–7.00	4.00–8.00	3.00–4.50	3.50–6.50	3.50–6.50	3.50–7.00	4.00–8.00	3.50–7.00	6.00–9.30	7.00–13.00	6.00–12.00	6.00–10.00	6.00–9.50	9.00–12.00	7.00–12.00	10.00–20.00
	Transformer (Continued)																																
1218	12,000 volt Secondary, 120 volt, 60-cycle. Stud terminals.																											1	1	1	1	1	1
418HV	10,000 volt Secondary, 240 volt, 60-cycle. Terminals as required.							1	1	1	1	1	1	1	1					1	1	1	1	1									
2018HV	12,000 volt Secondary, 240 volt, 60-cycle. Stud terminals.																											1	1	1	1	1	1
	Fuel Unit—Sundstrand																																
217S	J2CB-100. Single-stage.	1	1	1	1							1	1																				
217S-2	H2CB-100. Two-stage.	1	1	1	1							1	1																				
417S-0	J3CB-100. Single-stage.					1		1	1	1	1			1	1	1	1			1													
417S-2	H3CB-100. Two-stage.					1		1	1	1	1			1	1	1	1			1													
6517S	J4PB-100 (formerly J4EB-100). Single-stage.																				1												
817S	H4PB-100 (formerly H4EB-100). Two-stage.																				1	1	1	1	1	1							
1217S	H5PB-100 (formerly H5FB-100). Two-stage.																											1	1	1	1	1	
2017S	H6KB-100 (formerly H6GB-100). Two-stage.																																1
4517FRD	H2PB-100. Two-stage.						1											1	1								1						
	Fuel Unit—Webster																																
217W	1R162D-1A. Single-stage.	1	1	1	1							1	1																				
217W-2	2R162D-1A. Two-stage.	1	1	1	1							1	1																				
417W	1R111D-1A. Single-stage.					1		1	1	1	1			1	1	1	1			1	1												
417W-2	2R111D-1A. Two-stage.					1		1	1	1	1			1	1	1	1			1	1	1	1	1	1	1		1	1	1	1	1	
2017-W	2R213D-1A. Two-stage.																																1
	Fan																																
219T	5¾″ x 4″. ⅝″ hub, ½″ bore.	1	1	1	1	1				1		1						1	1														
419MS	5¼″ x 3¾″. ⅝″ hub, ½″ bore.						1	1	1																								
519	6$\frac{5}{16}$″ x 4″. ⅝″ hub, ½″ bore.										1		1	1	1	1	1			1													
819S	7⅝″ x 4⅛″. 1¾″ hub, ½″ bore.																				1	1	1	1									
1219T	7⅝″ x 5⅝″. 3¾″ hub with keyway. ⅝″ bore.																											1					

Continued next page ▶

PART NUMBER ▼	PART DESCRIPTION ▼ / FIRING RANGE ▶ / MODEL ▶	0.65–1.35	1.35–2.00	0.65–1.25	1.00–1.65	0.65–1.35	2.00–4.50	0.65–1.00	1.00–1.65	1.50–2.50	2.50–4.00	0.65–2.00	1.50–3.00	0.75–1.75	1.75–3.00	1.50–3.00	3.00–4.50	4.00–7.00	4.00–8.00	3.00–4.50	3.50–6.50	3.50–6.50	3.50–7.00	4.00–8.00	3.50–7.00	6.00–9.30	7.00–13.00	6.00–12.00	6.00–10.00	6.00–9.50	9.00–12.00	7.00–12.00	10.00–20.00
		150F	150F	150N-2R	150N-3R	150SF-2	150FRD-1	400	400	400	400-4	400N-2	400N-3	400S-2	400S-3	450FR-1	450FR-2	450FRD-1	450FRD-1A	500S-35	650	700FR	700S-35	800S-4	950FR-1	950FR-2	950FRD-1	1200	1200N	1200FR-1	1200FR-2	2000S-5	2000
Fan (Continued)																																
2019R	8¼″ x 5$^{11}/_{16}$″. 3¾″ hub with keyway. ⅝″ bore.																											1	1	1	1	1
9519	7⅞″ x 5″. 1¾″ hub, ½″ bore.																								1	1						
9519FRD	6$^{5}/_{16}$″ x 5″. 1¼″ hub, ½″ bore.																										1					
Shaft Extension																																
520-1	½″ OD x 1¼″ length.																				1	1	1	1								
1220-1	⅝″ OD x ½″ OD x 3¼″ length.																											1	1	1	1	1	1
9520-1	½″ OD x 2½″ length.																								1	1	1						
Coupling																																
220	½″ ID x $^{7}/_{16}$″ ID x 3$^{3}/_{16}$″ length. Neoprene with nylon flanged ends.	1	1	1	1	1	1																									
520	½″ ID x $^{7}/_{16}$″ ID x 4½″ length. Neoprene with nylon flanged ends.							1	1	1	1	1	1	1	1					1	1	1	1	1									
1220	½″ ID x $^{7}/_{16}$″ ID x 6″ length.																											1	1	1	1	1	1
4520	½″ ID x $^{7}/_{16}$″ ID x 4$^{13}/_{16}$″ length. Neoprene with nylon flanged ends.															1	1	1	1						1	1	1						
Electrode Assembly																																
223	5″ insulator, counterbored.	2	2	2	2																											
223SH	5″ insulator, counterbored.					2																										
423	6″ insulator, counterbored.							2	2	2	2	2	2																			
423SH	6″ insulator, counterbored.						2							2	2																	
623SH	6″ insulator, counterbored.																			2			2	2								
1223L	6″ insulator, counterbored.																	1	1		1	1			1	1	1	1	1	1	1	1
1223R	6″ insulator, counterbored.																	1	1		1	1			1	1	1	1	1	1	1	1
2023SH	8″ insulator.																														2	
4523	6″ insulator, counterbored.															2	2															