



AMERICAN Standard

FORCED DRAFT SCOTCH PACKAGE UNIT

FORCED DRAFT SCOTCH PACKAGE UNIT

PLAINTIFF'S EXHIBIT

ASI-156

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American Standard Kewanee Boiler Manual

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FORCED DRAFT SCOTCH PACKAGE UNIT

CHAPTER 1

GENERAL INFORMATION

A. Introduction

This manual on Kewanee Forced Draft Scotch Package units has been prepared for the purpose of assisting the operating, maintenance, service, and installation personnel in the proper performance of their duties.

The manual information is, of necessity, general in nature and subject to modification by consulting engineer specifications, factory certified construction drawings, state or local codes, utility and insurance underwriters' requirements.

If questions arise concerning your specific requirements or if additional information is needed, please get in touch with your local American-Standard Industrial Division or Kewanee sales representative, or write direct to American-Standard Industrial Division, Detroit 32, Michigan.

B. Approvals and Requirements

The Kewanee Forced Draft Scotch Package Units are listed by Underwriter's Laboratories, Inc. to burn oil not heavier than Commercial Standard CS12-48 Grade No. 6 when the model number includes the letter "H", and oil not heavier than CS12-48 Grade No. 5 when the model number does not include the letter "H", also to burn natural, mixed or manufactured gas fargas or combination gas-oil burners.

Kewanee units meeting the requirements of Associated Factory Mutual Fire Insurance Companies, Factory Insurance Association and special State, local and utility codes are available on special order.

All Kewanee Boilers are built in accordance with the American Society of Mechanical Engineers Boiler Construction Code. This code covers the specifications of the materials used and outlines the method of construction and the test procedure.

LOW PRESSURE

1. All units are hydrostatically tested to 60 pounds pressure.
2. The units are inspected and stamped by a properly authorized insurance inspector showing that the unit complies with the A.S.M.E. Low Pressure Heating Boiler Code.

HIGH PRESSURE

1. All units are subjected to a hydrostatic test of 1-1/2 times the maximum allowable working pressure.
2. The units are inspected and stamped by a properly authorized insurance inspector showing that the unit complies with the A.S.M.E. Power Boiler Code.

C. Boiler-General Information

The Kewanee Forced Draft boiler is of the Scotch marine type, two-pass, horizontal fire tube, ASME construction, mounted on "I" beam skid base. Steel jacket with mineral or glass fiber insulation and lifting loops is standard equipment. Fire tubes are rolled, not welded, and equipped with spinner blades for more efficient heat transfer. Rear access door and cast-iron front flue doors are gasket sealed for pressure firing.

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FORCED DRAFT SCOTCH PACKAGE UNIT

**C. Boiler-General Information
(Continued)**

Steam trim (safety valves, gauge, water column assembly, low water cutoff and feeder) or hot water trim (relief valves, altitude gauge and thermometer and water feeder), fuel burning equipment, and required boiler and fuel burning controls are mounted and piped ready for field connection to fuel, water, electricity and heat distribution systems.

See Figure 1-1, Page 3 and Figure 1-2, Page 4 for ratings, data, and dimensions of the high pressure and low pressure boiler units.

D. Burner-General Information

The Kewanee Forced Draft oil burner is of the horizontal rotary cup type in which oil is delivered into a high speed rotating cup. As a thin film of oil is spun from the rim of the atomizing cup it enters into a cone of high velocity primary air which directs the shape of the flame pattern and assists in preparing the oil particles for combustion.

The Kewanee Forced Draft gas burner is of the multiple-jet ring type design in which gas is mixed with the secondary air in the burner throat before entering the combustion area.

Primary air is supplied by the primary air fan which is an integral part of the oil burner. Secondary air is supplied by the secondary air fan which has adequate capacity to supply all of the air required for combustion under a positive combustion chamber pressure, thereby eliminating the need for a natural draft type stack.

Fuel-air control is by means of a modulating motor which, in response to heat demand, op-

erates the gas or oil volume control valves and the primary and secondary air dampers to maintain the proper air-fuel ratio over a wide firing range.

See Figure 1-3, Page 5 for ratings and data of fuel burning equipment.

E. Controls-General Information

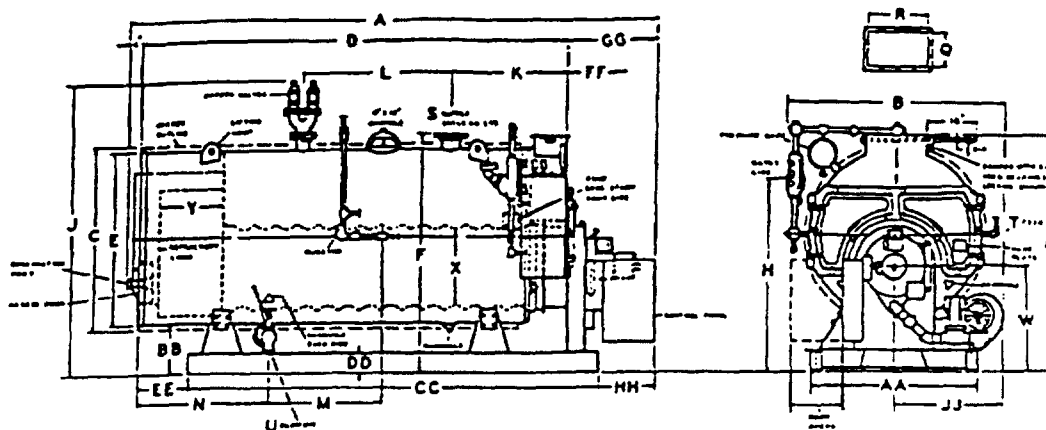
Operating and combustion safety controls are provided to turn the boiler on and off in response to steam pressure, water temperature, or water level; modulate firing rate in response to heat demand; turn the boiler off, and require manual reset, in case of an unsafe firing condition; program the burner and blower operation to provide pre-purge, proved pilot, monitored main flame, and post-purge sequences.

Control combinations to satisfy special local job requirements are available at additional charge.

Although the Kewanee unit is considered "automatic" in its operation, the operator must become familiar with the function and maintenance of the various controls, valves, instruments, etc., which affect the safety and efficiency of the unit operation. Carelessness and laxity in testing and maintaining the various controls can lead to high operating costs, boiler damage, and even danger to life and property.

Figures 1-4, Page 6 ; 1-5, Page 7 ; and 1-6, Page 8 show the major items of control equipment for the operator's information and guidance in following the instructions in this manual.

FORCED DRAFT SCOTCH PACKAGE UNIT



ratings

Unit Number *	80	81	82	83	84	85	86	87	88	89	90	91	92	93
Rating—horsepower.....	2768	3179	3911	4618	5665	6787	7916	9077	11257	13595	15758	18070	20321	22577
—MBH.....	2768	3179	3911	4618	5665	6787	7916	9077	11257	13595	15758	18070	20321	22577
—steam per hour 212°F.....	11540	13248	16300	19218	23620	28280	32980	37800	47320	56640	65640	75290	84670	9425
—steam radiation.....	sq. ft.	24.7	28.4	34.9	41.3	50.6	60.6	70.7	81.0	101.4	121.4	142.7	161.3	181.4
Firing rate—oil 140000 Btu.....	gph.	23.1	26.5	32.6	38.4	47.2	56.6	66.0	75.6	94.6	113.3	131.3	150.6	169.3
—oil 150000 Btu.....	gph.	24.61	28.73	35.29	41.72	50.81	60.84	69.95	81.24	101.96	121.93	142.58	162.02	182.21
—gas.....	MBH.....	412	473	582	686	843	1010	1178	1350	1690	2023	2345	2689	3024
Heating surface ASME.....	sq. ft.	62.5	67.7	83.4	94.7	118.5	149.9	164.1	185.1	228.2	271.5	313.5	348.7	432
Net furnace volume.....	cu. ft.	3296	3784	4556	5488	6744	8280	9424	10800	13520	16184	18760	21512	24192
Safety valve capacity lb. steam per hr.....		3296	3784	4556	5488	6744	8280	9424	10800	13520	16184	18760	21512	24192

data

Outside surface to cover (unanchored).....	sq. ft.	178	197	222	252	297	332	373	438	493	575	658	751	84
Approximate dry weight—125 lb. W.P.....		13750	14450	16550	19100	22150	26350	29950	33620	38450	45100	50300	54650	59950
—150 lb. W.P.....		14600	15050	17450	20100	23150	27850	31450	35400	40550	47300	52900	58350	63700
Vent diameter.....	in.	15	16	17	19	20	22	23	24	26	28	30	32	34

dimensions, inches

Number	80	81	82	83	84	85	86	87	88	89	90	91	92	93
A — length overall.....	176	180 1/4	194	216	230	235 1/4	242 1/4	251 1/4	264	280	289	295	295	302
B — width overall.....	78	78	81 1/4	83	86	86	89 1/4	90 1/4	94	109	112	114	125 1/4	127 1/4
C — boiler — width.....	65	65	71	71	77 1/4	77 1/4	84	84	90	102	108	112	116	120
D — length.....	139	153 1/4	158	178	183	199	223	213	227	240	241	247	254	265
E — inside diameter.....	60	60	66	66	72	78	78	84	84	96	102	106	110	114
F — steam supply height.....	84	84	90 1/4	90 1/4	97	102 1/4	102 1/4	108	114 1/4	121 1/4	127 1/4	132 1/4	136	140
G — smoke outlet height.....	85 1/4	85 1/4	91	91	97 1/4	102	102	108	113	119 1/4	125 1/4	129 1/4	133	137 1/4
H — water line height.....	67 1/4	67 1/4	71	71	75	78 1/4	78 1/4	82	89	94	100	104 1/4	107 1/4	110 1/4
I — safety valve height.....	89	90	94	108	117 1/4	122 1/4	128 1/4	132	144	150 1/4	158 1/4	162	166	179
K — steam supply.....	32	43	44	50	57	58	64	65	65	66	67	68	72	72
L — safety valve.....	51	52	53	60	69	69	78	86	78	84	84	84	84	84
M — feed water.....	30	37	37	47	53	47	59	52	60	66	66	66	67	71
N — blowoff.....	48	48	51	51	53	64	64	66	66	66	66	66	71	80
O — smoke outlet — inside width.....	12	12	13	13	14	15	15	16	16	17	18	19	20	21
P — smoke outlet — inside length.....	17	17	22	22	23	26	26	29	34	37	40	42	44	47
S — steam supply size.....	4	4	6	6	6	6	6	6	8	8	8	10	10	10
T — feed size.....	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	2	2	2 1/4	2 1/4	2 1/4
U — blow-off size.....	2	2	2	2	2	2	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4
W — furnace — height.....	37 1/4	37 1/4	39	39	41	42	43	43	44 1/4	47 1/4	49 1/4	50 1/4	52	52
X — inside diameter.....	26 1/4	26 1/4	29 1/4	29 1/4	31 1/4	34 1/4	34 1/4	38	40 1/4	44	50	50	52	52
Y — rear chamber.....	24	24	26	26	28	33	33	33	33	34	34	34	39	46
AA — base — width.....	60	60	66	66	72	78	78	84	90	96	96	96	96	102
BB — floor to boiler.....	18	18	18	18	18 1/4	17 1/4	17 1/4	17	17	18	18	18	18	18
CC — length.....	130	143	146	167	179	179	206	194 1/4	207	222 1/4	222 1/4	228 1/4	236	233 1/4
DD — height.....	8	8	8	8	8	8	8	10	10	10	12	12	12	12
EE — location.....	18	19 1/4	20	20	22	27 1/4	27 1/4	28	30	29 1/4	29 1/4	29 1/4	31	40 1/4
FF — tube replacement space.....	83	97 1/4	98	118	129	129	152	139	151	162	161	165	167	167
GG — control panel.....	33	33	32	34	33	37 1/4	35 1/4	34 1/4	35	36	35	34	35	33
HH — control panel.....	24	24	24	25	25	25	25	25	25	24	24	24	24	24
JJ — fan to CL of unit.....	37	37	37	38 1/4	38 1/4	38 1/4	44	44	46	48 1/4	48 1/4	48 1/4	50	58

*For complete unit number designations for various fuels, refer to Kewanee "Burner Data," page 5.

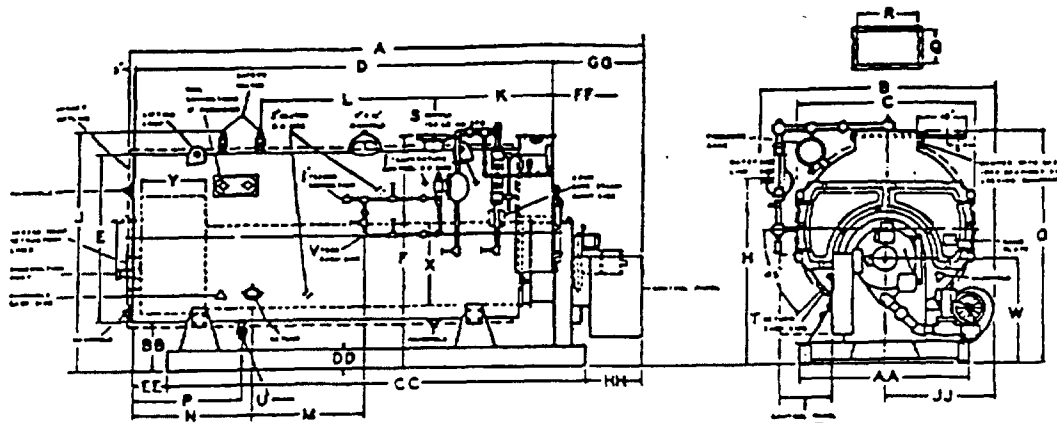
FIG. 1-1—HIGH PRESSURE BOILER DATA

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FORCED DRAFT SCOTCH PACKAGE UNIT



ratings

Unit number **	80	81	82	83	84	85	86	87	88	89	90	91	92	93
Rating—horsepower.....	83	97	118	139	173	204	242	277	346	415	484	553	622	691
—M Btu.....	2802	3259	3958	4657	5820	6982	8138	9300	11619	13937	16256	18574	20893	23211
—steam per hour 212°F.....	2850	3350	4060	4780	5980	7170	8360	9550	11930	14310	16690	19070	21450	23830
—steam radiation.....	sq. ft. 11680	13580	16490	19400	24250	29090	33910	38750	48410	58070	67730	77390	87020	96710
—water.....	sq. ft. 18680	21730	26390	31050	38800	46550	54250	62000	77460	92920	108370	123830	139240	154740
MCA net steam radiation.....	sq. ft. 9580	10000	12160	14300	17860	21440	25000	28580	35720	42860	50000	57140	64280	71420
Firing rate—oil 140000 Btu.....	gph. 25.0	29.1	35.3	41.6	52.0	62.3	72.7	83.0	103.7	124.4	145.1	165.8	186.5	207.2
—oil 150000 Btu.....	gph. 23.4	27.2	33.0	38.8	48.5	58.2	67.8	77.5	96.8	116.1	135.5	154.8	174.0	193.4
—gas.....	M Btu/h. 3503	4074	4948	5821	7274	8728	10172	11626	14524	17422	20320	23218	26107	29014
Heating surface ASME.....	sq. ft. 417	485	589	693	864	1039	1211	1384	1729	2074	2419	2764	3108	3454
Net furnace volume.....	cu. ft. 62.5	69.1	83.5	93.3	112.8	137.4	152.6	182.0	223.4	272.1	328.0	356.2	398.8	435.7
Safety valve capacity lb. steam per hr.	2802	3259	3958	4657	5820	6982	8138	9300	11619	13937	16256	18574	20893	23211

data

Outside surface to cover (unanchored).....	sq. ft. 186	208	253	263	308	357	378	410	470	529	572	610	650	696
Approximate dry weight.....	lb. 10250	11250	13750	15450	17900	20300	22750	26600	30550	35900	40700	43600	47200	50600
Vent diameter.....	in. 15	16	17	19	20	22	23	24	26	28	30	32	34	36

dimensions, inches

Unit number **	80	81	82	83	84	85	86	87	88	89	90	91	92	93
A —length overall.....	156	182 1/2	183	205 1/2	217 1/2	216 1/2	243 1/2	243 1/2	271 1/2	271 1/2	274	281	288 1/2	296
B —width overall.....	79	79	84 1/2	86	89	94	97 1/2	100 1/2	116	116	122	126	131 1/2	134
C —boiler—width.....	64	64	69	69	75	81	82	87	93	99	105	109	113	117
D —length.....	130	146 1/2	148	168 1/2	181 1/2	181 1/2	205 1/2	206	220 1/2	232 1/2	236	244	250 1/2	259
E —inside diameter.....	60	60	66	66	72	78	78	84	90	96	102	106	110	114
F —steam supply height.....	84	84	90	90	97	102	102	107 1/2	114 1/2	121 1/2	127 1/2	131	135	139
G —smoke outlet height.....	85 1/2	85 1/2	91	91	97 1/2	102	102	107 1/2	113 1/2	119 1/2	125 1/2	129	133	137
H —water line height.....	66 1/2	66 1/2	70 1/2	70 1/2	74 1/2	77 1/2	77 1/2	82	87 1/2	93	98 1/2	102	106	108
J —safety valve height.....	80	88	95 1/2	95 1/2	100 1/2	105 1/2	107	113	119	126	132	135 1/2	139 1/2	143 1/2
K —steam supply.....	37	43	44	50	57	58	64	65	63	66	67	68	72	72
L —safety valve.....	62	70	69	84	84	84	96	84	96	108	108	108	108	108
M —feed water—each side.....	26	33 1/2	31	41	43	43	49	43	49	53	53	50	46 1/2	49
N —return—each side.....	43	45	47	47 1/2	51 1/2	50 1/2	56 1/2	66	70 1/2	71 1/2	74	84	90	96
P —drain.....	39	41	41	41 1/2	41 1/2	46 1/2	46 1/2	59	59 1/2	58 1/2	61	66	72	72
Q —smoke outlet—inside width.....	12	12	13	13	14	15	15	16	16	17	18	19	20	21
R —inside length.....	17	17	22	22	23	29	29	29	34	37	40	42	44	47
S —steam or water supply size.....	8	8	8	8	8	8	8	8	10	10	10	12	12	12
T —return size (two).....	4	4	4	4	4	4	4	4	6	6	6	6	6	6
U —drain size.....	2	2	2	2	2	2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
V —feed water size.....	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	2	2 1/2	2 1/2	2 1/2
W —turnace—height.....	37 1/2	37 1/2	39	39	41	42	42	43	44 1/2	47 1/2	49 1/2	50 1/2	52	52
X —inside diameter.....	29 1/2	29 1/2	32 1/2	32 1/2	34 1/2	37 1/2	37 1/2	41	43 1/2	46 1/2	52 1/2	54 1/2	54 1/2	54 1/2
Y —test chamber.....	24	24	24	24	24	24	28	30	32	34	34	34	36	42
AA—base—width.....	60	60	66	66	72	78	78	84	90	96	96	96	96	102
BB —floor to boiler.....	18	18	18	18	18 1/2	17 1/2	17 1/2	17	17	18	18	18	18	18
CC —length.....	130	143	146	167	179	179	206	194 1/2	207	222 1/2	222 1/2	228 1/2	230 1/2	230 1/2
DD —height.....	8	8	8	8	8	8	8	8	10	10	12	12	12	12
EE —location.....	9	12 1/2	10	10 1/2	10 1/2	9 1/2	9 1/2	21	23 1/2	22	24 1/2	25 1/2	31	38 1/2
FF —tube replacement space.....	78	94	94	114	124 1/2	119	142 1/2	139	151 1/2	159	161	167	163	169 1/2
GG —control panel.....	33	33	32	34	33	32	35	34 1/2	35	36	35	34	35	34
HH —control panel.....	24	24	24	25	25	25	25	24	24	24	24	24	24	24
JJ —fan to CL of unit.....	37	37	37	38 1/2	38 1/2	38 1/2	44	44	46	48 1/2	48 1/2	48 1/2	58	58

**150 lb. American Standard Flange

**For complete unit number designations for various fuels, refer to Kewanee Burner Data, page 5.

FIG. 1-2—LOW PRESSURE BOILER DATA



AMERICAN-Standard

Kewanee Boiler Mfg. Co.

FORCED DRAFT SCOTCH PACKAGE UNIT

KEWANEE MODEL NUMBER "					Gas Controls Standard -- UL 1000 bu./cl. -- .61-g.			Motor Data H.P.		Electric Oil Heater 230-v.		Oil Pump Capacity G.P.M.	
No. 5 or Lighter Oil	No. 5 or Lighter Oil & Gas	No. 4 Oil	No. 4 Oil & Gas	Gas	Standard Safety & Operating Gas Valves	Inlet Gas Pressure In. w.c.	Control Group Size	Oil Burner	Forced Draft	Watts	Phase	KP	KS
KPE-80	KPEC-80	KSH-80	KSHC-80	KG-80	6	5	2 1/2	1.0	1.5	2500	1	45	
KPE-81	KPEC-81	KSH-81	KSHC-81	KG-81	6	5	2 1/2	1.0	1.5	2500	1	40	
KPE-82	KPEC-82	KSH-82	KSHC-82	KG-82	6	5	2 1/2	1.0	1.5	2500	1	40	
KPE-83	KPEC-83	KSH-83	KSHC-83	KG-83	6	5	2	1.5	2.0	3250	1	115	107
KPE-84	KPEC-84	KSH-84	KSHC-84	KG-84	8	6	3	1.5	2.0	3750	1	115	107
KPE-85	KPEC-85	KSH-85	KSHC-85	KG-85	8	7	3	1.5	2.0	3750	1	115	107
KPE-86	KPEC-86	KSH-86	KSHC-86	KG-86	8 1/2	7	4	3.0	3.0	5000	3	205	130
KPE-87	KPEC-87	KSH-87	KSHC-87	KG-87	9 1/2	7 1/2	4	3.0	3.0	5000	3	205	130
KPE-88	KPEC-88	KSH-88	KSHC-88	KG-88	12	9	4	3.0	5.0	5000	3	205	142
KPE-89	KPEC-89	KSH-89	KSHC-89	KG-89	20	14	4	3.0	5.0	5000	3	205	192
KPE-90	KPEC-90	KSH-90	KSHC-90	KG-90	20	18	4	3.0	7.5	5000	3	305	192
KPE-91	KPEC-91	KSH-91	KSHC-91	KG-91	23	20	4	5.0	7.5	5000	3	305	244
KVPE-92	KVPEC-92	KVSH-92	KVSHC-92	KG-92	26 1/2	22 1/2	4	7.5 ¹	7.5	5000	3	340	303
KVPE-93	KVPEC-93	KVSH-93	KVSHC-93	KG-93	31 1/2	26 1/2	4	7.5 ¹	7.5	5000	3	340	303

*Controls for other pressures or insurance requirements available.

¹V-Belt Drive

²230-v., 60Hz, 1 PH, All Other Motors 230-v., 60Hz, 3 PH, Standard

³Variances of Model Designation are used for Special Burner Assemblies.

FIG. 1-3—BURNER DATA

FORCED DRAFT SCOTCH PACKAGE UNIT

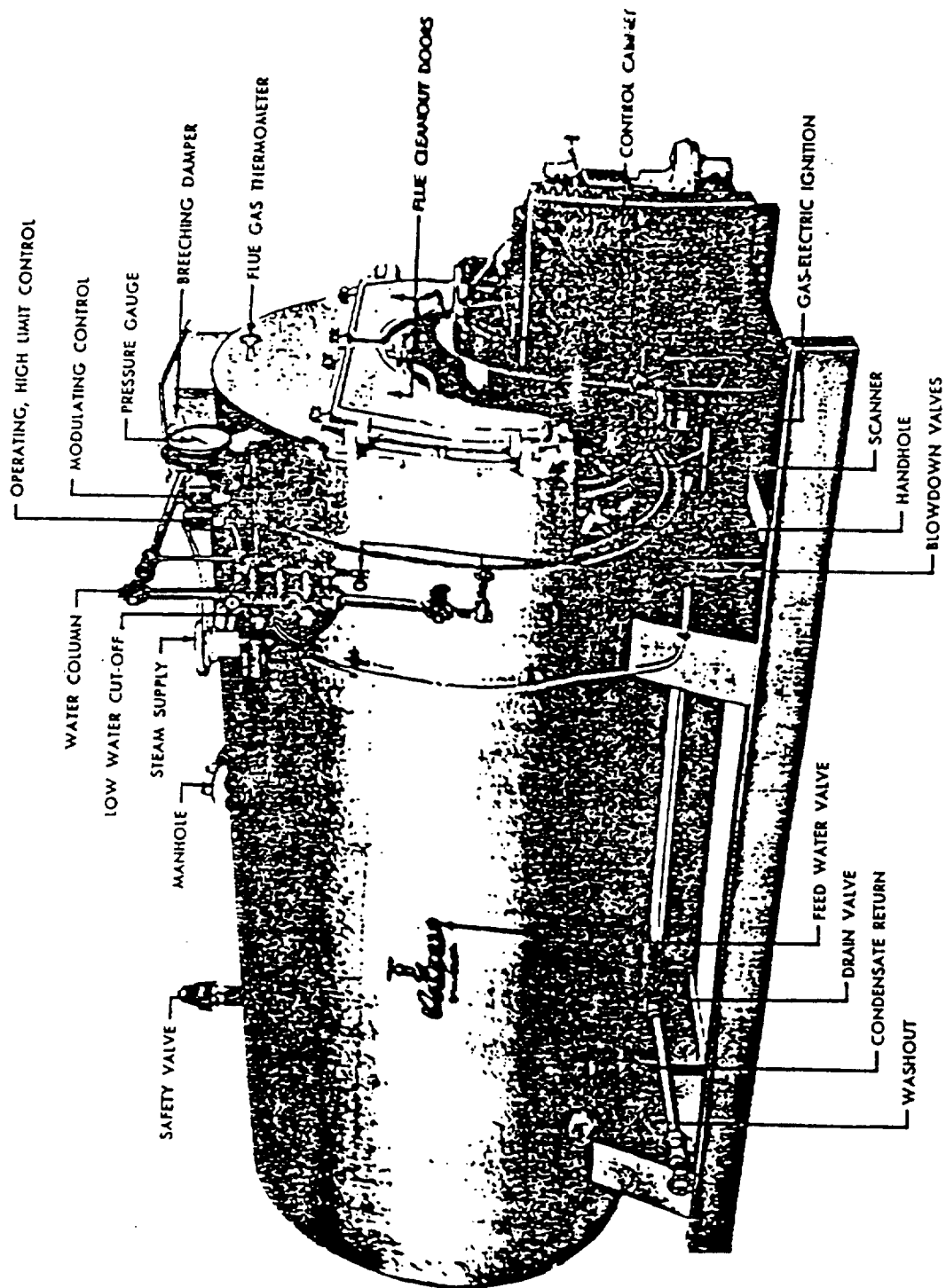


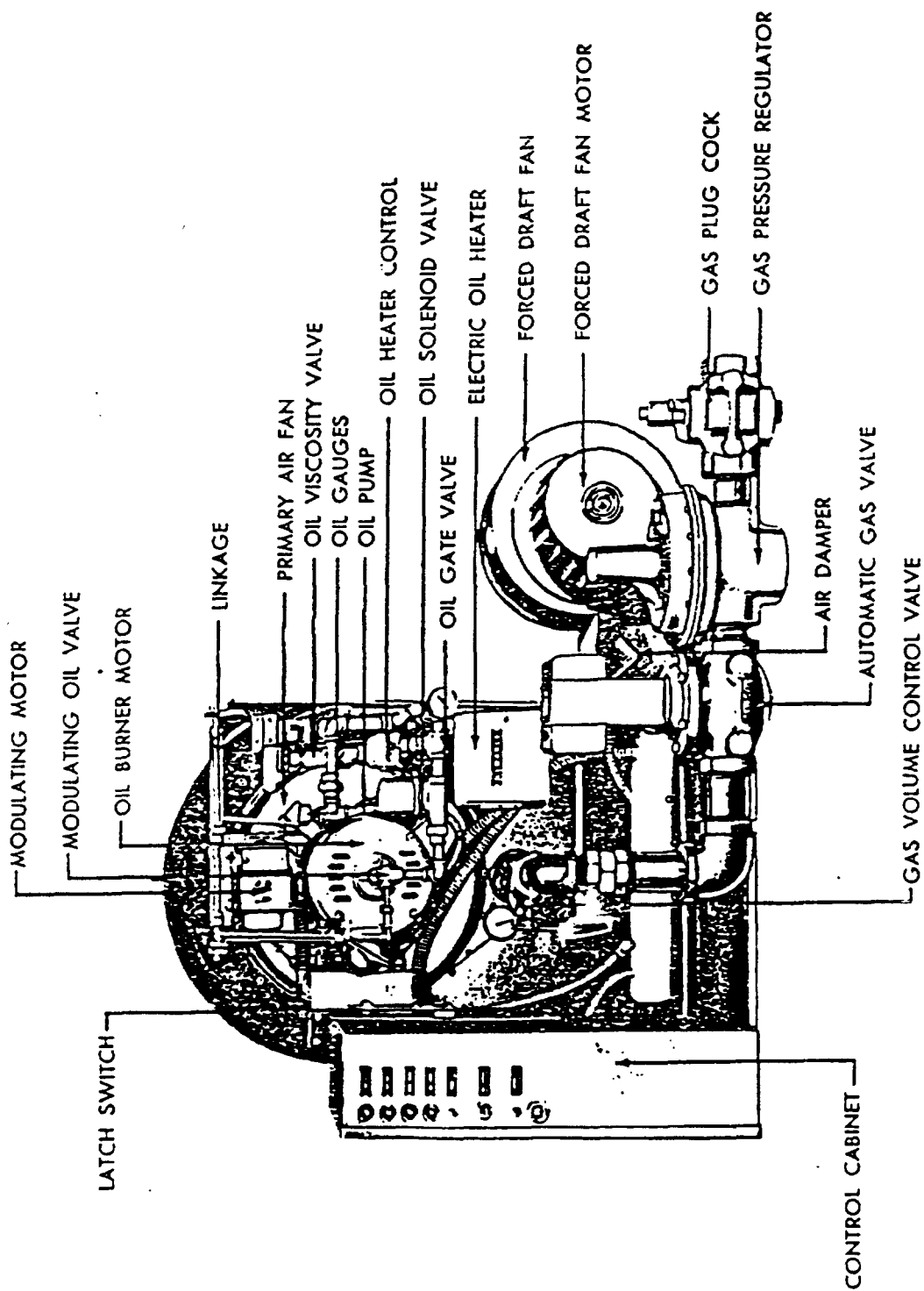
FIG. 1-4—BOILER IDENTIFICATION

AS 000081



AMERICAN Standard

FORCED DRAFT SCOTCH PACKAGE UNIT



A5 000082



FORCED DRAFT SCOTCH PACKAGE UNIT

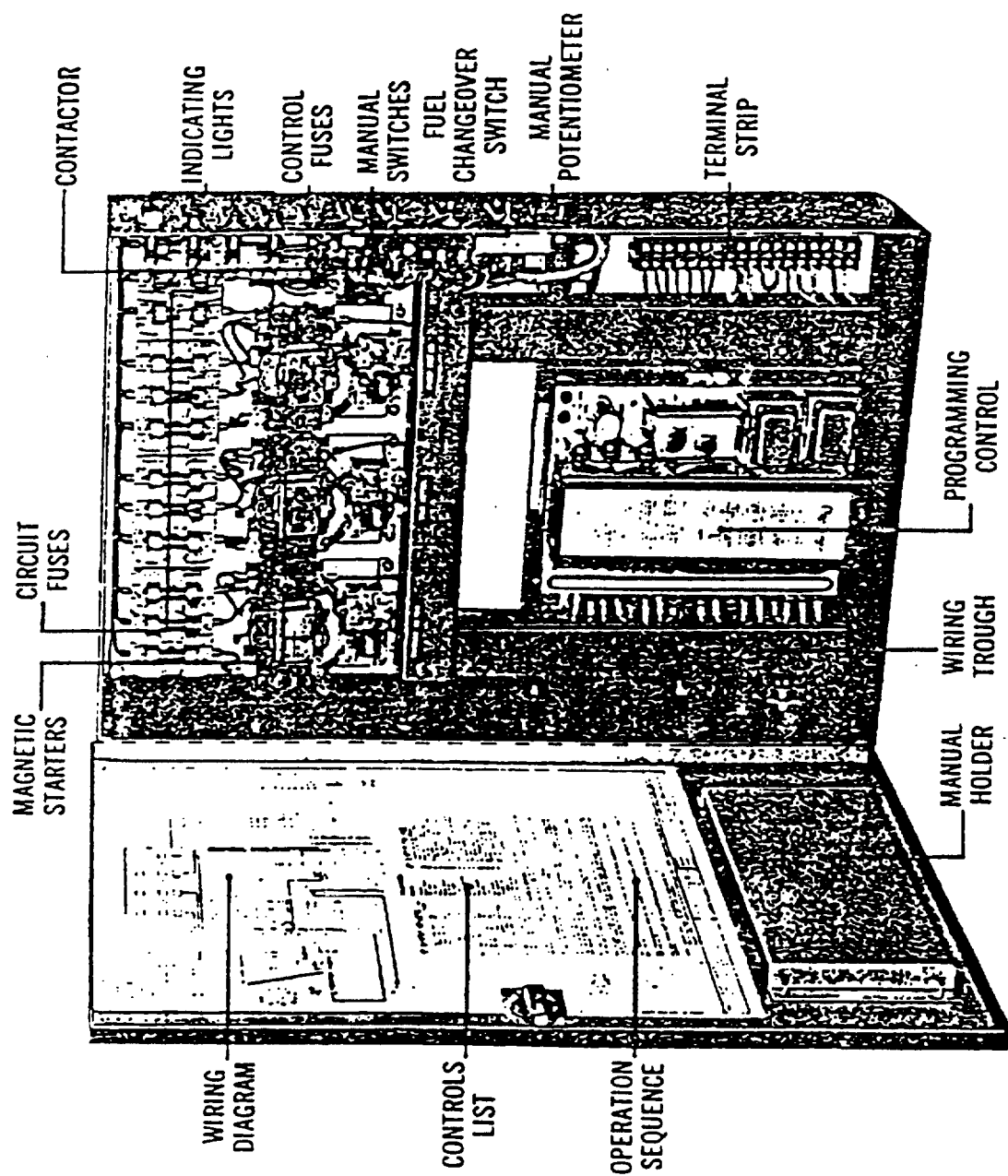


FIG. 1-6—CONTROL CABINET IDENTIFICATION



FORCED DRAFT SCOTCH PACKAGE UNIT

G. Electrical Supply

The Kewanee Forced Draft Package has been factory prewired except for three possible connections: (1) source of power, (2) remote oil pump, (3) remote emergency switch. See Figure 3-1, Page 28 for a schematic wiring diagram of the controls and motors. The wiring diagram for your particular unit is fastened inside the door of the control cabinet.

Wiring connections to the Kewanee unit shall

be installed in compliance with the rules of the National Electrical Code or any local or other codes having jurisdiction. All motors and electric heaters on the unit are protected by fuse blocks inside the control cabinet.

Wiring from the control cabinet to a remote-located oil pump or emergency switch shall not be less than No. 14 gauge wire. The normal size of wiring to the boiler control cabinet and main panel fuse size are shown below: -

TYPICAL WIRE AND FUSE SIZES

Boiler Size	Oil and Gas-Oil Models		Gas Only Models	
	Wire Size	Fuse Size-Amps	Wire Size	Fuse Size-Amps
80-82	#10	30	#12	15
83-85	#8	50	#12	15
86-87	#8	60	#10	20
88-89	#6	100	#10	40
90-91	#6	100	#10	50
92-93	#4	100	#10	50

For 230 Volt, 60 Cycle, 3 Phase Operation

H. Gas Supply

The gas piping and gas control sizes furnished as standard equipment with the Kewanee Unit, and the minimum gas pressures required at the manual gas cock are shown in Figure 1-3, Page 5. These control sizes are based on natural gas. Special control groups for LP gas or manufactured gas are available on special order. Gas control groups for higher or lower pressure than that specified in Figure 1-3 are available on special order.

Gas pressure regulators for the main burner and for the gas-electric ignition are included as part of the standard boiler equipment on jobs using natural gas. No regulator is supplied for LP gas.

A source of constant gas supply is required for the gas-electric ignition on both gas and oil firing.

Gas piping should be sized to provide the required minimum pressure at the manual gas cock when operating at maximum input. Consult your local utility on any questions regarding gas pressure, piping pressure drops allowable and local piping requirements.

Gas piping should be installed in accordance with the National Board of Fire Underwriters' Pamphlet 54 and any other local codes which may apply. All gas piping should be tested after installation with air pressure or inert gas of at least three times the gas pressure that will be used. The piping ahead of the manual

H. Gas Supply (Continued)

shut-off valve shall include a full size dirt pocket or trap.

The standard Kewanee gas control group is in accordance with the requirements of Underwriters' Laboratories. Special control groups meeting the requirements of Associated Factory Mutual Fire Insurance Companies and the Factory Insurance Association are available at added cost. Local code and utility companies may require special and additional gas controls. The gas control arrangements required by various insurance underwriters are illustrated in Figure 2-1, Page 14.

I. Oil Supply

SELECTION OF OIL:

Fuel oils normally used in the Kewanee Forced Draft Package Unit are Nos. 2, 4, 5 and 6 or Bunker C. No. 2 and No. 4 oils are normally burned without any preheating equipment. Because of wide variation in viscosity and pour point, some No. 5 oils can be burned with no heating, some with only burner electric heating, and some No. 5 oils must have complete heating similar to No. 6 oil. No. 6 is generally more attractive from a fuel cost standpoint, but cost of oil heating equipment, maintenance cost, local availability, use of oil as standby fuel to gas, and other factors must be considered before selecting the fuel to be burned on any installation.

OIL TANK LOCATION:

The rules of the National Board of Fire Underwriters (Pamphlet 31) and of State and city regulations, if any, should be followed in locating and installing oil storage tanks.

The oil burner will operate satisfactorily with the tank above or below the burner level. When the tank is above the burner level the return line pressure should not exceed 15 psi. When the tank is below the burner level the bottom of the tank should not be more than 15 feet below the level of the burner pump or of

the high point of the suction line. Tank higher or lower than those above can be used with auxiliary equipment. Consult the local Kewanee sales office in such cases.

INSTALLING OIL TANK:

Consult local authorities for specifications installing inside tanks.

Outside underground tanks should be buried with an earth cover or by a combination of earth and concrete. Before starting to excavate, it is advisable to check the location of sewer, water, and gas mains entering the building. Tanks buried in soft earth or in high moisture area may require anchoring with steel straps to a reinforced concrete mat under the tank.

Fill pipe and vent line shall be installed the tank in accordance with local and national code requirements. See Figure 2-2, Page for a typical oil storage tank installation.

OIL PIPING:

Suction piping should be tested to the bottom of the tank. A vacuum test holding 25" vacuum for a period of 12 hours is the satisfactory suction piping test.

No gate valve shall be installed in the return line without a relief by-pass.

The normal oil pipe sizes for a maximum of equivalent feet of length and 12 feet of vertical lift are: 2" suction and return on Ur 80-85; 2-1/2" suction and return on Ur 86-88; and 3" suction and return on Ur 89-93. These pipe sizes apply to No. 5 or No. 6 oil. For light oil pipe sizes and multiple installations, consult your local Kewanee sales office.

OIL PIPING SYSTEMS:

The Kewanee Forced Draft Scotch Package equipped with an integral oil pump on ur



FORCED DRAFT SCOTCH PACKAGE UNIT

1. Oil Supply (Continued)

burning No. 5 and lighter oil. Figure 2-3, Page 16 illustrates the arrangements for integral pump burners using the lighter grades of No. 5 fuel oil. High pour point No. 5 oils will also require tank oil heaters. See Figure 2-2, Page 15 and Figure 2-6, Page 19. Separate suction lines or an auxiliary pump set should be used for multiple installations.

The piping layout in Figure 2-4, Page 17 shows a circulating loop system with a separate pump set supplying oil to integral pump burners. Any number of boilers may be connected to the loop as long as the separate pump set has sufficient capacity. Note that oil burner supply lines are taken from the bottom of the loop in order to reduce the chances of air being drawn into the burner.

The Oil Flow Diagram in Figure 2-5, Page 18 illustrates the arrangement for a Kewanee unit designed to burn No. 6 Bunker C Oils. The oil to the burner is supplied by a separate pump set, furnished with the boiler unit, which may be mounted on the boiler skids or at a remote location near the oil tank. This system also includes an integral electric oil heater on the burner, a hot oil well or tank coils installed in the oil tank, and a steam or hot water oil heater mounted on the boiler.

BOILER MOUNTED OIL HEATERS:

A below-water-line oil heater (on hot water or low pressure steam units) or a steam oil heater (on high pressure steam units) is supplied as a component part of the Kewanee unit for No. 6 oil.

Standard oil heaters are of the baffled U-tube type. Safety type heaters, as required in many local areas, are available on special order.

INTEGRAL ELECTRIC OIL HEATERS:

Integral electric oil heaters are mounted on the burner to assist the auxiliary oil heating

equipment in maintaining oil temperature at the atomizing cup, and also to assist in start up after a burner shutdown. For further information regarding the electric preheater see the Service Section of this manual, Page 40. Standard wattages of heaters are shown on Figure 1-3, Page 5.

ELECTRIC LINE OIL HEATERS:

Most systems of oil heating involving electric line oil heaters, such as the "Thermal Electric" system, are designed and supervised by the manufacturer of the system. The contractor installing the boiler should check to make sure that the oil piping requirements for the Kewanee unit have been met when using this system.

TANK OIL HEATERS:

All No. 6 and heavy No. 5 fuel oil installations should contain a provision for heating the oil in the tank to a pumpable temperature. (3,000 SSU maximum pumping viscosity.)

A tank coil or suction bell heater may be used to heat the oil in the vicinity of the tank suction line. Either steam or forced hot water may be used as a heating medium for the coil. This type tank heater, combined with the integral electric heater, is normally used on high pour point oil. For No. 6 oil the boiler mounted oil heater is also required.

A hot oil well may be incorporated in the oil piping system when a boiler mounted oil heater is used. This system permits the return of hot oil to the vicinity of the suction line. Hot water or steam lines may be inserted through the well to extend full length of the tank in case of high pour point or mixed oils. See Figure 2-2, Page 15, and Figure 2-6, Page 19.

Steam or hot water lines supplying heat to the tank coil should be insulated and waterproofed with the oil suction and return lines. See Figure 2-2, Page 15.

When a high pour point oil, such as No. 6 or Bunker C is used as fuel, the oil pump should be set for constant circulation of oil between the tank and the burner.



FORCED DRAFT SCOTCH PACKAGE UNIT

J. Steam & Water Supply

The Kewanee Forced Draft Scotch Package includes water column, gauge glass, gauges, thermometers, safety valves, low water cutoff, blowdown valves, water feeder or feedwater pump switch mounted and piped. Inspect these boiler mounted accessories carefully to make sure that no damage has resulted in shipment or installation.

Feedwater openings with baffle plates are located on each side of the shell. See Figure 1-4, Page 6. Do not feed water through the drain opening at the bottom of the shell. Check city water pressure and install pressure reducing valve if necessary for proper operation of the water feeder on the low pressure boiler.

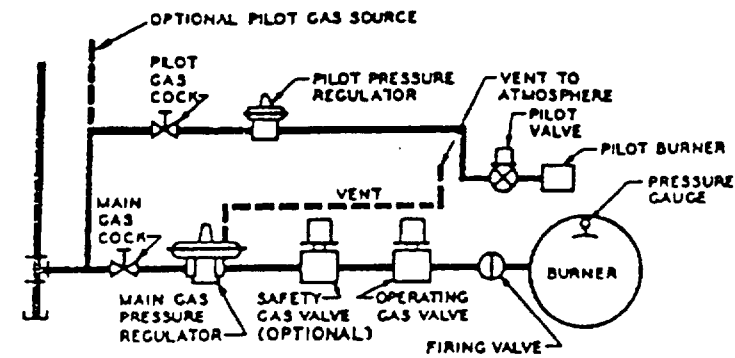
Do not permit a boiler filled with raw water to stand idle over an extended period of time.

Feedwater treatment varies considerably and depends on the pressure at which the boiler is operated, the raw water source, the per cent of make-up water required, and other factors. Feedwater treatment should be used because it prolongs the boiler life and helps produce a better quality of steam. A certified water consultant or water treating company should be contacted and their recommendations followed rigidly.

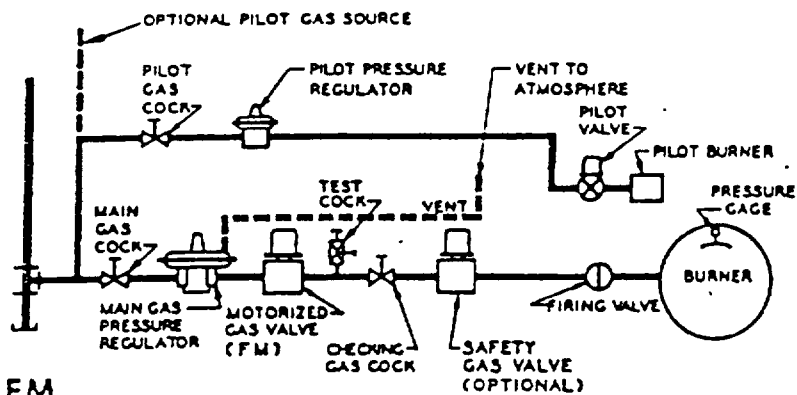
Risers and returns should be piped according to job specifications. In the absence of such specifications, consult the local Kewanee sales office.

All boiler drains, blow down valves, safety valves, water column blow down, and low water cutoff blow down should be vented to a convenient sewer, or to a blow down tank on high pressure steam.

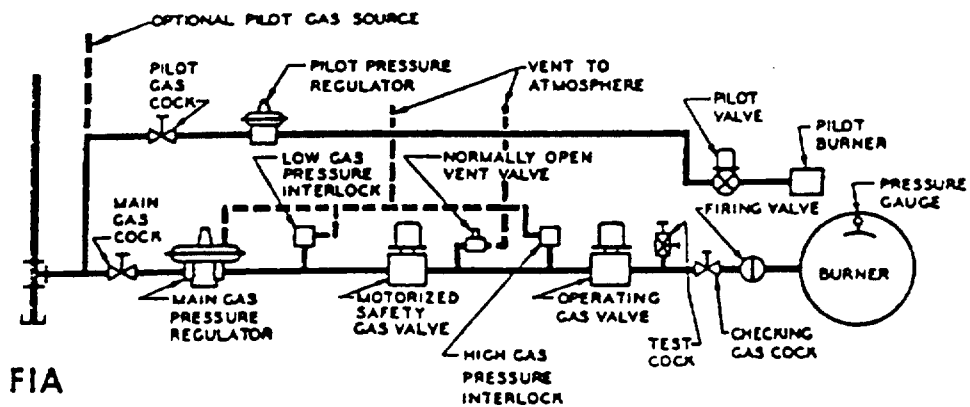
FORCED DRAFT SCOTCH PACKAGE UNIT



UL



FM



FIA

FIG. 2-1—TYPICAL UL-FM-FIA GAS CONTROLS

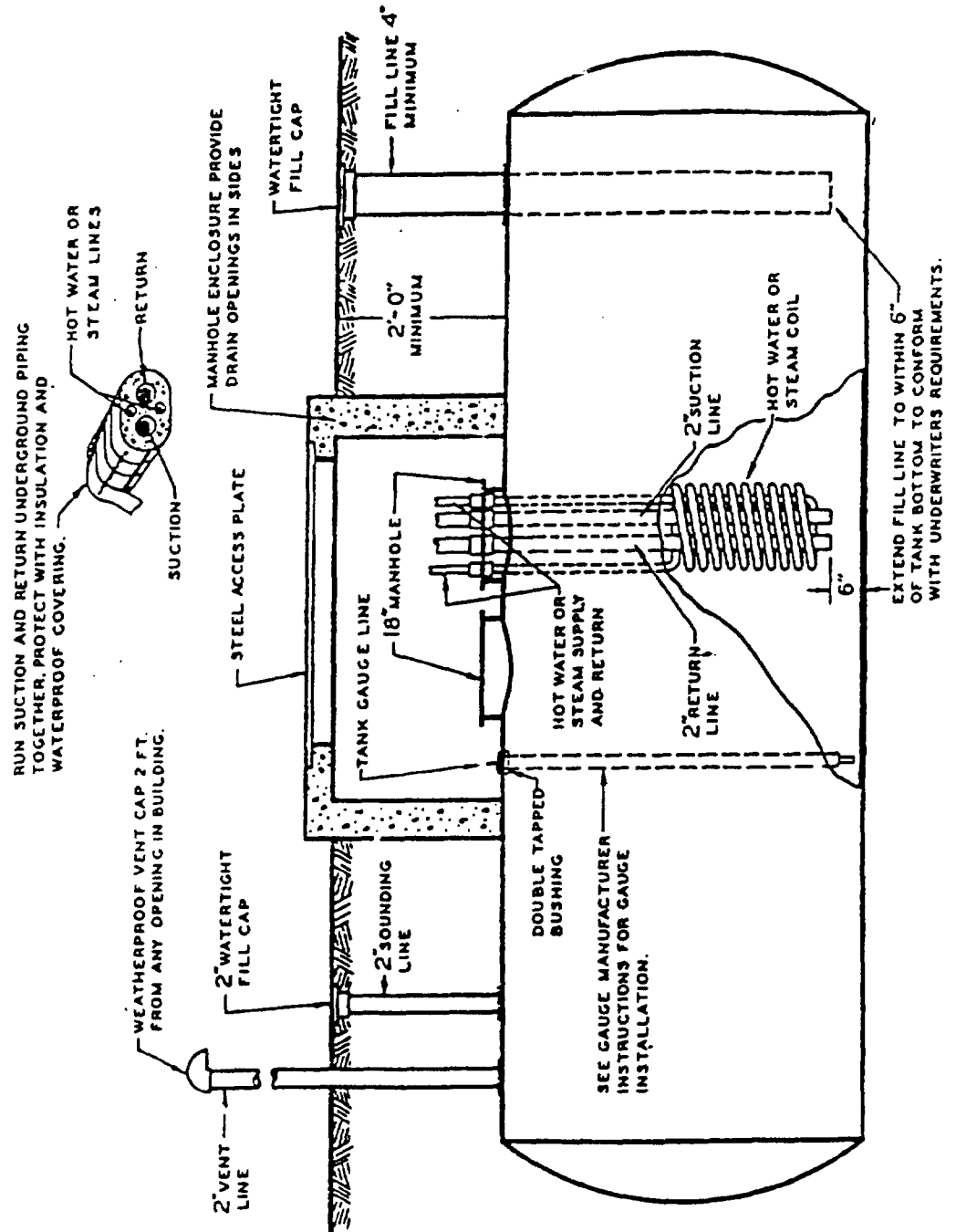


AMERICAN Standard

FORCED DRAFT SCOTCH PACKAGE UNIT

Boiler Man

FORCED DRAFT SCOTCH PACKAGE UNIT

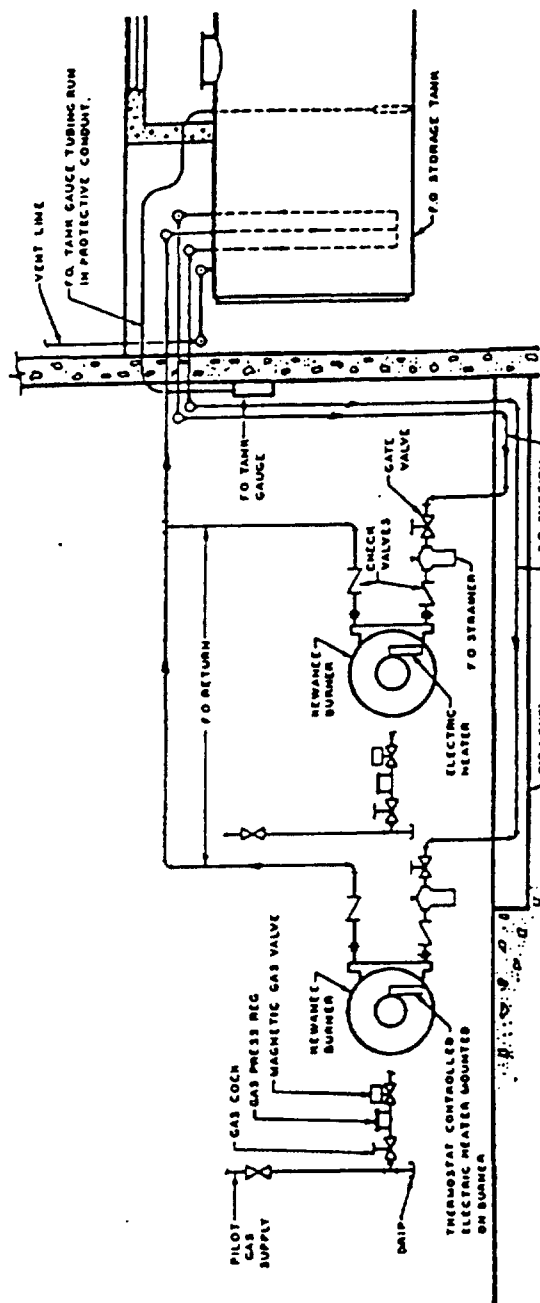


NOTE: CHECK LOCAL CODE REQUIREMENTS

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FORCED DRAFT SCOTCH PACKAGE UNIT



WHEN USED FOR SINGLE BURNER INSTALLATION
SIMPLY OMIT PIPING TO LEFT HAND BURNER.

See Fig. 2-5 for burners
without integral pump.

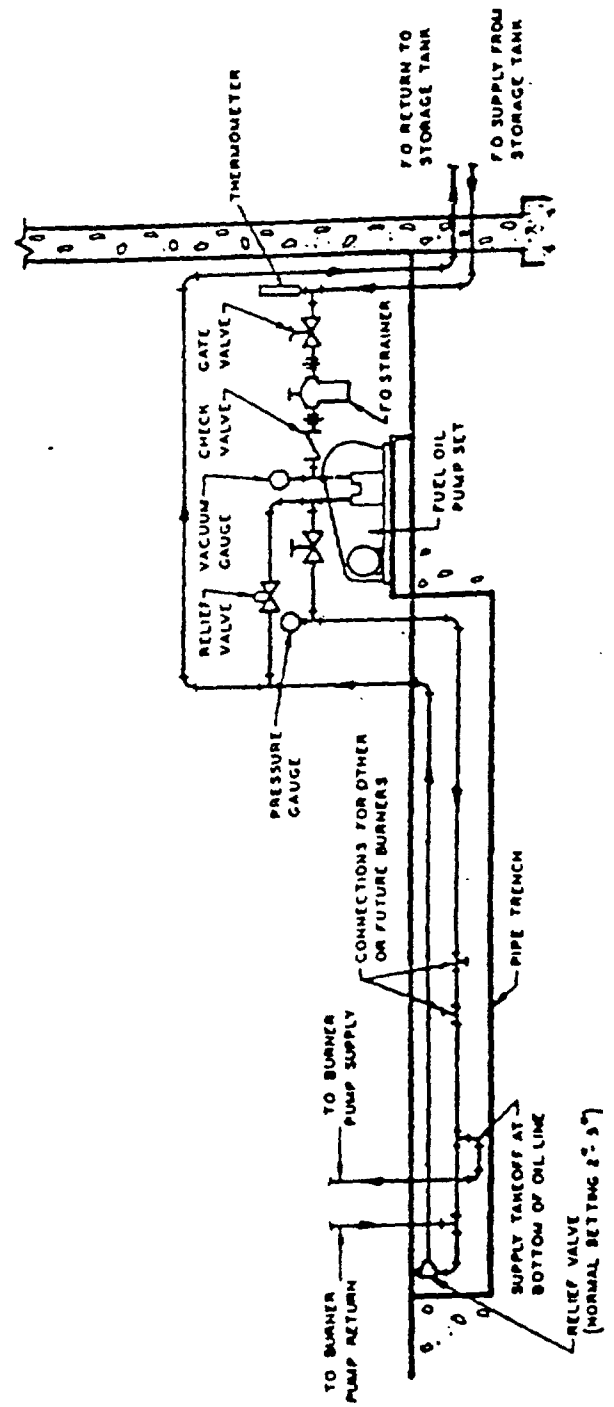
FIG. 2-3—TYPICAL OIL PIPING (KPE)



AMERICAN Standard

SCOTCH PACKAGE UNIT

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FORCED DRAFT SCOTCH PACKAGE UNIT

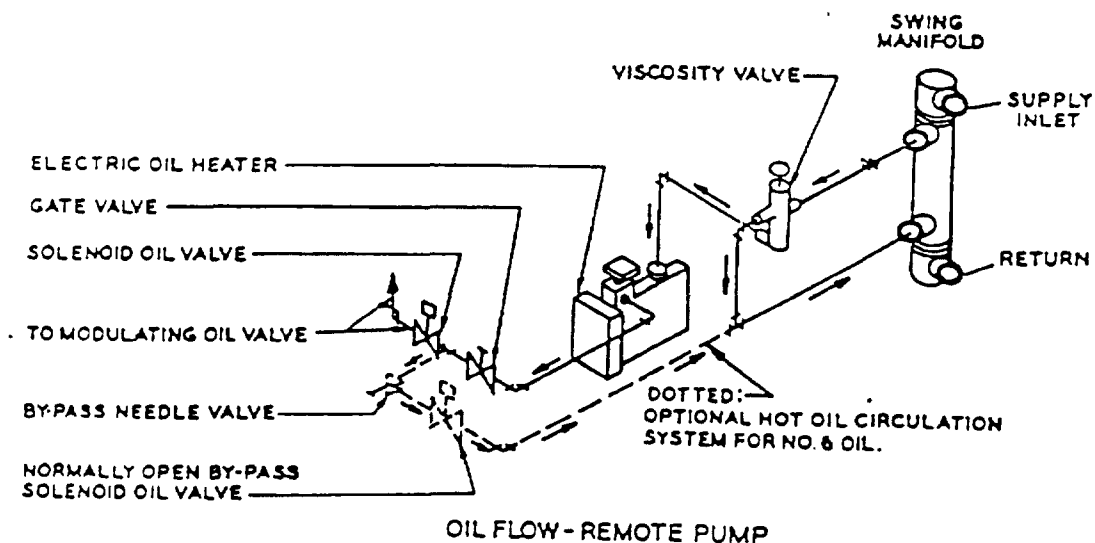
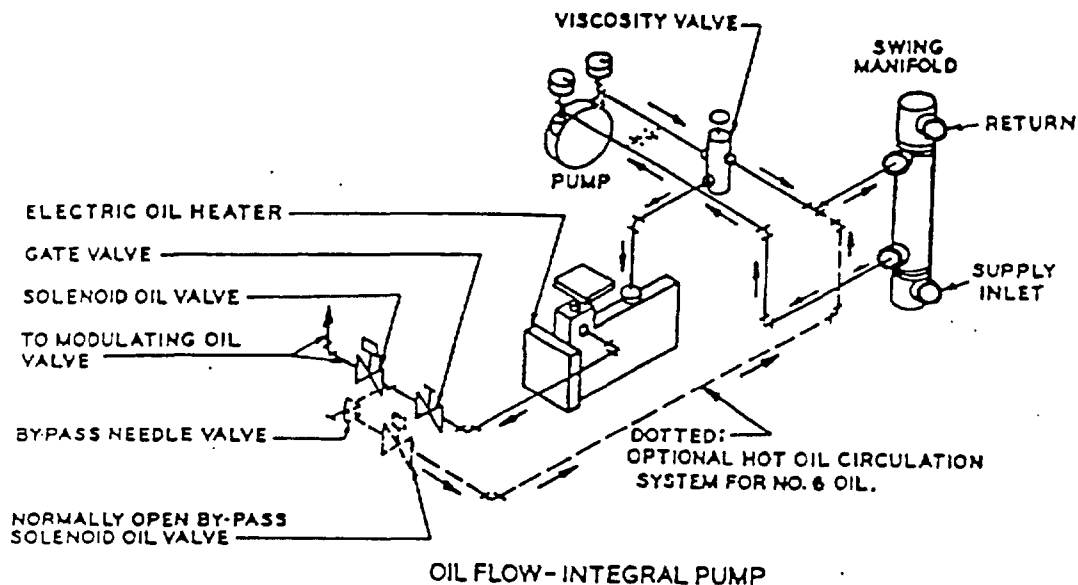
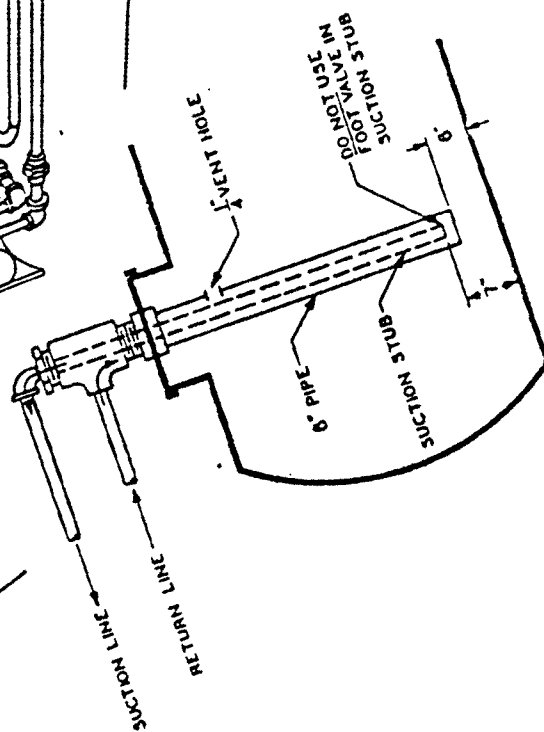
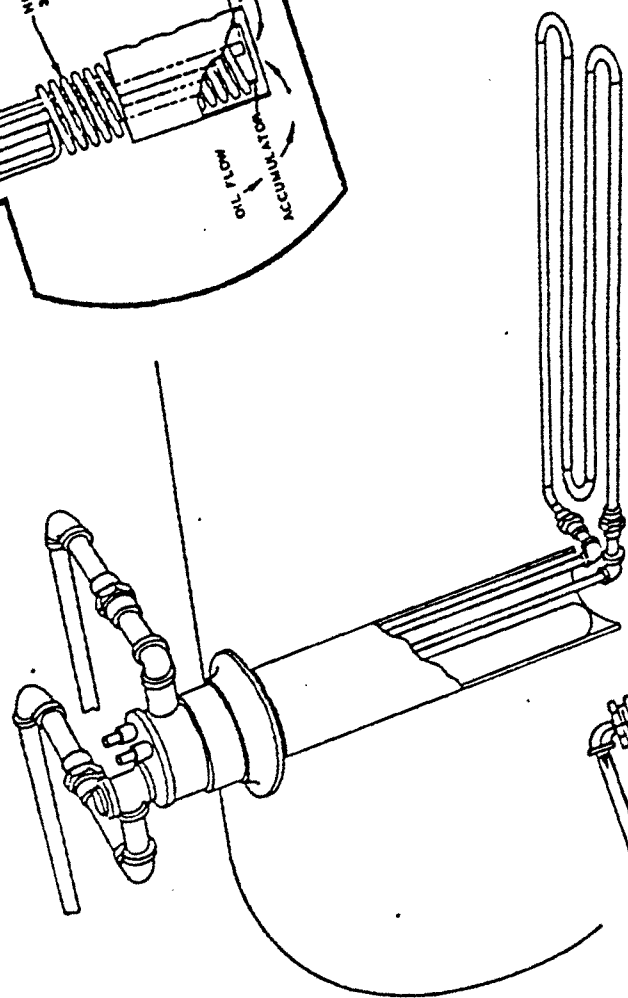
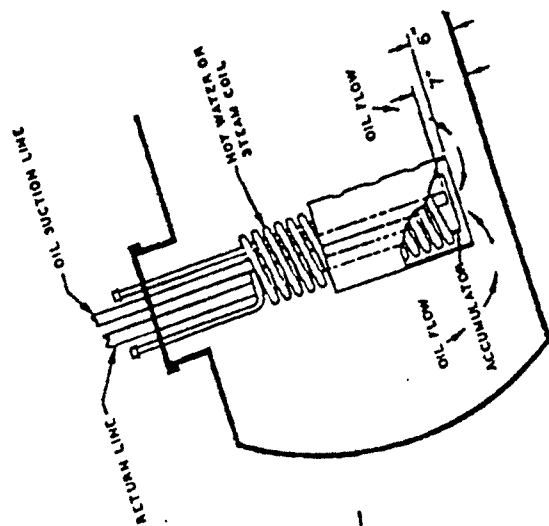


FIG. 2-5-TYPICAL OIL FLOW



FORCED DRAFT SCOTCH PACKAGE UNIT





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FORCED DRAFT SCOTCH PACKAGE UNIT

B. Special Instructions-Controls

1. The Kewanee Forced Draft Package uses the Minneapolis-Honeywell R-4788, or Fireye FP-2 system, to control burner operation and combustion safety. Before attempting to operate this unit the boiler operator should study carefully the control instruction sheets in Chapter 7, Manufacturers Data Section.
2. The operator should become familiar with the location and purpose of all controls governing the boiler's operation. Schematic wiring diagram, Figure 3-1, Page 28, Figure 1-4, Page 6, Figure 1-5, Page 7, and Figure 1-6, Page 8, show the most important valves, instruments and electrical controls which regulate the boiler operation.
3. Sequence of operations. The following description is based on Figure 3-1, Page 28, and Figure 3-2, Page 29 which shows a Minneapolis-Honeywell R-4788 flame safeguard system. Refer to wiring diagram and sequence of operations in control cabinet of each unit for specific requirements:

Requirements for burner starting: Cold oil lock-out (No. 6 oil only), latch switch (36), burner control switch (18), remote emergency switch (47) (if any), low water cut off (48), operating pressure controller or aquastat (50), high limit pressure controller or aquastat (49), low-fire-start switch (40) and gas valve auxiliary switch (51) must be closed. All the above switches, except the operating limit control (50), should be closed after a normal burner shut down.

When the operating limit control (50) calls for heat, relay (12) will commence the prepurge period by energizing blower motor (31) and burner motor (32). After a 30 second prepurge period, the ignition transformer (43), gas valve (44) and ignition indicating light (13) will be energized and pilot will be established.

In an additional 10 seconds, providing pilot flame is monitored by scanner (41) and air switch (35) is actuated by blower air pressure, main fuel valve (38 oil) or (51 gas) and main fuel indicating light (14) will be energized. The modulating motor (39) will start to high fire position depending on demand of modulating control (46). If manual-automatic switch (22) is in manual position, potentiometer (23) sets fixed firing rate with no modulation. If switch (22) is in automatic position, potentiometer (23) sets maximum firing rate with modulating control of lower firing rates.

In an additional 60 seconds (oil) or 15 seconds (gas) the ignition transformer (43), pilot gas valve (44) and pilot indicating light (13) will be de-energized. Now the main flame is monitored by scanner (41).

When operating controller (50) is satisfied or any of switches (18), (36), (47), (48) and (49) are open the main fuel valve (38 oil) or (51 gas) and main fuel indicating light (14) are de-energized. Modulating motor (39) will return to low fire position, blower motor (31) and burner motor (32) will continue to operate for a 15 second post purge period.

Ignition Failure: If pilot is not ignited or scanner (41) does not properly monitor pilot, main fuel valve (38 oil) or (51 gas) will not open and warp switch on relay (12) will be energized. The unit will go into flame failure position and energize flame failure indicating light (15).

Flame Failure: Following a normal cycle -- pilot on, main burner on, pilot off -- if the main flame is extinguished or not properly monitored by the scanner (41), the main fuel valve (38 oil) or (51 gas) will close in approximately 4 seconds and modulating motor (39) will start to low fire position. The safety warp switch is energized causing the burner to go to flame failure position as shown by indicating light (15).

B. Special Instructions-Controls (Continued)

Air Switch Failure: In case the forced draft blower does not operate, or if the air switch (35) fails, the burner will go through a normal pre-purge and ignition cycle. The main fuel valve (38 oil) or (51 gas) will not open and the burner will go to flame failure position shown by indicating light (15).

Whenever the burner goes into the flame failure position, light (15) is on. Wait three minutes to allow warp switch to cool, then manually re-set relay (12) to re-start burner.

NOTE: Selector switch (20) permits selection of fuel (gas or oil). Electric oil heater (33) is not energized when gas is selected. Pump switch (21) permits manual (constant) or automatic (operates with burner) oil pump operation.

C. Special Instructions-Oil Firing

1. Be certain all oil and gas piping is complete and necessary valves are open.
2. Purge the air from the gas line leading to the gas-electric ignition assembly. Open shut-off cock to gas-electric igniter.
3. Disconnect power to the electric oil heater by either removing fuses in the control cabinet or disconnecting one wire at the temperature controller mounted on the oil heater.
4. Check oil burner linkage. This linkage was set by the factory when the boiler was fire-tested, but the following settings should be checked to determine whether damage has occurred which disrupted the linkage. The primary air damper should be about one-fourth open. Secondary air dampers should be about one-fourth open and the modulating oil valve should be about one-fourth open. Slots in the end of the shafts controlling the air dampers and the modulating oil valve indicate the throttling position.
5. Close the gate valve on the burner cated upstream from the oil solen valve.
6. Remove cap from oil strainer in suet line and fill strainer with fuel oil or bricating oil. After the burner motor been started, refill the strainer as requi to provide sufficient oil to prime pump. When replacing the oil strai cap be very careful to assure a vacu tight seal.
7. Operate the oil pump until oil is obtai from the tank. With a separate pump : the oil pump may be operated by leav the burner switch in an "off" posit and turning the oil pump switch to "manual" position. On an integral pu burner, the oil may be pumped by tu ing the burner switch to the "c position and removing the top vacu tube from the R-478B relay. If prefer the oil pump may be operated by mc ually holding in the coil on the l starter.
8. Observe the pressure gauge when the is pumped to the burner. Pressure sho not exceed 20 psi. Higher pressures, w a separate pump set, are generally cou by a closed or partially closed valve the pressure side of the pump. Hig pressures, on an integral pump, may reduced by closing the oil viscosity va slightly.
9. Turn off the integral pump by turning : burner switch to the "off" posit. The separate oil pump may be left "manual" or switched to "automati on the pump switch.
10. Check spark gap on gas-electric igni (1/16"-3/32"). Natural and manufactur gas pilots have a 3/16" gas orifice. ? LP gas orifice is 7/64".
11. Remove top vacuum tube in the R-47 and push tab on top relay. It will provide a constant pilot duri



FORCED DRAFT SCOTCH PACKAGE UNIT

C. Special Instructions-Oil Firing (Continued)

- the starting operation. On the Fireye FP-2 control a constant pilot is secured by replacing the four-pronged AC line plug with a three-pronged test plug, and turning the knurled knob on the timer to the desired phase of operating sequence.
12. The pilot flame should be carefully checked for proper operation. A reading of 100 to 140 DC volts should be indicated from the test jacks on the R-4788 control. A reading of between 70 and 90 DC volts should be indicated on the Fireye control. The gas pilot normally requires 2"-4" w.c. pressure for natural or manufactured gas. Check gas pressure at Tee outside the igniter assembly. Adjust the pilot gas pressure regulator as necessary to secure a good stable pilot flame with no fluctuation in voltage readings.
 13. To light off the oil burner, set the manual potentiometer in a "closed" position. Set fuel selector switch on "oil". Turn on the burner switch. The burner will go through its pre-purge period, the pilot will turn on and be proved, permitting the oil solenoid valve to open. At this time, slowly open the closed gate valve on the burner. After a slight delay oil will be delivered to the cup and the main flame will be established. If oil is not delivered to the cup within a few minutes, turn the manual potentiometer up so that the modulating valve will open further.
 14. Reconnect the electric heater after a flame is established.
 15. As soon as a stable flame is established, hold the fire in this position by means of the manual potentiometer for a period of about 30 minutes or until the water in the boiler is warm.
 16. Adjust oil temperature control on the electric oil heater to temperature required to provide atomization of oil. These temperatures may vary from 100° to 140° for No. 5 oil and from 130° to 200° for No. 6 oil.
 17. Bring the unit to high fire by turning the manual potentiometer to the "open" position. Be sure gate valve is wide open. Increase or decrease the high fire oil rate by opening or closing the viscosity valve, if adjustments are required.
 18. Unit should be operated at high fire until steam pressure or boiler water temperature is high enough to enable any auxiliary oil heating equipment to provide a stable source of heat. The burner should remain on constant ignition during this time until all of the air pockets in the oil line have been eliminated and oil temperatures through all heaters are constant.
 19. Change the burner firing rate from high to low several times by means of the manual potentiometer. Check CO₂ at high, low and intermediate fire. The Kewanee unit should not require any major firing adjustments since it has been factory fired and tested. If minor linkage corrections are necessary, see the Service section of this manual, Page 40. Adjust fuel-air ratio to achieve 11 to 12-1/2 CO₂ by flue gas analysis with a smoke rating of not in excess of No. 2 on the Shell-Bochrach smoke scale.
 20. Restart burner several times to check for smooth light off.
 21. Flame failure check:
 - a. Replace vacuum tube (T1) in the R-4788 relay.
 - b. Start burner.
 - c. After the ignition indicating light goes off, close the manual fuel valve on the burner rapidly to extinguish the main flame.
 - d. In approximately four seconds the automatic fuel valve will close and the modulating motor will start to a closed position.
 - e. The R-4788 relay will go to lockout position and the flame failure light will show on the control cabinet.

C. Special Instructions-Oil Firing (Continued)

22. Ignition failure check:

- a. Close the shut-off cock on the gas pilot line. Jumper pilot low pressure gas switch (if any).
- b. Start the burner.
- c. The ignition indicating light on the control cabinet will come on but the pilot flame will not be established.
- d. The main fuel valve will not be energized.
- e. The pilot indicating light will go off and the unit will go to a flame failure position.

23. Limit control check:

- a. Start the burner and permit the boiler to run until the limit control settings as shown on the limit controls have been reached.
- b. The burner will turn off when the set pressure or temperature has been reached. Occasionally there will be a slight difference between the settings on the limit controls and the readings on the pressure or temperature gauges. The limit controls should be set to match the pressure or temperature gauge readings.
- c. After a differential pressure or temperature drop, the burner should restart automatically.
- d. With burner operating in the normal running position, open the blow down valve on the low water cutoff. Burner should turn off, and restart automatically when the proper level of water in the low water cutoff is re-established.

24. Air switch check:

- a. Cover air inlet on forced draft blower. Close manual fuel valve.

- b. Start burner. Burner should go through the normal pre-purge and ignition periods, but the main fuel indicating light should not be energized.

- c. After the ignition turns off, the burner should go to flame failure position.

25. Latch switch check:

- a. Open latch switch. Close main fuel valve.
- b. Turn on burner switch. Either the burner will not start, or the oil valve will open, depending on control sequence used.
- c. Adjust latch switch to provide a tight seal between the burner fan housing and the windbox.

26. The emergency shut-off switch, if used, should be checked to make sure that it turns off the burner.

27. After the above procedures have been completed, the operator should be carefully instructed in the proper maintenance and service of the equipment. See Chapter 4, Page 31, of this manual.

D. Special Instructions-Gas Firing

CAUTION: When firing gas on a combination gas-oil burner which does not swing out the oil burner while firing gas, the shaft seal assembly on the oil burner **MUST BE** lubricated through the plug in the modulating oil valve to prevent seal damage. Oil line valves should be kept open to assure pump lubrication.

1. The gas piping, control groups and valves should be checked for compliance with local utility and the customer's insurance underwriter's requirements.
2. Purge air from gas lines to the lubrication plug cock of the gas burner control group. Some local gas companies require that this be done by their personnel. Close manual gas cock.
3. Check gas burner linkage. This linkage was set by the factory when the boiler was first tested but the following settings should be checked to determine what damage has occurred which disrupted

FORCED DRAFT SCOTCH PACKAGE UNIT

D. Special Instructions-Gas Firing (Continued)

linkage. The primary air damper (on combination gas-oil firing) should be about one-fourth open. Secondary air dampers should be about one-fourth open. The gas volume control valve should be about one-fourth open.

4. Set fuel selector switch to "GAS".
5. Check spark gap on gas-electric igniter (1/16"-3/32"). Natural and manufactured gas pilots have a 3/16" gas orifice. The LP gas orifice is 7/64".
6. Remove top vacuum tube in the R-478B and push tab on top relay. This will provide a constant pilot during the starting operation. On the Fireye FP-2 control a constant pilot is secured by replacing the four-pronged AC line plug with a three-pronged test plug, and turning the knurled knob on the timer to the desired phase of operating sequence.
7. The pilot flame should be carefully checked for proper operation. A reading of 100 to 140 DC volts should be indicated from the test jacks on the R-478B control. A reading of between 70 and 90 DC volts should be indicated on the Fireye control. The gas pilot normally requires 2"-4" w.c. pressure for natural or manufactured gas. Adjust the pilot gas pressure regulator as necessary to secure a good stable pilot flame with no fluctuation in voltage readings.
8. To light off the gas burner, set the manual potentiometer in a "closed" position. Turn on the burner switch. The burner will go through its pre-purge period, the pilot will turn on and be proved, permitting the main gas valve to open. At this time, slowly open the closed manual gas shut-off valve. If the gas piping was properly purged of air, the main flame will be established almost immediately. If the main flame is not established quickly, turn the manual potentiometer up so that the gas volume control valve will open further.
9. As soon as a stable flame is established, hold the fire in this position by means of the manual potentiometer for a period of about 30 minutes or until the water in the boiler is warm.
10. Bring the unit to high fire by turning the manual potentiometer to the "open" position. Be sure that the manual gas shut-off valve is wide open.
11. Check gas ring pressure gauge. The ring gas pressure required for full firing capacity is stamped on the burner label.
12. Clock gas meter for firing rate. Be sure to check any necessary meter pressure correction factors with your local utility. Firing rate may be increased or decreased by adjusting the gas pressure regulator. Adjust firing rate to conform to standard specifications.
13. Change the burner firing rate from high to low several times by means of the manual potentiometer. Check CO₂ at high, low, and intermediate fire. The Kewanee unit should not require any major firing adjustments since it has been factory fired and tested. If minor linkage corrections are necessary, see the Service section of this manual, Page 40. Adjust fuel-air ratio to achieve a combustion rating of 8-1/2 to 10 percent CO₂ by flue gas analysis with no CO.
14. Restart burner several times to check for smooth light off.
15. Make flame failure check using procedures outlined in Paragraph 21, Page 24.
16. Make ignition failure check using procedures outlined in Paragraph 22, Page 25.
17. Make limit control check using procedures outlined in Paragraph 23, Page 25.
18. Make air switch check using procedures outlined in Paragraph 24, Page 25.

FORCED DRAFT SCOTCH PACKAGE UNIT

D. Special Instructions-Gas Firing
(Continued)

19. Make latch switch check using procedures outlined in Paragraph 25, Page 25.
20. The emergency shut-off switch, if any, should be checked to make sure that it turns off the burner.
21. After the above procedures have been completed, the operator should be carefully instructed in the proper maintenance and service of the equipment. See Chapter 4, Page 31 of this manual.

E. Special Instructions - Gas-Oil Firing

1. Set fuel burning equipment in accordance with the specific instructions listed in this chapter for oil firing.
 2. Adjust burner in accordance with the specific instructions listed in this chapter for gas firing.
- CAUTION: Observe oil burner shaft seal lubrication requirements on Page 25.
3. Linkage for gas volume control valve may be adjusted as required without changing the setting of the linkage for the oil control valve.
 4. Keep the primary and secondary air settings matched for both fuels so that no adjustments are necessary when changing fuels during normal operation.

5. On combination gas and No. 6 oil, do not permit the No. 6 oil to "set up" in the oil tank and lines. Keep the tank heater in operation at all times.

6. The change from gas to oil requires:
 - a. On No. 6 oil, set oil pump switch in "manual" position prior to change-

- over to assure an adequate supply of oil at proper operating temperature
- b. Shut off burner switch.
- c. Remove plastic cone cover, swing oil burner in position and close latch switch (units with swing-out oil burner arrangement).
- d. Change fuel selector switch from "gas" to "oil".
- e. Close main gas shut-off valve.
- f. Turn on burner switch.

7. Change from oil to gas requires:

- a. Shut off burner switch.
- b. Swing-out oil burner, insert plastic cone and engage cone switch (units with swing-out oil burner arrangement).
- c. Change fuel selector switch from "oil" to "gas".
- d. Open main gas shutoff valve.
- e. Turn on burner switch.
- f. Caution - do not close gate valves in oil lines to unit with integral pump at any time burner is operating, except on swing-out oil burner arrangement.
- g. On No. 6 oil, the oil pump switch may be set on either "Manual" or "Automatic". Do not turn off source of heat to tank heater.

F. Special Instructions-Boiler

1. All new boilers, as well as the steam and water piping connected to the boiler contain oil, grease, and foreign matter. It is essential to clean the system because these materials are responsible for such difficulties as overheating of metal, foaming and priming, and high maintenance costs on strainers, traps and vents.
2. On steam systems, condensate may be wasted for several days or until tests show the elimination of undesirable impurities.
3. On hot water systems, chemical cleaning is generally necessary and the entire system should be drained after treatment.



FORCED DRAFT SCOTCH PACKAGE UNIT

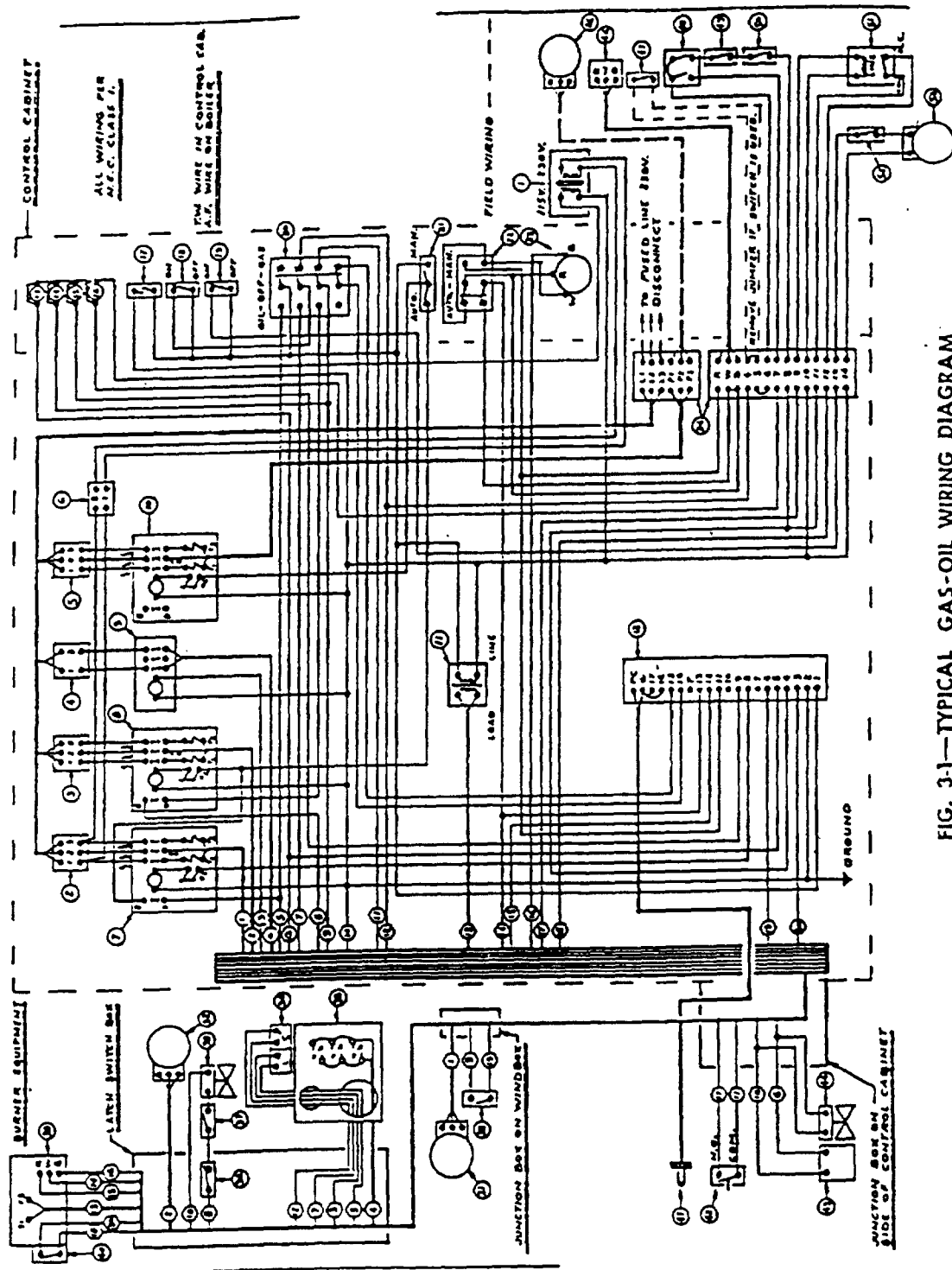


FIG. 3-1—TYPICAL GAS-OIL WIRING DIAGRAM

FORCED DRAFT SCOTCH PACKAGE UNIT

FIG. 3-2-TYPICAL GAS-OIL CONTROL EQUIPMENT

ITEM	DESCRIPTION	FUNCTION
1	Transformer 250/115V	Control circuit power source
2	3-Pole fuse block	Forced draft fan motor circuit fuse
3	3-Pole fuse block	Oil burner motor circuit fuse
4	2-Pole fuse block	Electric oil heater circuit fuse
5	2-Pole fuse block	Oil pump motor circuit fuse (Remote pump unit only)
6	2-Pole fuse block	Control circuit transformer fuse
7	Magnetic starter	Forced draft fan motor starter
8	Magnetic starter	Oil burner motor starter
9	Magnetic contactor	Electric oil heater contactor
10	Magnetic starter	Oil pump motor starter (Remote pump unit only)
11	Transformer 115/24V	Modulating motor power supply
12	Programming relay	Programming and flame safeguard control
13	Indicating lamp - white	Indicates ignition
14	Indicating lamp - amber	Indicates main fuel
15	Indicating lamp - red	Indicates flame failure
16	Indicating lamp - red	Indicates low water
17	1-S.P. MKP Holder with 8 amp. fuse	Control circuit fuse
18	S.P.S.T. Toggle-switch	Burner switch-on-off
19	S.P.S.T. Toggle-switch	Circulating water pump switch-on-off (Below-water-line oil heater unit only)
20	4-P.D.T. Switch	Fuel selector switch - oil-off-gas
21	S.P.D.T. Toggle-switch	Oil pump motor switch - auto., man.
22	D.P.D.T. Toggle-switch	Modulating motor switch - auto., man.
23	Manual potentiometer	Modulating motor control - close/open
24	Terminal strip	Wiring connections
25	Spare terminals	See wiring diagram in control cabinet
26		
27		
28		
29		
30	Forced draft fan motor Oil burner motor Electric oil heater Electric oil heater control Air switch Latch switch (on oil burner) Air/oil interlock Solenoid oil valve Modulating motor Modulating motor and switch Flame detector (Scanner) Gas sense switch Ignition transformer Ignition gas valve Oil pump motor Modulating control Emergency switch (by others) Low water cut-off with alarm switch Safety high limit control Operating limit control Main gas valve with auxiliary switch Oil temperature control Circulating water pump	Secondary air supply
31		Drives atomizer, primary air fan, oil pump (Integral pump unit only)
32		Heats oil to atomizing temp
33		Oil temperature limit switch, controls operation of electric oil heater
34		Safety switch proving secondary air
35		Safety switch proving primary air (If used)
36		Automatic oil valve
37		Modulates fuel-air supply
38		Prevents low-fire start interlock
39		Monitors pilot and main flame
40		Safety switch proves gas sense locked in position
41		Provides spark for ignition
42		Automatic pilot gas valve
43		Circulates oil from tank to burner (Remote pump unit only)
44		Controls modulating motor in response to heat demand
45		Remote emergency switch to turn off burner
46		Stops burner on low water condition
47		Safety limit to operating control
48		Starts and stops burner in response to boiler pressure or temperature
49		Automatic gas valve with safe closing safety feature
50		Operates circulating water pump (Below-water-line oil heater unit only)
51		Circulates boiler water through water-to-oil oil heater (Below-water-line oil heater unit only)
52		See wiring diagram in control cabinet
53		
54		
55		
56		
57	Spare terminals	See wiring diagram in control cabinet
58		
59		
60		



FORCED DRAFT SCOTCH PACKAGE UNIT

F. Special Instructions-Boiler (Continued)

4. The boiler installer should use the following procedure in washing oil, grease, and other impurities from the new boiler:

- a. Remove the safety or relief valve.
- b. Close the valve in the steam or flow line.
- c. Add caustic soda and soda ash (equal parts) to the boiler water through the safety or relief valve opening at the rate of one pound for each five horsepower of boiler rating. See Figure 1-1, or 1-2. Fill boiler with such treated water to middle of gauge glass.
- d. Remove any controls or accessories that may be damaged by the chemicals used.
- e. Provide a pipe connection from the safety or relief valve opening to a convenient drain to serve as a vent.
- f. Fire the boiler at a low rate, sufficiently to keep the boiler water at steaming temperature, allowing the generated steam along with entrained water and impurities to dis-

charge through the vent. With a hot water boiler keep temperature at about 210°F. Feed water to the boiler as required to maintain the water level in the glass. It may be necessary to stop burner if water leaves the boiler through the vent faster than it can be added through the feed line. With a hot water boiler keep water trickling from vent.

- g. Continue the boiling process for a minimum of 8 hours. Longer boiling time is recommended for 125 horsepower boilers and larger. Up to 48 hours boiling time may be necessary for unusually difficult job applications.
- h. Drain boiler while hot; then remove the manhole cover and all handhole covers.
- i. While the boiler is still warm, flush interior surfaces with water from a hose nozzle under full pressure until all traces of dirt and impurities have been removed and the water coming from the boiler is clear. Start at the top of the boiler and work down.
- j. Repeat the boiling process if necessary to insure a clean boiler.



FORCED DRAFT SCOTCH PACKAGE UNIT

CHAPTER 4

MAINTENANCE PROCEDURES

A. General Maintenance

1. After the burner has been started and adjusted by your Kewanee service representative, linkage settings, fuel pressures and temperatures should not be changed or tampered with by persons not thoroughly experienced with the burner and fuel system. Service calls caused by "tinkeritis" or poor maintenance procedures are not covered by any "free service" plan.
2. It is preferable to keep a No. 6 oil fired boiler in operation, rather than shut down over week-ends or other off periods. Less difficulty and better overall economy will be obtained by keeping the boiler on instead of allowing the entire system to cool off. Control arrangements are available to provide a low pressure or temperature in the boiler during such periods.
3. Keep a constant check on the fuel supply. Do not depend on "automatic delivery" - watch the supply yourself. Check fuel gauges on the oil tank (or on the LP gas tank, if LP is used for ignition). Keep track of the supply and re-order before the tanks are empty.
4. Keep the boiler, the burner, and the entire boiler room clean. Do not allow fuel to leak anywhere - it is dangerous. A clean boiler room is essential to first-class boiler operation.
5. Keep the burner control cabinet door closed. The electrical contacts in the cabinet are very sensitive to dust and dirt.
6. Never close vents supplying air to the boiler room. If cold air currents cause difficulty with other boiler room equipment, air ducts should be installed to direct the flow of fresh air.
7. Repair all leaks promptly. All piping connections to the boiler and all accessories should be maintained leak-proof because even a minor leak, if neglected, may soon become serious. This applies especially to water column, water glass, water level control piping, and manhole and handhole gaskets. If serious leaks occur, shut down boiler immediately and gradually reduce steam pressure. Do not attempt to make repairs while the boiler is under pressure.
8. Foaming or priming may occur in a steam boiler and cause large quantities of water to pass over into the steam main. It can be detected by violent fluctuations of the water in the glass or by sudden dropping of the water level in the glass. This trouble may be caused by dirt or oil in the boiler water, an overdose of boiler compounds, carrying too high a water level in the boiler, or a high overload on the boiler. In case of serious trouble, stop the burner and decrease the load on the boiler. Then alternately blow down and feed fresh water several times. If foaming does not stop; cool, empty and wash out the boiler and refill with fresh water.
9. Any problem in regard to extreme foaming or priming, scale in boiler, corrosion or pitting should be referred to a concern specializing in boiler water chemistry. Do not experiment with "home-made" treatments or compounds.



FORCED DRAFT SCOTCH PACKAGE UNIT

A. General Maintenance

(Continued)

10. A boiler filled with raw water should not be left idle. The water should first be boiled with the steam chamber vented to drive off any dissolved gases. In the case of hot water boilers, heat the water in the boiler to 200° for the same reason. The boiler water should then be made alkaline with caustic soda. Use 1.5 ounces of caustic soda per 100 gallons of water contained within the boiler.
11. Caution, do not add large quantities of cold feedwater to a hot boiler.

B. Daily Maintenance

1. Clean atomizing cup if necessary and make sure surface is smooth. Never use a sharp instrument on the cup. If cup becomes damaged, replace it.
2. Check to make sure cup is in the center of air nozzle. Cup should protrude 1/16" to 1/8" from the nozzle.
3. Clean scanner.
4. Check oil temperature if heater is used.
5. Check boiler water level in the glass and the steam pressure on the gauge on steam boilers. Check temperature reading and water pressure on hot water boilers.
6. On high pressure steam boilers, blow down at least one full opening and closing of blowdown valve, except where the amount and frequency of blowing down are determined by chemical analysis.
7. On high pressure steam boilers, the gauge cocks and the blowdown valves on the water cutoff, water column and water glass should be operated to make sure these connections are clear.

C. Weekly Maintenance

1. Check boiler flues and clean if necessary. The frequency of flue cleaning will depend on the fuel used, the burner setting, and other factors of the job performance. Protect burner and controls from dust and dirt during tube cleaning. Make sure linkage and other relatively light parts are not damaged.
2. Check all burner linkages, tighten if necessary.
3. Note condition of belts on belt-drive oil pumps and burners. Have spare available and replace before the old one breaks.
4. Test the low water cutoff by turning off the water supply, opening blowdown valve to remove rust and dirt, and then observing whether or not the burner cuts out with low water in the glass.
5. On low pressure steam boilers, the gauge cocks and blowdown valves on the water column and water glass should be operated to make sure these connections are clear.

D. Monthly Maintenance

1. Check ignition assembly and electrode. Clean if necessary.
2. Check primary and secondary air dampers. Remove any accumulation of lint or dirt.
3. Inspect condition of refractory.
4. Inspect oil strainer screen and clean if necessary. The frequency of cleaning oil strainers will depend upon the quality of oil in use. Be sure the cap gasket is in good order and mating surfaces clean. A light coat of clean grease will help secure a vacuum-tight joint. Note - close the gate valve ahead of the strainer before removing the cap to prevent loss



FORCED DRAFT SCOTCH PACKAGE UNIT

**D. Monthly Maintenance
(Continued)**

of oil prime. Turn off oil pumps while cleaning strainer.

5. Lubricate motors in accordance with motor manufacturer's instructions.
6. Check lubricating oil level in burner gear box while burner is turned off. Add Kewanee Gear Box Oil if oil level is low. Do not fill above test plug level.
7. Lubricate oil burner shaft seal.
8. On low pressure boiler, drain off a small amount of water from the boiler drain valve to remove sediment and rust accumulation. Don't overdo and waste clean water.
9. Test boiler safety valves.
10. Clean stop-drip trap inside atomizing cup. See page 37.

E. Annual Maintenance

1. Have the burner inspected and checked by your local Kewanee service representative.
2. Drain and flush burner gear box. Refill with Kewanee gear box oil.
3. Replace vacuum tubes and scanner cell in electronic controls. This replacement is inexpensive insurance against future service calls.
4. Drain and clean sediment out of electric oil heater and boiler mounted oil heater.
5. Check condition of oil tank. Clean and remove sludge if necessary.
6. If the boiler is to be out of service for the summer, be sure to break all power connections to the boiler and auxiliaries.

7. To protect the fire side of the boiler from corrosive action of combustion deposits scrape all carbon, rust, soot or other deposits from fire surfaces. Apply thin coating of oil or grease if boiler is to remain out of service for the summer.

8. To clean water side of the boiler, remove all manhole and handhole covers. Hosi the inside of the boiler with water under high pressure and use hand scrapers to remove any mud, scale, etc. Start at top o boiler and work down.

9. Call for boiler inspection if required by your state, municipal, or insurance agencies. The boiler must be fully accessible both inside and out for the inspector.

10. Since local conditions determine the use of wet or dry storage during summer shut-down periods, information as to type of boiler protection required should be obtained from your boilerwater consultant or insurance company.

11. Wet storage. See that the feedwater and steam connections are tight. After a light steaming period vented to the atmosphere to expell dissolved gases, completely fill the boiler, add sodium sulfite (approximately 1.5 lbs. per 100 gallons of added feedwater) and caustic soda (approximately 3 lbs. of caustic soda for 1000 gallons of water within the boiler) to provide a protective concentration of chemicals. Tests should be conducted occasionally to make sure that the boiler is properly protected.

12. Dry storage. Drain the boiler, clean it internally, and then air dry it thoroughly. Boiler room should be kept dry and well ventilated to prevent boiler surface corrosion.



AMERICAN Standard

Kewanee Boiler Works

FORCED DRAFT SCOTCH PACKAGE UNIT

AS 000107

FORCED DRAFT SCOTCH PACKAGE UNIT

CHAPTER 3

SERVICE PROCEDURES

A. Adjustments And Repairs

The Service Procedures detailed in this section of the manual are intended as a guide in making certain repairs and adjustments which may be necessary during the operating life of the Kewanee Unit. Many of these repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your authorized Kewanee Service Representative for dependable service assistance.

REPLACE WATER GAUGE GLASS:

1. Close water glass shut-off valves, open glass drain cock, remove guard rods, remove glass, clean openings.
2. Make sure new glass is proper size and length.
3. Insert new glass, use new rubber gaskets. Take care not to set stuffing box nuts too tight.
4. Open top valve slightly. When glass is warm, close drain cock. Open bottom valve slightly, check for leaks.
5. When water level has become stable open both valves, replace guard rods.

APPLY MANHOLE AND HANDHOLE COVERS:

1. Clean metal surfaces where cover plate bears against shell plate.
2. Always use new gaskets. Apply graphite paste or grease to gasket to prevent sticking and secure tightness.
3. Use care in centering cover plate and gasket in shell opening. Draw bolts up firmly. Tighten if necessary to make leak proof when raising steam pressure.

REMOVE BEARINGS:

1. Remove the air nozzle, atomizer, front half of fan housing and the fan from the front end of burner.
2. Remove the modulating valve, belt guard and adapter, seal and pulley from the back end of belt drive burners or remove motor stator (including adapter and end bell) and rotor from direct drive burner.
3. Remove upper pump bolt which would interfere with shaft removal on KP Models 83 through 93.
4. Remove all screws holding bearing caps to gear box. KP Models 80 through 82 do not have a fan-end bearing cap.
5. Tap the seal end of the shaft, using a block of wood for a cushion to prevent damage to the shaft until the shaft slides out of the rear bearing and drives the front bearing out of the gear box. Twist shaft while tapping to disengage the worm and gear of pump.
6. The fan-end bearing may be removed from the shaft by placing a yoke behind the bearing or oil slinger and tapping the drip trap on the end of the shaft. Use extreme care to prevent damaging the threads.
7. To remove the rear bearing from the gear box, insert a wooden dowel through the fan-end bearing opening and tap until the rear bearing is forced out of the gear box. Remove retaining rings and tap bearing out of bearing cap.



FORCED DRAFT SCOTCH PACKAGE UNIT

A. Adjustments And Repairs (Continued)

REPLACE BEARINGS:

1. New bearings should be special high-temperature packed bearings similar to New Departure.
2. Press fan-end bearing and slinger onto shaft until shoulder on shaft is exposed.
3. Press rear bearing into bearing cap and/or gear box.
4. Insert shaft into front hole of gear box and through rear bearing, twist shaft to engage pump gears, apply force to fan end of shaft until shoulder on shaft appears at rear bearing bore. It will be necessary to hold the rear bearing in place by use of tubing against a solid object while inserting the shaft.
5. Tap ends of shaft lightly so that bearings may be relieved of any strain and reassemble burner.

REPLACE PUMP GEAR:

1. If the lubricating maintenance procedures outlined in Chapter 4 are observed, pump gear and worm should never require replacement.
2. To remove pump gear drive, the pump must be unbolted from the burner assembly. The new gear must be placed in exactly the same position as the one removed so that the new gear is in exact alignment with the pump worm. The original factory dimension between the inner edge of the pump adapter and the outer edge of the pump drive gear wheel is 2-11/16" on Models 80 through 82, and 2-5/8" on Models 83 through 93.
3. The main shaft must be taken from the burner in order to gain access to the pump worm. Follow the procedure detailed in "To Remove Bearings".

REPLACE ROTOR (MODELS 80-88):

1. The rotor is mounted on a bushing which is fastened to the shaft by a left-hand thread lock nut and a key type washer. Use care not to distort the lock nut or washer.
2. Be sure that the faces of the lock nut, washer, and rotor bushing that contact each other are clean and lightly oiled before replacement.
3. After tightening the nut, check the shaft to make sure that it runs true. If a high point is found, the shaft can be straightened by firmly tapping to tighten the lock nut (not the shaft) at a point directly above the high point. It is important that the shaft run true to avoid vibration.

REPLACE PRIMARY AIR FAN:

1. The primary air fan is held on the main shaft by two set screws which press against keys inserted in fan keyways.
2. To remove the fan, loosen set screws and push fan back on the shaft. Remove keys, and clean the main shaft carefully.
3. Use hand pressure between the outer edges of the fan and the fan housing to pull the fan off the shaft. Do not force the fan off by prying.
4. If fan cannot be removed from shaft by cleaning the main shaft, a fan puller must be used. This is available from the factory.
5. Before replacing fan, clean any burn or carbon from main shaft, fan keys and bore of fan. Smooth slide fit is necessary.
6. Hold keys on shaft flats with a piece of string wound several times around shaft and keys, leaving one end of string dangling below fan diameter; slip fan over shaft and keys until fan will hold



FORCED DRAFT SCOTCH PACKAGE UNIT

**A. Adjustments And Repairs
(Continued)**

keys; withdraw the string by pulling on the end.

7. Push fan toward gear box to within $1/16$ to $1/8$ " from the rear fan housing. Tighten set screws and spin fan to make sure it does not rub on the fan housing. Reassemble and turn by hand to make sure the fan clears the front fan housing.

SERVICE ATOMIZING CUP:

1. The oil atomizing cup may be cleaned by swinging the burner away from the firing position and inserting a soft cleaning cloth inside the cup; light oil or solvent may be used to remove oil deposit.
2. To remove the cup from the main shaft, first remove the air nozzle, then unscrew the cup from the main shaft. Do not use a wrench on the atomizing cup. A quick twist of the cup should loosen the thread which is regular or right hand thread.
3. Do not use hard or sharp instruments in cleaning the cup. If the lip of the cup becomes slightly burred it may be smoothed by using fine emery paper.
4. If cup is damaged or burned, replace it.

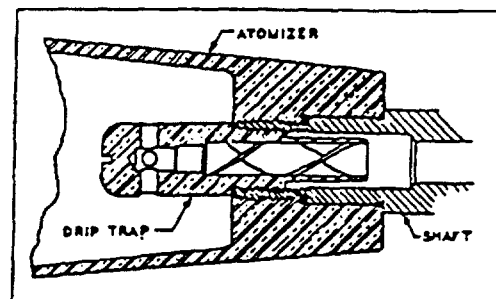
ADJUST AIR NOZZLE:

1. The air nozzle may be removed from the front fan housing by removing two bolts.
2. To adjust the variable vaned air nozzle for either a longer or wider flame pattern, release the two set screws holding the tapered portion of the air nozzle to the main body of the nozzle and turn the tapered portion until the air vanes are at the proper angle for the desired flame pattern.
3. The air nozzle must be centered exactly around the atomizing cup. The atom-

izing cup should extend about $3/32$ of an inch forward of the lip of the air nozzle. The position of the air nozzle can be changed by loosening the clamp bolt.

SERVICE STOP-DRIP TRAP:

1. The stop-drip trap is located inside the atomizing cup, fastened to the main shaft with right hand threads. The atomizing cup should be removed before removing the drip-trap. See Fig. 5-1.

**FIG. 5-1—STOP-DRIP TRAP**

2. The drip trap, which prevents oil in the hollow burner shaft from leaking into the atomizing cup during the off periods, must be cleaned periodically. Remove the drip trap, soak in kerosene or solvent, wipe dry and replace.
3. If oil still leaks into the atomizing cup while the burner is shut down, check to make sure the drip trap is tight and then check the solenoid oil valve which may be seating improperly.

REPLACE SHAFT SEAL:

1. The purpose of the shaft seal is to permit fuel oil to flow from the stationary rear end body into the rotating shaft without leaking. If the motor main shaft has to be removed for any reason or if the seal leaks, as shown by a drip of oil from the leak hole at the bottom of the motor housing, a new seal should be installed.



FORCED DRAFT SCOTCH PACKAGE UNIT

A. Adjustments And Repairs (Continued)

2. Complete instructions on replacing the rotary seal unit are included with each seal sent from the factory.

SERVICE OIL PUMP:

1. Both integral and separate oil pumps are Tuthill pumps of the internal gear type with a rated capacity of approximately 200% of the burner firing rate.

2. Field replacement of internal parts of any of the pumps, such as the seal, gears, or shaft, is discouraged. A factory overhaul or a complete pump assembly replacement is suggested since failure of one part usually indicates failure in other parts.

3. High capacity auxiliary pump sets, Sizes 5 and 6, use a lip type seal which may be replaced in the field.

CHECK OIL PUMP OPERATION

Trouble	Possible Cause
A. No oil delivered	1. Pump not primed 2. Suction lift too high 3. Air leak in suction line 4. Wrong direction of rotation 5. Worm or gear slipping on shaft 6. Pump gears worn 7. Pump seal leak
B. Capacity too low	1. Suction lift too high 2. Air leak in suction line 3. Suction line too small 4. Check-valve or strainer too small or obstructed 5. Mechanical defects: (a) Pump badly worn (b) Packing or seal defective
C. Pump is noisy	1. Pump not securely mounted. 2. Vibration caused by bent shaft or misalignment 3. Pump overloaded 4. Air leak in suction line 5. Suction lift so high that vapor forms within the liquid 6. Loose pulley 7. Viscosity of oil too high for the pump speed 8. Belts worn



FORCED DRAFT SCOTCH PACKAGE UNIT

A. Adjustments And Repairs
(Continued)

CHECK OIL PUMP OPERATION

Trouble	Possible Cause
D. Pump leaks	1. Cover bolts need tightening; gasket is broken or defective 2. If packed pump, packing may need tightening or replacing 3. If mechanical seal pump, seal may be scratched due to dirt 4. Pump bushings and other parts badly worn from abrasives in fuel oil

SERVICE VISCOSITY VALVE:

1. The viscosity valve is used to meter the desired quantity of oil to the atomizing cup. Excess oil is returned to the tank. The valve also includes an emergency relief feature in case of an unusual condition such as complete closure to the return line.
2. The only field service recommended for the viscosity valve is that of cleaning to remove particles of sediment or carbon. To clean the valve remove the cap from the bottom of the valve, drain and flush out any accumulation of sludge or dirt.
3. Viscosity valve stems have a left-hand thread.

REPLACE HINGE SEALS:

1. Be sure the latch holds the fan housing tight to the front plate. Support the burner with blocks under gear box to relieve swing joint hinges.

2. Open unions outside of swing hinge, between swing and burner pump, and on electric oil valve.
3. Support electric pre-heater pipes and valves connected to it on blocks.
4. Remove Allenhead screws from the hinges. Remove the four hinge pieces after marking them so that they can be mated when reassembled since they are not interchangeable.
5. Pull back the swing manifold and all parts connected to it until it is clear of its hinges.
6. Pull top and bottom sections from the swing manifold body. Clean the sections thoroughly, being careful not to scratch any part of the groove in which the "O" rings set.
7. Roll new "O" rings into the grooves. Lubricate the "O" rings and the grooves, push the sections into the body of the swing manifold and reassemble. Be careful not to cut or nick the "O" rings.



FORCED DRAFT SCOTCH PACKAGE UNIT

A. Adjustments And Repairs (Continued)

SERVICE GAS-ELECTRIC IGNITER:

1. The igniter assembly should be removed and cleaned regularly. The porcelain insulator should be kept clean and the entire electrode must be replaced if the insulator is cracked. Cleaning may be done with solvent.
2. When the electrode is replaced, a spark gap of $1/16"$ to $3/32"$ must be left between the electrode and the igniter body.
3. The orifice located in the base of the pilot nozzle should be kept clean. The natural or mixed gas orifice is $3/16"$. The LP gas orifice is $7/64"$.
4. The high tension wire between the transformer and the igniter electrode should be checked periodically for deterioration.

SERVICE ELECTRIC OIL HEATER:

1. Do not set oil heater temperature too high. Excessive temperatures may cause gasification or carbonizing, resulting in unsatisfactory starting conditions and shortened life of heater elements.
2. Electricity should be shut off to the heater and controls when doing any work on the electric heater.
3. The nuts holding the elements to the plate and the nuts holding the plate to the body should be tightened as necessary to prevent oil leaks. Install a new gasket to eliminate serious oil leaks around the element plate. Soak the new gasket in lubricating oil before installing.
4. Once each year, or oftener if required, the heater should be drained and flushed to remove the sludge from the bottom of the heater reservoir.

5. Individual heater elements may be disconnected from the power source without affecting the operation of the other elements.

6. Caution - Remove the oil heater thermostat before removing the element plate in order to prevent damage to the thermostat sensing element.

SET LINKAGES:

The curved slot linkage is designed to simplify adjustment of the correct proportioning of air to fuel ratio for both high and low fires without low fire adjustment interfering with the high fire adjustment.

A. ASSEMBLY OF LINKAGE:

1. Jack shaft or quadrant must be in high fire position before assembling. See Figure 5-2 and Figure 5-3.
2. Drive arms are secured to jack shaft by tightening the two set screws after setting the drive arms in the 45° position. The connecting rods driving the quadrants are shortened or lengthened by loosening the set screw in the square ball and socket joint, sliding the connecting rod through the socket joint until the 45° position is found. Tighten set screw in the ball and socket joints.
3. With the ball and socket joints and the connecting rod in place as in Fig. 5-3, adjust the rod length so that sliding the square ball and socket joint (when loose) in the curved slot arm (during high fire position) will not make the curved slot arm move. Leave ball and socket at outer end of slot until later.

B. WHEN THE LINKAGE IS PROPERLY ASSEMBLED:

1. Sliding square ball and socket joint back and forth in slot of arm during



FORCED DRAFT SCOTCH PACKAGE UNIT

**A. Adjustments And Repairs
(Continued)**

high fire position does not change setting of damper (or oil valve, gas valve or secondary air dampers).

2. Sliding square ball and socket joint back and forth in slot of arm during low fire position does change setting of damper (or oil valve, etc.) from approximately 20° to 90° movement. If less movement is desired. The angle ball joint may be screwed into another hole of jack shaft drive arm, but connecting rod must be reset so that high fire position is properly adjusted.

C. 1. ALL LINKAGE ADJUSTMENTS ARE MADE AT HIGH FIRE POSITION AND THEN ADJUSTED TO LOW FIRE POSITION.

2. Figure 5-3 shows how the linkage is arranged or must be corrected to achieve the proper final adjustment without difficulty. The linkage is driven to the high fire position by switching the modulating switch on the control cabinet to "manual" and turning the manual potentiometer to "open". To drive the linkage to the low fire position, turn the potentiometer to "close".

D. HIGH FIRE LINKAGE ADJUSTMENT OF THE OIL BURNER:

1. Adjust the high fire first.
2. The slot in end of modulating oil valve stem must be in a vertical plane. Adjust oil volume of high fire with the oil viscosity valve. If stem slot is not vertical loosen the two set screws in the curved slot arm sleeve, turn the stem slot until vertical and tighten both set screws permanently.

3. The slot of the primary air damper stem is nearly horizontal (damper wide open) during high fire. If more, or less, primary air is desired, loosen the two set screws in the curved slot arm sleeve, turn the stem slot to the desired position and tighten both set screws.

4. The secondary air dampers should be adjusted to deliver as much air as is required for a clean efficient fire. If more, or less, secondary air is desired, loosen the two set screws in the curved slot arm sleeve, turn the stem slot to the desired position and tighten both set screws.

E. LOW FIRE LINKAGE ADJUSTMENT OF THE OIL BURNER:

1. To adjust oil flow, loosen the slot nut on the ball and socket joint on the modulating oil valve arm slot. Slide the ball and socket closer to the stem for less oil or to the outer end of the slot for more oil. Tighten the slot nut on the ball and socket joint when desired oil volume of low fire is established. Do not adjust viscosity valve while linkage is in low fire position.
2. To adjust primary air, loosen the slot nut on the ball and socket joint on the primary air damper arm slot. Slide the ball and socket closer to the stem for less primary air or away from stem for more air. Always adjust for as much primary air as possible, without having a rough start.
3. To adjust secondary air, loosen the slot nut on the ball and socket joint on the secondary air damper arm slot. Slide the ball and socket closer to the stem for less secondary air or away from stem for more air.



FORCED DRAFT SCOTCH PACKAGE UNIT

A. Adjustments And Repairs
(Continued)

4. If further adjustments are made for high fire, the low fire adjustments must also be changed.

F. LINKAGE ADJUSTMENT OF GAS VALVE ON
COMBINATION GAS-OIL BURNERS:

1. First, adjust oil burner linkage as per paragraphs "D" and "E", Page 41.
2. With linkage in high fire position loosen the two set screws in the curved slot arm attached to the stem of the gas butterfly valve. Turning the spring assembly of the gas valve counterclockwise

(from stem end) opens gas valve and vice versa. Final adjustment may be made with the screw stop on the valve. Additional high fire adjustment may be made by adjusting the gas pressure regulator.

3. With the linkage in the low fire position, loosen the slot nut on the ball and socket joint in the arm slot. Slide the ball and socket closer to the stem for less gas or away from the stem for more gas. Tighten nut on ball and socket joint. A minimum setting of the gas valve can be made with the screw stop.

- G. On straight gas burners (without oil burner) adjust linkage as per paragraphs D1, D4, E3 E4, F2, and F3, Pages 41 and 42.



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FORCED DRAFT SCOTCH PACKAGE UNIT

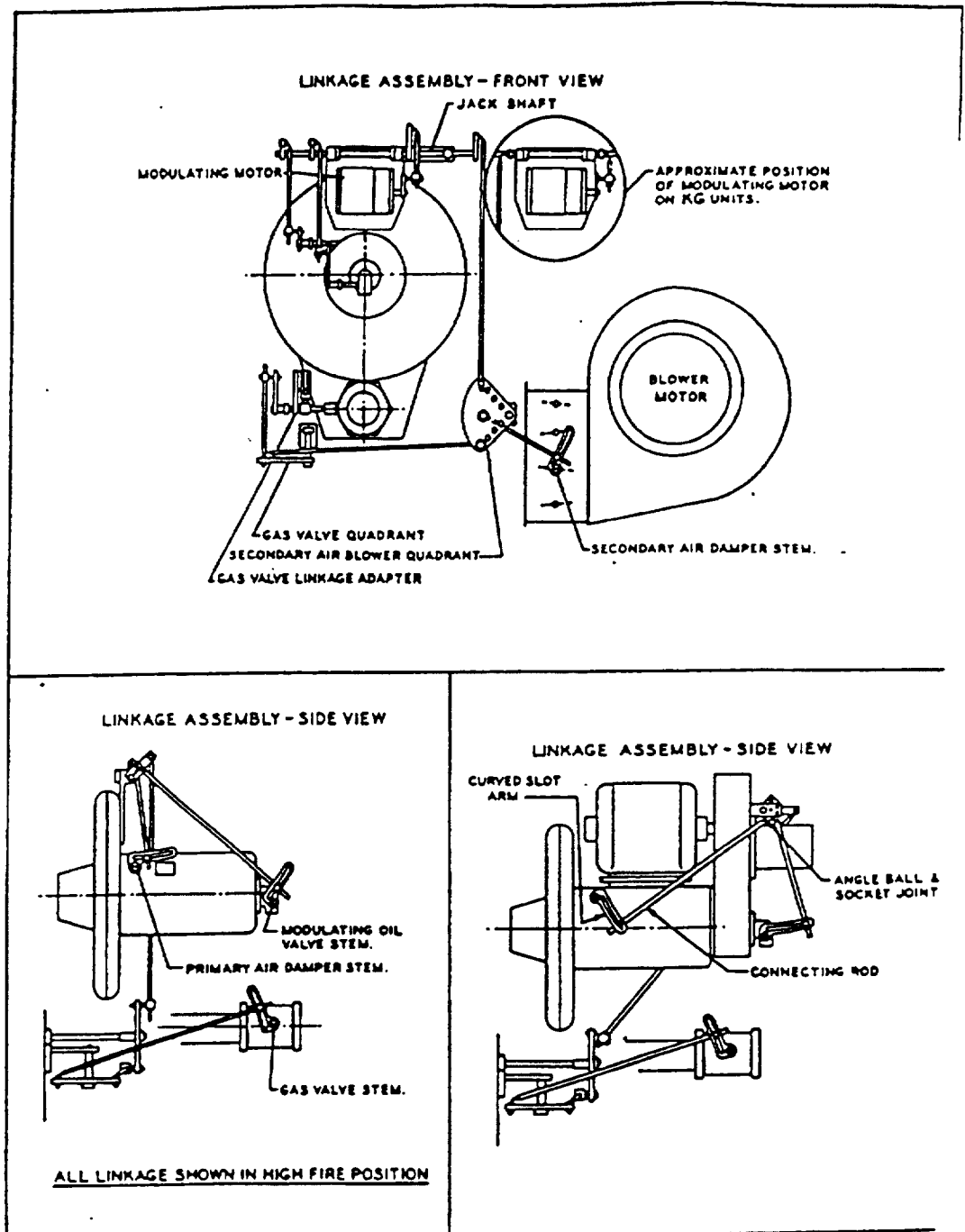


FIG. 5-2—LINKAGE ARRANGEMENT



FORCED DRAFT SCOTCH PACKAGE UNIT

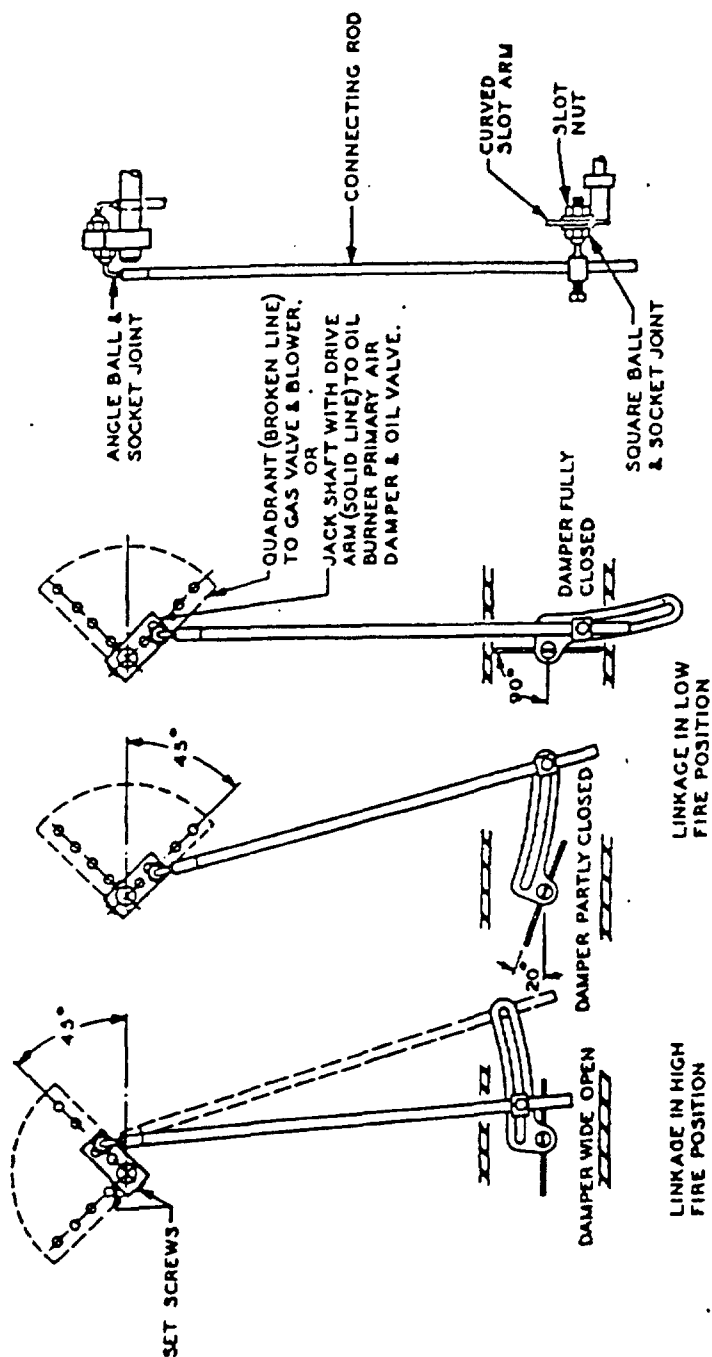


FIG. 5-3—LINKAGE ADJUSTMENT

B. Service Check List

(Read Instructions on Combustion Safety Control)

PROBLEM AND POSSIBLE CAUSE	REMEDY
A. BURNER MOTOR WILL NOT START	
1. Switch off	1. Put switch in "ON" position.
2. Fuse blown	2. Replace fuse.
3. Overload relays disengaged	3. Press reset button on motor starter. If motor appears to be overloaded, check cause.
4. Holding coil of motor starter burned out	4. Replace.
5. Limit controls, low fire interlocks open	5. Increase setting of limit controls to desired pressure, adjust low fire end switch.
6. Low water cut-off open	6. Flush sediment out of low water control. Add water, if necessary.
7. Cold-oil lockout switch open (No. 6 oil models)	7. Engage heater switch and set preheater thermostat to desired temperature. If heater does not warm up, elements may be burned out; if so, replace. If replacement is not available, run a jumper across cold-oil lockout switch and operate burner on cold oil. It is recommended that a constant gas pilot be used to maintain ignition until hot oil is obtained from other preheaters.
8. Programming relay in safe position	8. Press reset button.
B. BURNER MOTOR STARTS, BUT NO FIRE RESULTS—IGNITION FAILURE	
1. Electrode grounded	1. Clean electrode and porcelain. If porcelain is cracked, replace it.
2. Electrode not set properly	2. Adjust for 1/16" to 3/32" spark gap.
3. Defective transformer	3. Replace.
4. Failure of gas supply, or pressure too low	4. Clean magnetic gas valve; make certain that valve is operative. Test pressure. 2"-4" w.c. recommended. Open all valves in gas line.
5. Gas flowing away from spark	5. Gas pressure too high. If over 5" w.c., adjust pressure regulating valve. Forced secondary air may blow out pilot; if so, shield pilot, or reduce size of low fire.
6. Scanner does not see pilot flame	6. Remove, clean and reset.



FORCED DRAFT SCOTCH PACKAGE UNIT

B. Service Check List—Continued

PROBLEM AND POSSIBLE CAUSE	REMEDY
C. BURNER MOTOR STARTS, IGNITION PILOT OBTAINED, BUT NO OIL DELIVERED	
1. Oil valves closed	1. Open gate valve in suction line; open viscosity valve, gate valve, and modulating valve on burner.
2. Storage tank empty	2. Fill.
3. Strainer or viscosity valve clogged	3. Clean strainer or valve.
4. Air in suction line	4. Purge line of air by keeping oil pump in operation and checking suction line for possible air leaks, especially at strainer and swing joints; prime strainer.
5. Solenoid oil valve not opening	5. Coil may be burned out; replace. Valve may be sticking; clean with kerosene or solvent.
6. Water in fuel	6. Pump sludge from bottom of oil storage tank; drain strainer body.
D. FIRE PUFFS BACK AT START	
1. Breeching damper closed	1. Open.
2. Oil too volatile	2. Oil temperature may be too high. 140 to 180° recommended for No. 6 Oil. 140° maximum for No. 5 Oil.
3. Gas pilot not in vicinity of atomizer	3. Pilot passageway must aim towards atomizer and flame should reach lip of atomizer.
4. Improper air and oil mixture	4. Set mixture of air and oil for the most efficient fire.
5. Low fire start	5. Reduce primary air and/or quantity of oil.
E. PULSATING FIRE	
1. Fire too lean	1. Cut down air supply. Adjust secondary and primary air.
2. Air in oil	2. Eliminate air by tightening and purging oil lines.
3. Fire too small	3. If minimum fire is desired for normal operation, a smaller air nozzle may be used.
4. Belts too loose	4. Increase belt tension so that no slipping results.
5. Loose secondary air vanes	5. Secure vanes and tighten linkage.



FORCED DRAFT SCOTCH PACKAGE UNIT.

B. Service Check List—Continued

PROBLEM AND POSSIBLE CAUSE	REMEDY
E. PULSATING FIRE (CONTINUED)	
6. Insufficient combustion air	6. Provide air inlets to boiler room, 125% stack area minimum.
F. BURNER RECYCLES TOO OFTEN	
1. Limit differential set too low	1. Increase limit differential.
2. Low water level set improperly	2. Adjust setting so that burner is not stopped (within safe water levels) before boiler feed replaces water.
3. Surging water level	3. Priming and foaming of boiler. Determine cause of condition and remedy.
G. NOISY OPERATION	
1. Noisy pump	1. Oil pressure too high (35 to 50 lbs.); check and flush lines, fittings and valves, See Page 38.
2. Combustion noises	2. See "E" above.
3. Noisy bearings	3. Replace and check. Remedy cause of bearing failure.
H. CARBON DEPOSITS	
1. Oil impingement	1. Narrow the flame by use of vaned nozzle.
2. No. 6 oil	2. Increase oil temperature.
3. Lack of primary air pressure and volume	3. Open primary air damper. Check burner speed; if less than 3500 RPM check cause (may be low voltage, faulty bearings, loose belts, rotor or fan slipping on shaft, etc.) Fan housing may be fouled with fuel oil; dismantle and clean.
4. Dirty oil atomizer	4. Clean and polish with fine emery paper.
5. Atomizer improperly located in relation to nozzle	5. Atomizer should be concentric with and projecting about 3/32" beyond lip of air nozzle.
6. Oil atomizer damaged	6. Replace oil atomizer if rim is out-of-round or burned.
I. BOILER DOES NOT CARRY LOAD	
1. Steam pressure too low	1. Increase limit and operating control settings.

FORCED DRAFT SCOTCH PACKAGE UNIT

B. Service Check List Continued

PROBLEM AND POSSIBLE CAUSE	REMEDY
1. BOILER DOES NOT CARRY LOAD (CONTINUED)	
2. Firing rate too low	2. Open manual potentiometer. Make sure fuel valves are open. Reset fire if necessary. Check linkages.
3. Dirty heating surfaces	3. Clean tubes.
4. Boiler priming and foaming	4. Drain, flush, condition water.
5. Fire not efficient	5. Check linkages, reset fire for proper combustion.
6. Gas pressure too low	6. Check with local utility.
J. LACK OF HEAT	
1. Valves closed	1. Open supply and return valves. Check zone valves.
2. Poor circulation	2. Check circulating or condensate pumps.
3. Improper distribution	3. Check temperature control system thermostats, valves, traps.
4. Cold areas	4. Check heating units, valves, coils, blowers, filters, traps.
5. Boiler not carrying load	5. See "I" above.



FORCED DRAFT SCOTCH PACKAGE UNIT

CHAPTER 3

PARTS PROCEDURES

A. Ordering Replacement Parts

WHERE TO ORDER PARTS:

Parts for Kewanee units should be ordered from the authorized Kewanee Service Representative who started and adjusted your unit. His name is listed on the first page of this manual or on the Operating Instruction Card. If necessary, parts may be ordered direct from American-Standard Industrial Division, 101 Franklin Street, Kewanee, Illinois, or from your local American-Standard Industrial Division or Kewanee Sales Office.

HOW TO ORDER PARTS:

1. Always include complete nameplate data as shown on the boiler fluedoor and on the burner windbox.
2. If parts are required for electric controls, motors, pumps, etc., also include complete nameplate data taken from the item for which the parts are required.
3. List the complete name, description and Kewanee part number of each part included in your order. Refer to the Parts List in this manual.
4. State quantity desired of each item.
5. State whether shipment is to be made by express, parcel post or freight.

PARTS RETURNED UNDER WARRANTY OR FOR REPAIR:

1. Notify American-Standard Industrial Division, Kewanee, Illinois (or your local ASID or Kewanee Sales Office) of the part to be returned; model and serial number of unit from which it was

taken; whether the part is being returned for credit, replacement, or repair. A Return Material Tag will be sent to you.

2. Do not send any part to the Kewanee plant without a Return Material Tag
3. Remove usable fittings from the part drain oil (if any), clean, and attach the appropriate section of the Return Material Tag securely to the part.
4. Pack the part properly to avoid shipping damage and ship prepaid to American-Standard Industrial Division, 101 Franklin St., Kewanee, Illinois.

B. Replacement Parts Inventory

Every boiler plant owner can assure more economical and effective operation by purchasing a small inventory of replacement parts for the use of the operator in maintaining and servicing the boiler unit.

The following suggested list of replacement parts stock is a minimum inventory. Consult your authorized Kewanee service representative for replacement parts stock adequate to meet the full requirements of your particular job.

1. Replacement electrical fuses.
2. Set of tubes for electronic control.
3. Scanner cell for electronic control.
4. Set of manhole and handhole gaskets.
5. Water gauge glass with rubber gaskets.
6. Ignition electrode and porcelain.
7. Gear box lubricant.
8. Oil strainer gasket.
9. Oil atomizing cup.
10. V-Belts (for oil pump and V-Belt burners only).



FORCED DRAFT SCOTCH PACKAGE UNIT

PARTS LIST INDEX

To determine correct name of the various parts, refer to the following figures:

	Page
Fig. 6-1 Direct Drive Burner.....	51
Fig. 6-1 Belt Drive Burner	51

DESCRIPTION	PAGE	DESCRIPTION	PAGE
Air Nozzle Assembly	52	Motor Mount Plate and Parts	58
Air Damper	52, 62	Motor Starters	59
Atomizer	52	Oil Pump and Parts	53, 56
Bearings and Caps	53	Pump Drive Gear	53
Belts, Ropes and Sheaves	57	Pump Drive Worm	53
Clamps	52	Pump Hole Cover	53
Contactors	59	Oil Strainers and Parts	56
Controls:		Oil Valves and Coils	60
Variable Fire Motors and Parts	59	Plastic Cones	52
Motor Starters-Ignition Transformers..	59	Preheaters and Parts	54
Heater Contactors-Enclosed Relays...	59	Pulleys, Shaft and Motor	57
Air and Gas Pressure Switches and		Pump Set Parts	56
Interlocks	60	Rear End Modulating Valve	54
Gas Pilot Valves and Pressure		Relief Valve	54
Regulators	60	Retaining Rings	53
Program Controls and Parts	60, 61	Rotary Seal	54
Control Cabinet Parts	61	Rotor Locknut and Keyed Washer....	53
Drip Trap	53	Seals:	
Fan Housing Assembly	52, 62	Pump	56
Fireye Controls	60, 61	Burner	54
Front Plate Assembly	52	Shaft, Burner	53
Gauges and Fittings	54	Shaft Slinger	53
Gear Box Assemblies	52	Shut-off Hand Valve	54
Gear, Pump Drive	53	Stop Drip Trap	53
Ignition Assembly	55	Strainer Assembly	56
Latch Switch Box and Parts	52	Swing Manifold Assembly	54
Linkage, Oil Burner	55	Thermometer	55
Main Shaft	53	Transformers	59
Manifolds:		"V" Belts	57
Swing-2 Pass	55	"V" Ropes	57
Gas	61	Valves	60
Minneapolis-Honeywell Controls	59, 61	Viscosity Valve Assembly	54
Motors	58		

FORCED DRAFT SCOTCH PACKAGE UNIT

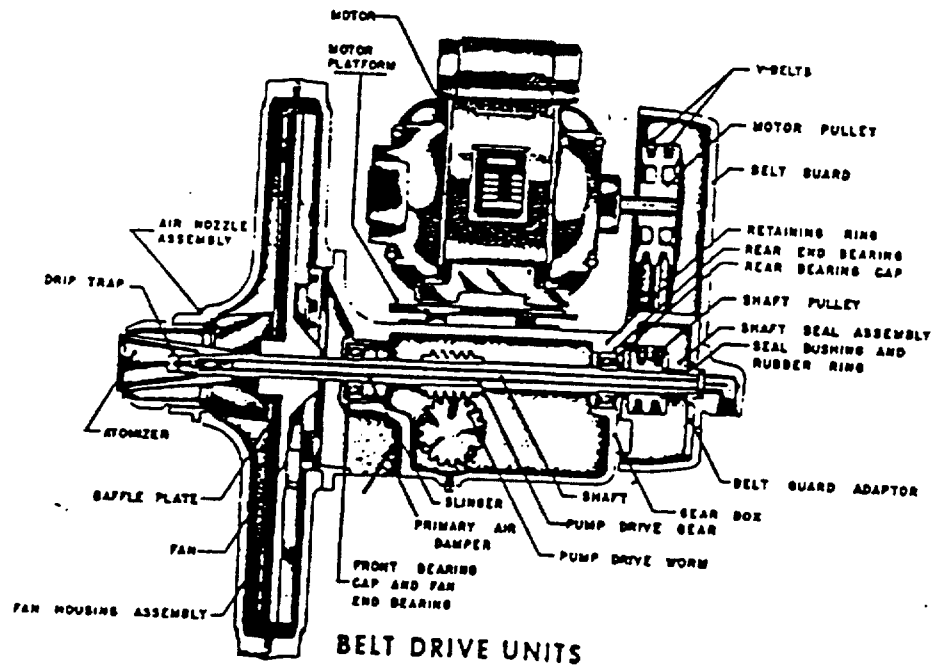
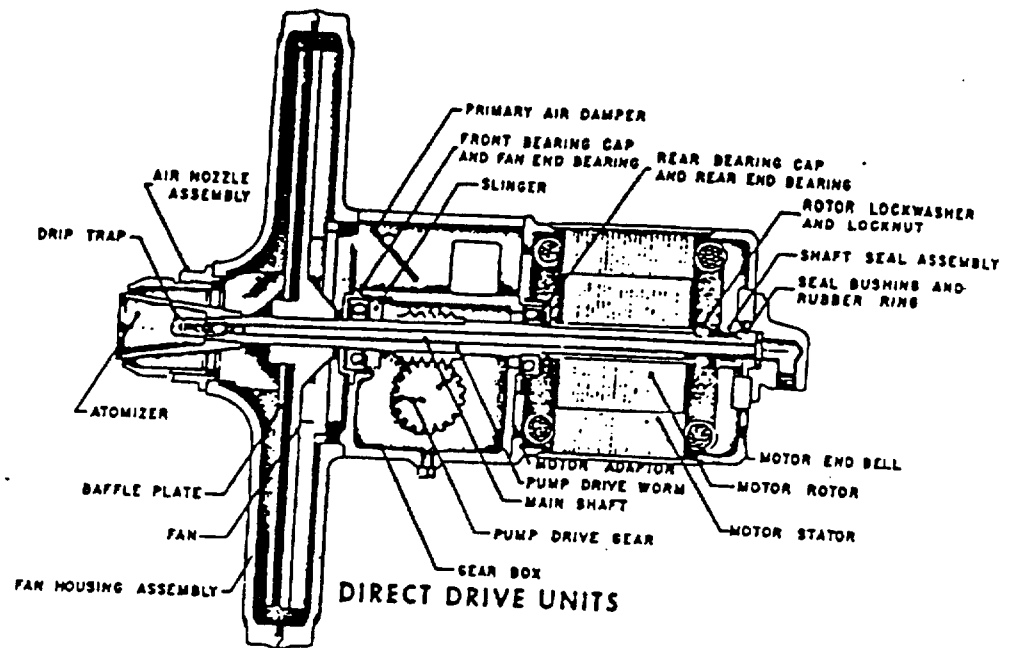


FIG. 6-1—PARTS IDENTIFICATION



Kewanee Boiler Manual

FORCED DRAFT SCOTCH PACKAGE UNIT

PARTS DESCRIPTION

DESCRIPTION	UNIT SIZE	PART NUMBER		DESCRIPTION	UNIT SIZE	PART NUMBER
OIL ATOMIZER (Cup)				PLASTIC CONE (Standard)		
Standard		Tapered	Str. Shot	Used in tile door or	80-82	290351
O.D. x Length		Std.	Special	gas manifold	83-93	290352
2 x 4-1/2	80-82	290026	290327	PACKING (Asbestos Seal)		
2-1/2 x 5	83-85	290027	290328	1/4 x 1/4 x 25" for #290348	80-82	290353
3 x 5-1/2	86-88	290028	290329	Plastic Cone	83-93	290354
3 x 6-1/2	89-93	290029	290330	1/4 x 3/8 x 37" for #290349 and		
				290350 Plastic Cone		
				"Tadpole" cross section tape for		
				forced draft manifold or tile door		
				seal.		
				 24"	80-82	290355
				 37"	83-93	290356
AIR NOZZLE ASSEMBLY		Plain	Fixed	PACKING CLAMP		
Std. Lg.		(No	Vane	Holds tadpole tape in	80-82	290357
Bore Bore		Vanes)	20°	manifold or tile door	83-93	290358
2-3/8 2-1/2	80-82	290331	C.W.			
3 3-1/8	83-85	290332	Vane			
3-5/8 3-1/4	86-88	290333	290336			
3-3/4 4	89-91	290334	290337			
4 4	92-93	290335	290338			
			290021			
			290022			
			290023			
			290024			
			290025			
If C.C.W. rotation, a different angle or large bore is desired, specify requirement on order.				TILE DOOR CLAMP		
				Holds tile door or gas manifold to		
				forced draft windbox.	80-93	290359
				LATCH SWITCH BOX		
				Assembly includes box, hinged		
				cover, mounting plate, clamp		
				plate, stiffener, switch and		
				terminal enclosure.	80-93	290360
				SWITCH only for		
				290360 assembly	80-93	290361
				TERMINAL ENCLOSURE only		
				for switch	80-93	290362
				LATCH LEVER		
				Assembly includes spacer and		
				attaching screws	80-93	290254
				GEAR BOX ASSEMBLY		
				For direct drive burners with in-		
				tegral pumps only, including gear		
				box body, shaft, bearings, pump		
				and gears, air damper, drip trap,	80-82	290030
				retaining ring(s), slinger(s), bear-	83-85	290031
				ing cap(s), L.H. locknut and keyed	86-88	290032
				washer, fan keys and oil fill cup.	89-91	290363
				GEAR BOX ASSEMBLY		
				For direct drive, pumpless burners		
				only, including gear box body,		
				shaft, bearings, cover plate, air		
				damper, drip trap, retaining ring(s),		
				slinger(s), bearing cap(s), L.H.	80-82	290033
				locknut and keyed washer and fan	83-91	290034
				keys.		

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FORCED DRAFT SCOTCH PACKAGE UNIT

PARTS DESCRIPTION—Continued

DESCRIPTION	UNIT SIZE	PART NUMBER	DESCRIPTION	UNIT SIZE	PART NUMBER
GEAR BOX ASSEMBLY			BEARINGS		
For belt drive burners with integral pumps only, including gear box body, shaft, bearings, pump and gears, air damper, drip trap, retaining ring(s), slinger, bearing cap(s), fan keys and oil fill cup.			Both Ends of Shaft	80-82 83-93	290061 290063
Ser. #9291 to #24453	80-82	290035	FRONT BEARING CAP		
Ser. #24453 and Up	83-85	290036	Direct Drive Burners		
Ser. #9291 to #24453	86-88	290037	All	83-91	290069
Ser. #24453 and Up	86-88	290364	Belt Drive Burners		
Ser. #9291 to #24453	89-91	290365	All	83-91	290070
Ser. #24453 and Up	89-91	290366	Ser. #9291 to #24453	86-91	290371
All	92-93	290365	Ser. #24453 and Up	86-91	290070
			All	92-93	290371
GEAR BOX ASSEMBLY			REAR BEARING CAP		
For belt drive, pumpless burners only, including gear box body, shaft, bearings, cover plate, air damper, drip trap, retaining ring(s), bearing cap(s), slinger and fan keys.	80-82	290040	Direct and Belt Drive Burners	80-82	290063
Ser. #9291 to #24453	83-85	290041	Includes Ret. Ring	83-93	290064
Ser. #24453 and Up	86-91	290368			
All	86-91	290041			
	92-93	290368			
PUMP HOLE COVER			RETAINING RINGS		
For pumpless gear boxes	80-82	290097	Rear Bearing (Tru-Arc)		
	83-93	290098	Direct and Belt Drive		
			for Gear Box Mtg.	80-82	290065
			Direct and Belt Drive	83-93	290066
			for Bearing Cap Mtg.		
PRIMARY AIR DAMPER			ROTOR LOCKNUT AND KEYED WASHER		
Includes plate, shaft and screws.			Direct Drive Burners	80-82	290067
Direct Drive Burners	80-82	290043		83-91	290068
	83-91	290044			
Belt Drive Burners	80-82	290045			
	83-93	290046			
GEAR BOX BODY With air damper			DRIp TRAP		
Direct Drive Burners	80-82	290047		80-82	290071
	83-91	290048		83-91	290072
Belt Drive Burners	80-82	290050		92-93	290073
	83-93	290051			
GEAR BOX EXTENSION			SHAFT SLINGER		
Belt Drive Burners	92-93	290369	Front Bearing	80-82	290074
				83-93	290075
GEAR BOX OIL FILL CUP			Rear Bearing	83-91	290076
Integral Pump Burners Only	80-93	290054	Direct Drive Only		
GEAR BOX LUBE (WGO)			PUMP DRIVE WORM		
Integral Pump Burners Only	80-93	290055	Integral Pump Burners Only		
			Three Thread	80-82	290077
MAIN SHAFT			Two Thread	83-88	290078
Direct Drive Burners	80-82	290056	Three Thread	89-93	290079
	83-91	290057			
Belt Drive Burners	80-82	290058	PUMP DRIVE GEAR		
	83-85	290059	Integral Pump Burners Only		
Ser. #9291 to #24453	86-91	290370	Mate of Worm	Number of Teeth	Bore of Gear
Ser. #24453 and Up	86-91	290059	290077	19	7/16"
All	92-93	290371	290078	21	5/8"
			290079	21	3/4"

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FORCED DRAFT SCOTCH PACKAGE UNIT

PARTS DESCRIPTION—Continued

DESCRIPTION	UNIT SIZE	PART NUMBER	DESCRIPTION	UNIT SIZE	PART NUMBER
<u>VISCOSITY VALVE</u>			<u>FITTING - Oil Burner</u>		
Assembly	80-82*	290204	Pressure Gauge, Hex Brass with 1/8" N.P.T. tapped hole on side for gauge. N.P.T. Threads.		
	83-85	290205	3/8" Fem. x 3/8" Male x 1-3/4" long	80-82	290200
	86-91	290206	3/8" Male x 3/8" Male x 1-7/8" long	80-82	290201
	92-93	290207	1/2" Male x 1/2" Male x 2" long	83-85	290202
*Size 80-82 "H" Models require 290205 assembly.			3/4" Male x 3/4" Male x 2" long	86-93	290203
<u>STEM assembly</u>			<u>REAR END MODULATING VALVE</u>		
Viscosity Valve			Assembly Including	80-88	290179
Includes stem, lower and relief pistons, spacer, spring and spring follower.	80-85	290372	Plugged Holes for	89-91	290178
	86-93	290373	Thermometer and Lubricant	92-93	290180
<u>ADJUSTING WHEEL</u>			<u>REPAIR KIT</u>		
Viscosity Valve Assembly	80-93	290374	For Rear End Modulating Valve.	80-93	290181
			Includes 2 "O" Rings and 2 Tru-Arc Rings with Instructions.		
<u>SPRING Only</u>			<u>ROTARY SEAL Assembly</u>		
Viscosity Valve Assembly	80-93	290375	Complete with instructions	80-93	290182
<u>HAND VALVE (Shut-off)</u>			<u>SWING MANIFOLD</u>		
3/8" Gate Valve	80-85	290208	2 Pass Assembly.		
1/2" Gate Valve	86-93	290209	Includes one body, 2 nipples and 2 "O" rings	80-92	290183
				83-93	290184
<u>RELIEF VALVE (Adjustable)</u>			<u>BODY - (2 Pass Swing Manifold)</u>	80-82	290185
75# Factory Set				83-93	290186
Size			<u>NIPPLE - (2 Pass Swing Manifold)</u>		
3/4" I.P.S.		263077	Top and Bottom Nipples are alike	80-82	290187
1" I.P.S.		290210	Includes one "O" Ring	83-93	290188
1-1/4" I.P.S.		260084	<u>"O" RINGS - (2 Pass Swing Manifold)</u>	80-82	290189
			Set of 2	83-93	290190
<u>VACUUM GAUGE (Oil)</u>			<u>ELECTRIC OIL PREHEATERS AND PARTS</u>		
0-30" - 1-5/8" O.D. - 1/8" I.P.S.			<u>HEATER ASSEMBLY Complete</u>		
Oil Burner Mounting	80-93	290191	Less Thermostat and Wiring.		
			Specify voltage.		
<u>PRESSURE GAUGE (Oil)</u>			2500 Wats	80-82	290224
0-100 P.S.I. - 1-5/8" O.D. - 1/8" I.P.S.			3750 Wats	83-85	290225
Oil Burner Mounting	80-93	291092	5000 Wats	86-93	290226
0-200 P.S.I. - 2-1/4" O.D. - 1/4" I.P.S.			7500 Wats		290386
Oil Pump Set Mounting	80-93	291093	10000 Wats		290388
<u>FITTING - Oil Burner</u>			<u>HEATER BODY</u>		
Vacuum Gauge, Hex Brass with 1/8" N.P.T. tapped hole on side for gauge. N.P.T. Threads.			Machined casting and gasket only.		
3/8" Fem. x 3/8" Fem. x 1-1/2" long	80-82	290194	2500 Wats Size	80-82	290227
3/8" Male x 3/8" Fem. x 2" long	80-82	290195	3750 Wats Size	83-85	290228
1/2" Male x 1/2" Fem. x 2" long	83-85	290196	5000 Wats Size	86-93	290228
3/4" Male x 3/4" Fem. x 2" long	86-93	290197			

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FORCED DRAFT SCOTCH PACKAGE UNIT

KVS HC-92

PARTS DESCRIPTION-Continued

DESCRIPTION	UNIT SIZE	PART NUMBER	DESCRIPTION	UNIT SIZE	PART NUMBER
HEATER COVER Assembly Includes cover, hinge, plate and body gasket.			PILOT SHUTTER Oil Burners Only		290402
For 2500 Watt Heater	80-82	290229	OIL BURNER LINKAGE SYSTEM Curved slot type.		
For 3750 Watt Heater	83-85	290230		80-82	290403
For 5000 Watt Heater	86-93	290231		83-85	290404
For 7500 Watt Heater		290389		86-88	290405
For 10000 Watt Heater		290390		89-93	290406
HEATER BODY GASKET When heater has two bodies order one gasket for each body.			The above systems include the following parts in the required amounts.		
For 1 element heater		290391	MOTOR MOUNT PLATE For variable fire motors		290255
For 2 element heater		290392	CURVED SLOT ARM 1/c Standard (RH)		290257
For 3 element heater		290393	Special (LH)		290407
For 4 element heater		290394	JACK SHAFT For Variable Fire Motor Mount Plate 290255 1 Required		290408
For 2 element heater in 290228 body		290395	DRIVEN ARM (3-1/4" Long) Installed on 290408 Jack Shaft and Driven by Variable Fire Motor 2 Required		290256
HEATER ELEMENTS 1250 Watts Nominal Rating 115 Volts		290234	DRIVE ARM (1-3/4" Long) Installed on 290408 Jack Shaft to Drive Curved Slot Arms 2 Required		290413
230 Volts		290235	THRUST BEARING For 290408 Jack Shaft - 1/2" Hole 2 Required		290414
275 Volts		290236	SLEEVE BEARING Including Holder and Screw for Supporting Jack Shaft 2 Required		290416
HEATER THERMOSTAT Dual control - with thermostat and cold oil lockout		290396	BALL AND SOCKET JOINT Angle Type		290261
Single control - thermostat only		290397	Square Type (Straight)		290262
THERMOMETER - Oil Temperature Round Dial - 1/4" Male I.P.S. for on burner piping		290238	CONNECTING ROD 5/16" Diameter, threaded one end 1/4-20. 12 Inch		290258
Fan shaped dial - 1/2" Male I.P.S. for off burner piping		290237	24 Inch		290259
IGNITER ASSEMBLY Includes igniter body or discs, nozzle, spud, clamp, electrode and porcelain and voltage conductors. Specify type of gas.		290239	36 Inch		290260
PILOT SPUD Natural Gas		290398			
L.P. Gas		290244			
SCANNER TUBE Only For Igniter Assembly		290399			
ELECTRODE AND PORCELAIN For Igniter Assembly		290400			
PILOT GUARD Oil Burners Only		290401			

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FORCED DRAFT SCOTCH PACKAGE UNIT

PARTS DESCRIPTION—Continued

DESCRIPTION	UNIT SIZE	PART NUMBER	DESCRIPTION	UNIT SIZE	PART NUMBER
QUADRANT ASSEMBLY			PUMP ADAPTER		
For Driving Linkage. Includes one straight, one angle ball and socket joint, screws and lock washers for attaching to windbox.			Integral Part of 290104	83-85	290087
For Gas Valve Linkage		290417	Integral Part of Pumps 290105 and 290443	86-93	290088
For Blower Linkage		290418			
ADJUSTABLE ANGLE TYPE QUADRANT			PUMP SEAL and Cap Gasket		
Used when necessary to prevent strain on ball and socket joints of either gas valve or blower linkage		290419	Part of Pump 290104	83-85	290091
			Part of 290105 and 290443	86-93	290092
QUADRANT BRACKET Only			PUMP CAP and Gasket		
For Gas Valve Quadrant		290420	Part of 290104 Pump	83-85	290089
For Blower Quadrant		290421	Part of 290105 and 290443	86-93	290090
For Adjustable Angle Type Includes Movable Arm and Hinge Bolt, Nuts and Washers		290422			
OIL STRAINER, OIL PUMPS AND PARTS			GASKET Only for Cap		
STRAINER Assembly			Part of 290104 Pump	83-85	290093
Includes body, basket, outer cap, gasket, inner cap and lock handle.	80-82	290211	Part of 290105 and 290443	86-93	290094
	83-93	290212			
STRAINER BODY			RETAINING RING (Tru-Arc)		
	80-82	290213	Sets in groove in pump shaft behind seal.		
	83-93	290214	Part of 290104 Pump	83-85	290095
STRAINER BASKET			Part of 290105 and 290443	86-93	290096
	80-82	290215			
	83-93	290216			
STRAINER OUTER CAP			FOOT MOUNTED OIL PUMP ASSEMBLY		
	80-82	290217	Includes Pump, Foot, Outboard Bearing and Shaft Key		
	83-93	290218	For Tuthill Pump Set Number:		
STRAINER INNER CAP			1B, C		290100
	80-82	290219	2A, B, C		290101
	83-93	290220	3A, B, C		290102
STRAINER GASKET			4A, B, C		290444
	80-82	290221	5A, B, C		290445
	83-93	290222	6A, B, C		290446
STRAINER LOCK HANDLE					
3/4-10 Screw Thread	80-93	290223			
OIL PUMP AND SHAFT KEY			MOTOR BASE ASSEMBLY		
Complete with shaft seal. Replacement unit for integral pump burners where indicated and for pump set numbers:			Adjustable to fit motors on No. 1-4 pumps		290114
1A-1B-1C-1D (Tuthill 1LK)		290103			
2A-2B-2C (Tuthill 1L)		290084	PUMP SET BASE		
3A-3B-3C (Tuthill 2CS)		290104	No. 1-4		290447
4A-4B-4C (Tuthill 3CS)		290105	No. 5-6		290448
5A-5B-5C (Tuthill 4CS)		290443			
6A-6B-6C (Tuthill 5CS)		"	PUMP SET BELT GUARD		
		"	No. 1-4		290449
		"	No. 5-6		290450

*Do not use on pump sets
 **See Foot Mounted Oil Pump Assemblies

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FORCED DRAFT SCOTCH PACKAGE UNIT

PARTS DESCRIPTION—Continued

DESCRIPTION			UNIT SIZE	PART NUMBER	DESCRIPTION			UNIT SIZE	PART NUMBER			
SHEAVE (Pump Shaft)					STANDARD "A" GROOVE (1/2" Width) DRIVES							
O.D.	Bore	Grvs.			SHEAVE (Burner Shaft)							
12	7/16	1	.....	1B-1C	290117	Elec.						
10	7/16	1	.....	1D	290451	Cycle	O.D.	Bore	Grooves			
12	5/8	2	.....	2A	290113	50	2-1/2	3/4	2			
11	5/8	2	.....	2B	290119	60	3	3/4	2			
9	5/8	2	.....	2C	290120	50-60	3	3/4	2			
12	3/4	2	.....	3A-4A		50-60	3	3/4	3			
				-4B	290121	SHEAVE (Motor Shaft)						
11	3/4	2	.....	3B-4C	290122	Cycle	O.D.	Bore	Grooves			
9	3/4	2	.....	3C	290123	50-60	6	"	2			
12	1	2	.....	5A, 5B		60	6	"	2			
				6A, 6B	290452	50	+7-1/4	"	2			
9	1	2	.....	5C, 6C	290453	60	6	"	3			
						50	+7-1/4	"	3			
						60	6	"	3			
SHEAVE (Motor Shaft)					*Include motor shaft diameter.							
3-1/4	1/2	1	.....	1B	290454	BELTS AND ROPES						
3-1/4	5/8	1	.....	1B	290124	Cycle	Size	Type				
3-1/4	3/4	1	.....	1B	290125	50-60	A31	Rope.....	80-82			
4-1/4	1/2	1	.....	1C-1D	290455	60	A33	Rope.....	83-85			
4-1/4	5/8	1	.....	1C-1D	290126	50	A35	Rope.....	83-85			
4-1/4	3/4	1	.....	1C-1D	290127	60	A34	Rope.....	86-91			
2-1/4	5/8	2	.....	2A-3A		50	A36	Rope.....	86-91			
				-4A	290130	-	A38	Rope.....	92-93			
2-1/4	3/4	2	.....	2A-3A		GATES SUPER "HC" 3V (3/8" Width) DRIVES						
				-4A	290128	SHEAVE (Burner Shaft)						
2-1/4	7/8	2	.....	5A-5C		Elec.						
2-3/4	5/8	2	.....	6A-6C	290456	Cycle	O.D.	Bore	Grooves			
				2B-2C		60	3	3/4	1			
2-3/4	3/4	2	.....	3B-3C	290131	50	2-1/2	3/4	1			
				4B-4C		60	3-3/4	3/4	1			
2-3/4	7/8	2	.....	2B-2C		50	3-1/8	3/4	1			
				3B-3C		60	3-3/4	3/4	2			
				4B-4C	290129	50	3-1/8	3/4	2			
				5B-6B	290457	60	3-3/4	3/4	3			
Motor shaft diameter determines bore of sheave.					50					3-1/8	3/4	3
					60					3-1/4	3/4	3
					50					2.8	3/4	3
BELTS (Pump Set)					SHEAVE (Burner Shaft)							
Belt Length	Amount Req.					Elec.						
46	1			1B	290134	Cycle	O.D.	Bore	Grooves	80-82	290461	
46	2			2A-3A		60	3	3/4	1	80-82	290462	
				4A-4B	290134	50	2-1/2	3/4	1	83-85	290463	
48	1			1C	290135	60	3-3/4	3/4	1	83-85	290464	
44	1			1D	290133	50	3-1/8	3/4	1	86-88	290465	
44	2			2B, 3B,		60	3-3/4	3/4	2	86-88	290466	
				4C	290133	50	3-1/8	3/4	2	89-91	290467	
41	2			2C, 3C	290132	60	3-3/4	3/4	3	89-91	290468	
50	2			5A, 5B,		50	3-1/8	3/4	3	92-93	290469	
				6A, 6B	290458	60	3-1/4	3/4	3	92-93	290470	
45	2			5C, 6C	290459	50	2.8	3/4	3			

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FORCED DRAFT SCOTCH PACKAGE UNIT

PARTS DESCRIPTION—Continued

DESCRIPTION				UNIT SIZE	PART NUMBER
GATES SUPER "HC" JV (3/8" Width) DRIVES (Cont.)					
SHEAVE (Motor Shaft)					
Cycle	O.D.	Bore	Grooves		
50-60	6	5/8	1 ..	80-82	290471
50-60	7-1/2	7/8	1 ..	83-85	290472
50-60	7-1/2	1-1/8	2 ..	86-88	290473
50-60	7-1/2	1-1/8	3 ..	89-91	290474
50-60	7-1/2	1-3/8	3 ..	92-93	290475
BELTS ("HC" 3/8")					
Cycle	Size				
50-60	3V335			80-82	290476
60	3V400			83-85	290477
50	3V375			83-85	290478
50-60	3V400			86-93	290477
MOTOR MOUNT PLATE					
Belt Drive Burners. Plates must be drilled and tapped to match motor base holes.				80-82 83-91 92-93	290136 290137 290139
PIN (Motor Mount Plate)					
Belt Drive Burners 3/8" O.D. x 8" Long				80-82	290140
1/2" O.D. x 9-3/8" Long				83-93	290141
When ordering any motor, include the following information from motor to be replaced:					
1. Motor Manufacturer					
2. Motor Frame					
3. Horsepower					
4. Operating Voltage, Phase and Cycle					
5. Burner Serial Number (Not Motor Serial Number)					
If the motor to be replaced is obsolete or unavailable, we will supply the motor we now are using for the same purpose or promptly recommend the best way to get the burner back in operation.					

DESCRIPTION				UNIT SIZE	PART NUMBER
DIRECT DRIVE OIL BURNER MOTORS, 3500 RPM: 208, 220, or 440 volt, 3 phase 60 cycle					
ROTOR AND STATOR					
1 HP					290306
1-1/2 HP					290307
3 HP					290308
5 HP					290309
STATOR Only					
1 HP					290310
1-1/2 HP					290311
3 HP					290312
5 HP					290313
DIRECT DRIVE BURNER MOTOR					
GEAR BOX ADAPTER & END BELL					
Motor Make	Motor Frame	Motor HP	Unit Size	Adapter Part No.	End Bell Part Number
L.A.	163	1	80-82	290152	290146
L.A.	203	1-1/2	83-85	290154	290148
L.A.	224	3	86-88	290155	290149
U.S.	66-5	1	80-82	290479	290483
U.S.	56-8	1	80-82	290151	290145
U.S.	203-1	1-1/2	83-85	290480	290484
U.S.	204-2	1-1/2	83-85	290481	290485
U.S.	182	1-1/2	83-85	290153	290147
U.S.	184	3-5	86-91	290153	290147
BASE MOUNT MOTORS					
Used on belt drive oil burners, pump sets and inlet vortex type forced draft blowers.					
1750 RPM-60 cy, 1425 RPM-50 cy.					
115 or 230 volt, single phase					
1/3 HP					290296
1/2 HP					290297
3/4 HP					290487
1 HP					290299
1-1/2 HP					290300
208, 220 or 440 volt, 3 phase					
1/3 HP					290488
1/2 HP					290298
3/4 HP					290489
1 HP					290301
1-1/2 HP					290490
3 HP					290491
5 HP					290492
7-1/2 HP					290493
1160 RPM, 7-1/2 HP					290494

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SCOTCH PACKAGE UNIT

FORCED DRAFT SCOTCH PACKAGE UNIT,

PARTS DESCRIPTION—Continued

DESCRIPTION	UNIT SIZE	PART NUMBER	DESCRIPTION	UNIT SIZE	PART NUMBER
FLANGE MOUNT MOTORS			MAGNETIC MOTOR STARTERS		
Used on opposed damper type forced draft blowers and "G" Burners			NEMA SIZE		
1750 RPM, 60 cycle			00 Includes overload coils		290517
115 or 230 volt, single phase			0 Includes overload coils		290316
1 HP		290493	1 Includes overload coils		290317
1-1/2 HP		290496	M-H M931A MODULATING MOTOR		
208, 220 or 440 volt, 3 phase			Replaces M904E. Less transformer		236003
1 HP		290497	M-H M604C 2-POSITION MOTOR		
1-1/2 HP		290498	160° stroke. Less transformer.		
2 HP		290499	15 second timing		290507
3 HP		290500	60 second timing		290508
5 HP		290501	M-H AT72 Transformer		
7-1/2 HP		290502	For M904E, M931A, M604C and other 25 volt motors. Plate mounting on 4" junction box.		
1160 RPM, 7-1/2 HP		290503	AT72D1188, 115 volt		290511
When ordering, include the following information from starter to be replaced:			AT72D1196, 208 volt		290512
1. Starter Manufacturer			AT72D1204, 230 volt		290513
2. NEMA Size (00, 0 or 1)			LOW FIRE START		
3. Catalog Number (On starter)			Interlock Switch, adapter, arm and elec. conduit.		
4. Overload Heater Coil Number			For M904E, M931 and M604C		290514
5. Voltage of Magnetic Coil			SWITCH Only		
From motor energized by starter:			M-H BZE 6-2RQ		290516
1. Motor Manufacturer			RELAYS In Enclosures		
2. Horsepower			S.P.S.T. 115 volt		290520
3. Operating Voltage			S.P.S.T. 208 volt		290521
4. Label Amperage at Oper. Volts			S.P.S.T. 230 volt		290522
To further assure getting a proper replacement, include the burner serial number (not the motor) and which motor is controlled by this starter. This might be the oil burner, pump set or combustion air blower.			D.P.D.T. 115 volt		290523
If the starter to be replaced is obsolete, we will supply the latest type with the proper overload protection, provided that we have received the above information.			D.P.D.T. 208 volt		290524
STARTER OVERLOAD COILS			D.P.D.T. 230 volt		290525
Supply the same information as for motor starters above.			IGNITION TRANSFORMER		
Pkg. of 2		290318	6000 Volt Secondary*		
MAGNETIC CONTACTORS			120 volt, 50/60 cy. primary		290526
(Used with some electric oil heaters)			240 volt, 50/60 cy. primary		290527
3 Pole - 30 Amp. - 110 V - 550 V.			10000 Volt Secondary**		
Without enclosure - 115 volt coil		290319	120 volt, 50/60 cy. primary		290528
- 230 volt coil		290320	240 volt, 50/60 cy. primary		290529
With enclosure - 115 volt coil		290518	*Replaces all 5000 V. trans.		
- 230 volt coil		290519	**For diesel ignition oil burners		
When ordering, specify the part number, coil voltage, heater watts, volts, phase and burner serial number.			When ordering, give the burner serial number		

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FORCED DRAFT SCOTCH PACKAGE UNIT

1-704-375-1701

PARTS DESCRIPTION—Continued

DESCRIPTION	UNIT SIZE	PART NUMBER	DESCRIPTION	UNIT SIZE	PART NUMBER
GC L38E100 AIR-OIL INTERLOCK Mounted on Pumps & FIA Burners Range 2"-14" W.C.		290267	G-C K10-3/8" Valve Main oil burner fuel oil shut-off. (Glass Wound Coil) Complete Valve - 120 Volt 290276 Replacement Coil Only - 120 Volt 290282 Complete Valve - 208 Volt 290277 Replacement Coil Only - 208 Volt 290283 Complete Valve - 240 Volt 290278 Replacement Coil Only - 240 Volt 290284 Union Gasket Only 290288		
GC L38E101 FORCED DRAFT AIR INTERLOCK (Vortex Inlet Blowers) Range .5"-5.0" W.C.		290530	G-C K10-1/2" Valve 100 G.P.H. and larger oil burner Main shut-off valve (Glass wound coil) Complete Valve - 120 Volt 290279 Replacement Coil Only - 120 Volt 290285 Complete Valve - 208 Volt 290280 Replacement Coil Only - 208 Volt 290286 Complete Valve - 240 Volt 290281 Replacement Coil Only - 240 Volt 290287 Union Gasket Only 290289		
M-H C64SA Pressure Switch Gas Line Low Pressure S.P.D.T. Range 2"-20" W.C.		254084	M-H V4001-A Oil Valve Diesel Ignition, Delayed Opening 120 Volt 263625 208 Volt 263626 240 Volt 263627		
M-H C437G Pressure Switch Opens on Pressure Rise High pressure gas interlock Range 1-16 oz. 254077 Range .5-5 lb. 254054			MAXITROL RV-42 Pilot Gas Pressure Regulator with Adj. HO ¹ (Blue) Spring 4"-12" W.C. For 2 psi or under gas supply. 251101		
M-H C437H Pressure Switch Opens on Pressure Fall Low Pressure Gas Interlock Range 1-16 oz. 254076 Range .5-5 lb. 254053			FISHER S251-4 Pilot Gas Pressure Regulator Adjustable 5-1/4"-9-1/4" W.C. For over 2 psi gas supply. 290532		
AIR SAIL SWITCH Forced Draft Air Interlock (Opposed damper blowers) 290531			MAIN GAS BURNER VALVES & REGULATORS Contact the factory, supplying all pertinent information such as: 1. Burner serial number 2. Manufacturer of item 3. Catalog number from label 4. Voltage on label 5. Pipe size 6. Apparent trouble		
M-H L405E Fire Switch Manual Reset. Opens on Temperature Rise above 165°C. 254063			FIREYE FP2 System Includes 26RJ8 in cabinet and scanner 48 PTI Model 601B 206348 Model 600B 206538		
M-H V495 Gas Pilot Valve L.P., Natural or Mfg. Gas Complete Valve - 120 Volt 263316 Replacement Coil Only - 120 Volt 290274 Complete Valve - 240 Volt 263317 Replacement Coil Only - 240 Volt 290275					
G-C K3MZ Gas Pilot Valve L.P., Natural or Mfg. Gas Complete Valve - 120 Volt 260004 Replacement Coil Only - 120 Volt 206030 Complete Valve - 240 Volt 260002 Replacement Coil Only - 240 Volt 206031 Complete Valve - 208 Volt 260093 Replacement Coil Only - 208 Volt 206032					

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NEWARK BOTTLER VERMONT

FORCED DRAFT SCOTCH PACKAGE UNIT,

PARTS DESCRIPTION—Continued

DESCRIPTION	UNIT SIZE	PART NUMBER	DESCRIPTION	UNIT SIZE	PART NUMBER
FIREYE 26RJ8 Programming			MANUAL POTENTIOMETER		
Control Chassis Only			For Manual Positioning of Motor		
Model 6018		206431	Controlled Fire Size		
Model 6008		206539	Potentiometer		290268 ✓
FIREYE 48PT1 Scanner Only		254000	Dial Plate		290557
CABINET Only for 26RJ8		206542	Pointer Knob		290558
MOUNTING FRAME Only for			RELAYS - 25 Amp., 115/230 V.		
Installing 26RJ8 in Pkg.			S.P.D.T. 115 Volt Coil		290559
Control Cabinets		206544	S.P.D.T. 230 Volt Coil		290560
VACUUM TUBES, ETC. Only			D.P.D.T. 115 Volt Coil		290561
Model 6018 and 6008			D.P.D.T. 230 Volt Coil		290562
12AX7		257161	D.P.S.T. 115 Volt Coil		290563
12BH7A		257170	D.P.S.T. 230 Volt Coil		290564
6 Amp. Type 3AG Fuse		215193	INDICATING LIGHTS		
For Scanner 48PT1			Socket Only		290263
Firetron Cell		206024	Lamp Only		290264
M-H R478A Protectorelay			Lens Only (Specify Color)		290265
Chassis with Tubes Only		251112	Complete Assembly		290266
VACUUM TUBES Only			When ordering, include the		
Gray Model R478A			following information:		
M-H #102988 (3 Req.)		257162	1. Burner Serial Number.		
M-H #107303 (1 Req.)		257200	2. Type of Lamp - Neon or		
Golden Model R478A			Incandescent		
M-H #114624 (1 Req.)		257163	3. Control Voltage		
M-H #102988 (1 Req.)		257162	LABELS (Plastic) Engraved		
M-H R478B Protectorelay			White on Black Background		
Chassis with Tubes Only		251111	3" x 6"		290565
VACUUM TUBES Only			3/4" x 2"		290566
Gray Model R478B			Include the required wording		
M-H #102988 (2 Req.)		257162	of the label in the order.		
M-H #107303 (2 Req.)		257200	GAS MANIFOLD ASSEMBLY	80-82	290637
M-H #105608 (1 Req.)		257201	Includes Manifold, Refractory,	83-85	290638
M-H #100668 (1 Req.)		257161	Vanes, Spud Nipples and Caps,	86-88	290639
Golden Model R478B			Plastic Cone, Asbestos Tadpole	89-91	290640
M-H #114624 (1 Req.)		257163	Packing and Packing Clamp	92-93	290641
M-H #110969 (1 Req.)		257164	GAS MANIFOLD	80-82	290642
M-H #100668 (1 Req.)		257161	Includes all Parts Which Are	83-85	290643
FUEL SELECTOR Toggle Switch			Welded Together. With Drilled	86-88	290644
Stops at center-off. Must			and Tapped Holes	89-91	290645
be released and pressed again				92-93	290646
to continue throw to other			VANE ASSEMBLY	80-82	290647
fuel position.			For Gas Manifold	83-85	290648
5 Amp., 240 V. - 10 Amp., 120 V.				86-88	290649
2 P.D.T.		290554		89-91	290650
3 P.D.T.		290555		92-93	290651
4 P.D.T.		290556			

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FORCED DRAFT SCOTCH PACKAGE UNIT

PARTS DESCRIPTION—Continued

DESCRIPTION	UNIT SIZE	PART NUMBER
SPUD NIPPLES		
1/4" N.P.T. Both Ends		
3"		290652
3-1/2"		290653
4"		290654
4-1/2"		290655
5"		290656
5-1/2"		290657
6"		290658
6-1/2"		290659

SPUD CAPS

Drilled to Position, Angle
and Port Size as Indicated
on Factory Record. If
Complete Set is Not Required,
the Qty. Desired for Each Row
(Outer, Inner or Middle) Must
be Shown on Order

Drilled Each	290660
Blank Each	290661

PLASTIC CONES, ASBESTOS TADPOLE
PACKING, PACKING CLAMP AND TILE
DOOR CLAMPS ARE LISTED ON PAGE 52

The following parts are for blowers whose air delivery is
controlled by the opposed type damper assembly in the duct
connecting the blower to the windbox. Please supply the
burner (not the motor) serial number.

DESCRIPTION	BLOWER	
	SIZE	
BLOWER DAMPER LINK ASSEMBLY		
Includes four damper arms with set screws, two connecting and one reversing links, all riveted together.	7/8	290423
	1	290424
	1 1/8	290425
	1 1/2	290426
DAMPER BLADES (4 Required) Each		
	7/8	290427
	1	290428
	1 1/8	290429
	1 1/2	290430
DAMPER BLADE RODS (3/8" Dia.)		
Short Rods (3 Req.) Each	7/8	290431
	1	290432
	1 1/8	290433
	1 1/2	290434
Long Rod (1 Req.)	7/8	290435
	1	290436
	1 1/8	290437
	1 1/2	290438
DAMPER BLADE CLAMPS		
3/4" OD x 1/2" ID Collar With Set Screw		290439

DESCRIPTION	UNIT SIZE	PART NUMBER
BLOWER ADAPTER ASSEMBLY		
(Opposed Damper Type)	80-82	290567
Includes Housing, Damper Blades, Rods, Link Assembly, and all Screws, Nuts, Washers and Clamps for Attaching to Blower and Windbox.	83-85 86-87 88 89-91 92-93	290568 290569 290570 290571 290572

BLOWER ADAPTER HOUSING

(Opposed Damper Type)	80-82	290573
Welded Assembly Only	83-85 86-87 88 89-91 92-93	290574 290575 290576 290577 290578

BLOWER ASSEMBLY "

(Opposed Damper Type)		
With Air Dampers in Duct at Blower Outlet. Includes Housing, Wheel, Inlet Ring, Inlet Screen, Screen Clamps, Clamp Spacers, Motor Adapter and Flange Mount Motor.		
7/8 Blower	1-1/2 HP Motor	80-82 290587
7/8 Blower	2 HP Motor	83-85 290588
1 Blower	3 HP Motor	86-87 290589
1-1/8 Blower	5 HP Motor	88-89 290590
1-1/8 Blower	7-1/2 HP Motor	90-91 290591
1-1/2 Blower	7-1/2 HP Motor	92-93 290592

BLOWER WHEEL ONLY

(Opposed Damper Type)		
Internal Hub, C.W. Rotation with Bore as Specified in Order or From Factory Record		
Size 7/8	80-85	290593
Size 1	86-87	290594
Size 1-1/8	88-91	290595
Size 1-1/2	92-93	290596

INLET RING Only

(Opposed Damper Type)		
Blower Size 7/8	80-85	290601
Blower Size 1	86-87	290602
Blower Size 1-1/8	88-91	290603
Blower Size 1-1/2	92-93	290604

INLET SCREEN Only

(Opposed Damper Type)		
Blower Size 7/8	80-85	290605
Blower Size 1	86-87	290606
Blower Size 1-1/8	88-91	290607
Blower Size 1-1/2	92-93	290608

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FORCED DRAFT SCOTCH PACKAGE UNIT

PARTS DESCRIPTION—Continued

DESCRIPTION	UNIT SIZE	PART NUMBER	DESCRIPTION	UNIT SIZE	PART NUMBER
<u>MOTOR ADAPTER Only</u>			<u>BLOWER WHEEL Only</u>		
(Opposed Damper Type)			(Vortex Type)		
7/8 Blower 1-1/2 & 2 HP Motor	80-85	290609	External Hub, C.C.W. Rotation		
1 Blower 3 HP Motor . . .	86-87	290610	With Bore as Specified in Order		
1-1/8 Blower 5 HP Motor . . .	88-90	290611	or From Factory Record.		
1-1/8 Blower 7-1/2 HP Motor . . .	91	290612	Nominal Size 7/8	80-85	290617
1-1/2 Blower 7-1/2 HP Motor . . .	92-93	290613	Nominal Size 1	86-87	290618
			Nominal Size 1-1/8	88-91	290619
			Nominal Size 1-1/2	92-93	290620
<u>SCREEN CLAMPS Only</u>			<u>VORTEX DAMPER Assembly</u>		
(Opposed Damper Type)			Nominal Size 7/8	80-85	290625
All Blower Sizes - Each		290614	Nominal Size 1	86-87	290626
			Nominal Size 1-1/8	88-91	290627
			Nominal Size 1-1/2	92-93	290628
<u>CLAMP SPACERS Only</u>			<u>VORTEX SCREEN</u>		
(Opposed Damper Type)			Nominal Size 7/8	80-85	290629
All Blower Sizes - Each		290615	Nominal Size 1	86-87	290630
			Nominal Size 1-1/8	88-91	290631
			Nominal Size 1-1/2	92-93	290632
<u>BLOWER HOUSING Only</u>			<u>HOUSING FOOT Only</u>		
For All Blower Assembly Types			Vortex Side		
Nominal Size 7/8	80-85	290621	Nominal Size 7/8	80-85	290633
Nominal Size 1	86-87	290622	Nominal Size 1	86-87	290634
Nominal Size 1-1/8	88-91	290623	Nominal Size 1-1/8	88-91	290635
Nominal Size 1-1/2	92-93	290624	Nominal Size 1-1/2	92-93	290636
<u>BLOWER ASSEMBLY</u>			<u>BLOWER ADAPTER</u>		
(Vortex Type)			(Vortex Type Blower)		
With Air Dampers at Blower	80-82	290662		80-82	290579
Inlet. Includes Housing,	83-85	290663		83-85	290580
Wheel, Vortex Damper Assembly,	86-87	290664		86-87	290581
Screen, Foot, Motor Platform	88-90	290665		88	290582
and Foot Mount Motor.	91	290666		89-90	290583
	92-93	290667		91	290584
				92-93	290585

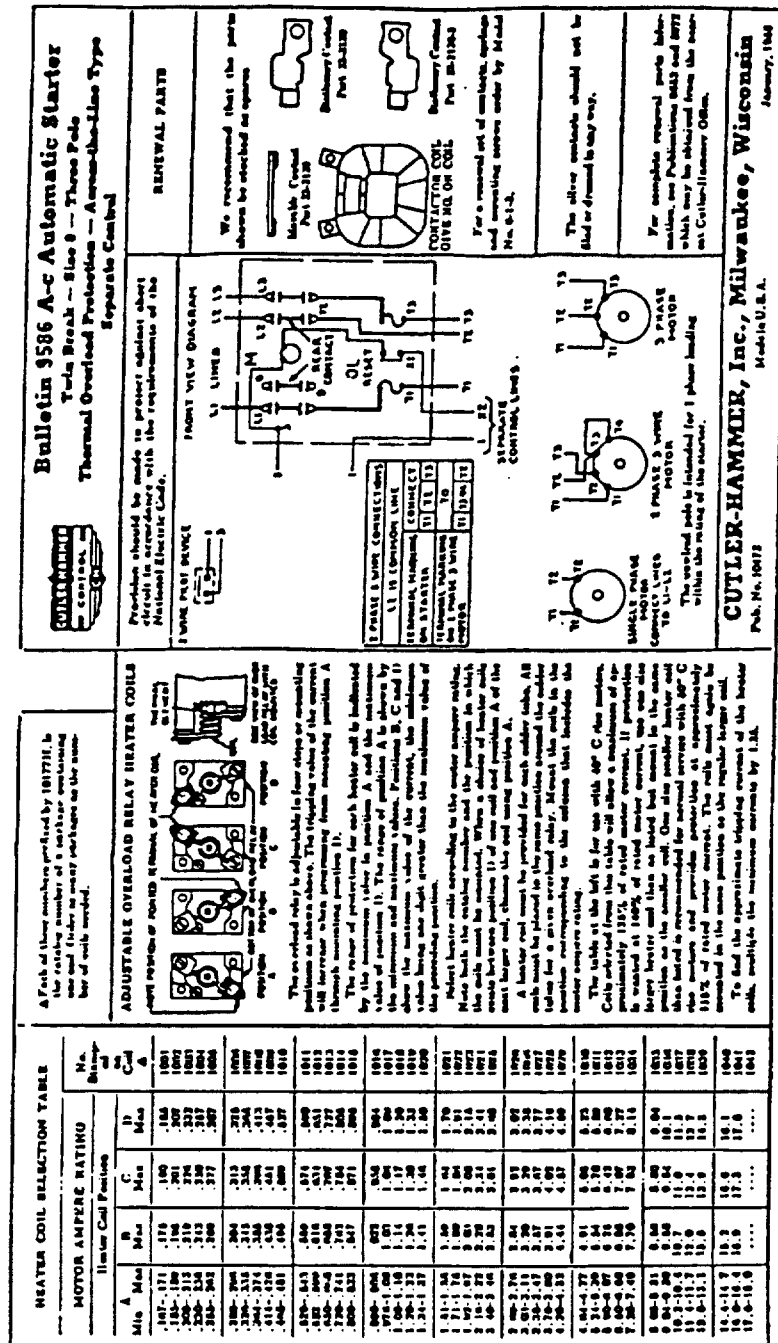
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CHAPTER 7

MANUFACTURERS DATA

This section of the manual contains material from manufacturer's literature which explains in detail the application, maintenance and service of various components used in standard Kewanee units. You may wish to insert additional data sheets for other controls included with your boiler unit. This manual, and manufacturer's literature on other boiler room equipment, should be kept for use as a complete source of reference material for maintenance and service.



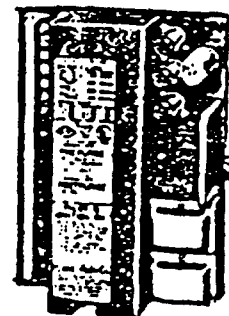


INSTRUCTIONS

Minneapolis-Honeywell Regulator Company

MINNEAPOLIS 8, MINNESOTA • TORONTO 17, ONTARIO

R478B FLAME SAFEGUARD RELAY



APPLICATION

The R478B is an electronic flame-safeguard and programming control for commercial and industrial application on gas, oil, and combination gas-oil burners and burner-boiler units. It is used with a flame-flicker type (lead-sulfide cell) flame detector and also has provisions for using a flame rod to prove the pilot.

FEATURES

SAFE-START CHECK: Prevents starting the burner and causes safety-switch lockout if the flame detector senses an actual flame or a flame-simulating component failure exists in the electronic network at any time during a burner-off period.

PREPURGE: 30 seconds fixed; or 1 or 3 minutes, field-selectable.

POSTPURGE: 20 seconds.

TIMED IGNITION: 2 selectable trial-for-ignition timings on each of two models: 15 or 60 seconds on 30-second-prepurge model; 15 or 30 seconds on the other.

INTERMITTENT OR INTERRUPTED PILOT: Field-selectable.

COMPLETE FLAME SUPERVISION: Pilot and main flame, or main flame only, field selectable. Flame rod may be used to prove gas pilot only.

CUTOFF OF FUEL: On loss of flame.

RAPID FLAME RESPONSE: Cuts off fuel in 2 to 4 seconds on loss of flame.

SAFETY-SWITCH LOCKOUT: On loss of flame, failure to ignite, or electronic-component failure; 15-second timing.

FIRING-RATE OPTIONS: On-off, high-low, or modulating, field-selectable. Return to high fire after fuel valve opens or after ignition period, field-selectable at R478 terminals.

INTERLOCK TERMINALS: Provide for separate safe-starting and running interlocks.

ALARM TERMINAL: Powered to operate an external alarm when safety-switch lockout occurs.

SEQUENCE INDICATING LAMPS: Three neon lamps indicate PREPURGE - POSTPURGE, PILOT and IGNITION, and FLAME - PROVEN, respectively.

SPECIFICATIONS

MODEL: R478B Flame Safeguard Relay. Use with flame-flicker type (lead-sulfide photocell) flame detector. (Flame rod may also be used to prove pilot.)

VOLTAGE AND FREQUENCY: 120, 208, and 240 volts, 60-cycle model standard. A 50-cycle 120-, 208-, and 240-volt model is available. Both models have a selectable-voltage link which permits

their use on 120, 208, or 240 volts.

ELECTRICAL RATINGS OF TERMINALS: 120 to 240 volts.

Ignition (Terminal 5)	300 VA
Pilot valve (Terminal 5 or 7)	70 VA
Main fuel valve, gas (Terminal 6)	120 VA
Main fuel valve, oil direct ignition (Terminal 7)	70 VA

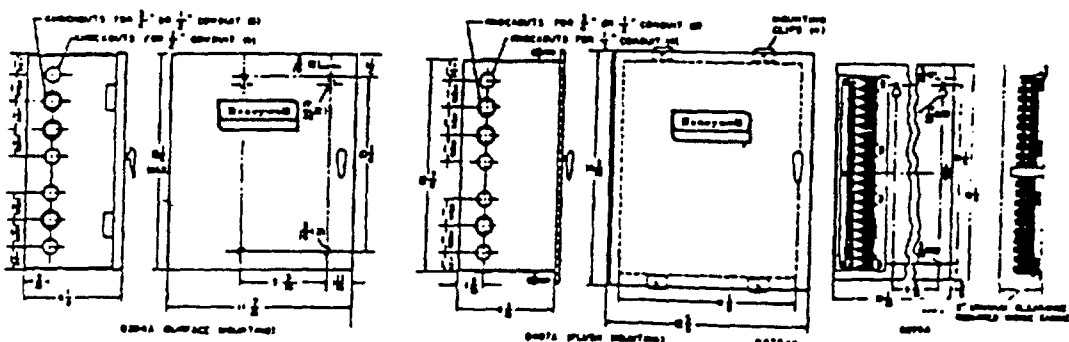


Fig. 1 - Installation dimensions - Q294A and Q407A Cabinets and Q295A Panel.

Alarm contact (Terminal 9) 120 VA
 Flame modulating control (Terminals
 10, 11, 12, and 13) 50 VA
 Burner Motor (Terminal 8):

Voltage	Full Load Amperes	Locked Rotor Amperes
120	5.2	31.2
208	3.7	22.2
240	3.7	22.2

POWER CONSUMPTION: 42 watts maximum; 13 watts standby.

MAXIMUM AMBIENT TEMPERATURE: 60-cycle, 115 F; 50-cycle, 100 F.

DIMENSIONS: See Fig. 1 for separate panel and cabinet dimensions.

MOUNTING: Q294A surface-mounting dust-resistant cabinet; Q295A panel for installation in suitable enclosure; or Q407A flush-mounting dust-resistant

cabinet. Cabinet or panel must be ordered separately. See Fig. 1.

VACUUM TUBES: (replaceable) See Fig. 11, for tube locations.

T1—Part No. 114624 (8CG7)

T2—Part No. 110969 (5965)

T3—Part No. 100668 (12AX7)

OPTIONAL SPECIFICATIONS: Specify one.

1. 30-second prepurge, field-selectable 15- or 60-second ignition timing, and 15-second safety-switch timing.
2. Field-selectable 1-or-3-minute prepurge, 15- or 30-second ignition timing, and 15-second safety-switch timing.

ORDERING INFORMATION: Specify —

1. Model number.
2. Voltage and frequency.
3. Timing combination.
4. Cabinet or panel, if required.

INSTALLATION

Applicable installation instructions provided by the burner manufacturer should be used in addition to the corresponding instructions given here. The checkout procedures on this sheet, and any others recommended by the burner manufacturer, should be used to perform a thorough operational check of the installation before putting the system into service.

FLAME DETECTOR

Proper flame detector installation is the basis of a good flame-safeguard installation. Refer to the instructions packed with the flame detector and to the burner manufacturer's instructions. Follow instructions carefully to make the best possible application of the flame detector.

PANEL OR CABINET

1. Locate the cabinet or panel where the surrounding temperature does not exceed 115 F for 60-cycle model, or 100 F for 50-cycle model.
2. The back of the panel or cabinet must be mounted vertical.
3. Be sure to allow clearances for servicing and for removal of the relay chassis.

WIRING

See also, TIMING ADJUSTMENTS.

1. All wiring must comply with applicable electrical codes, including use of NEC Class 1 wiring.
2. Refer to Figs. 2-6 and Fig. 12 for typical wiring diagrams; but follow the burner manufacturer's wiring diagrams, if provided.
3. Add required disconnecting means and over-load protection to power supply circuit.
4. Wiring circuits should be checked with a bell or lamp before the R478 chassis is installed.

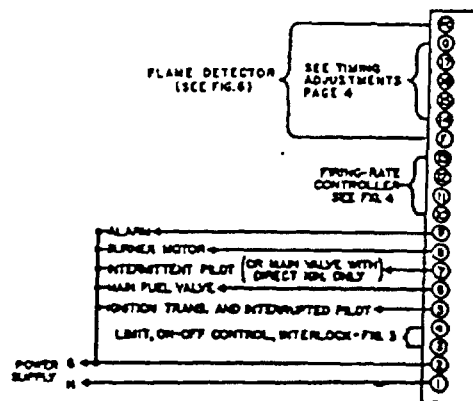


Fig. 2 — Basic R478B hookup. See also Fig. 3, 4, 5 and 6.

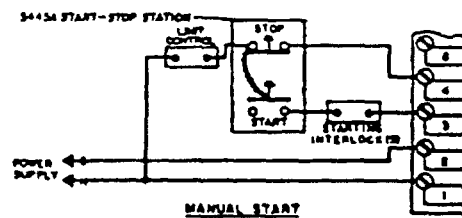


Fig. 3 — Starting circuits — manual and automatic start.

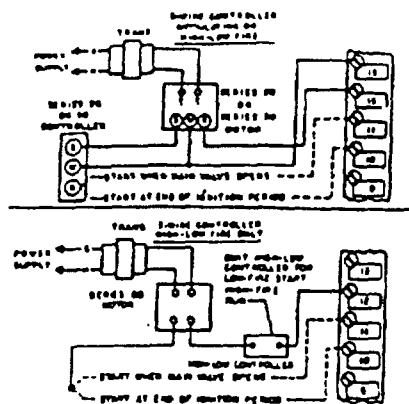


Fig. 4 - Firing-rate controls. R478 provides only switching for separate firing-rate controls.

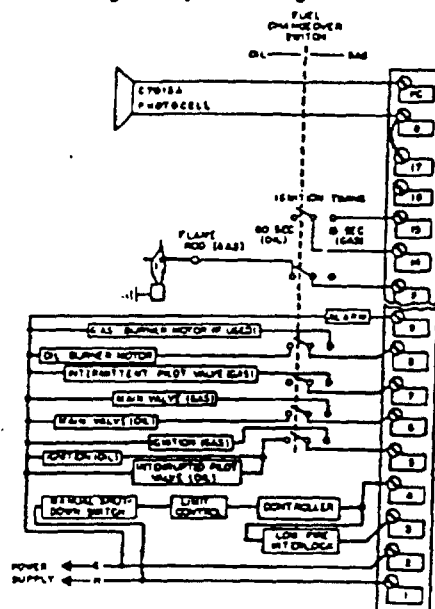


Fig. 5 - Typical gas-oil burner system.

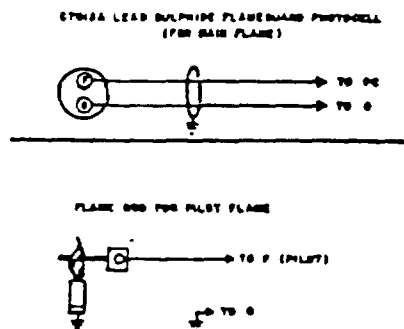


Fig. 6 - Flame detector connections to R478B.

CHASSIS

VOLTAGE SETTING: The R478 can be set for any one of the three common a-c line-voltage supplies—120, 208, or 240. Set the adjustable link to match the supply voltage:

1. Loosen the center screw (Fig. 7).
2. Remove the end screws, rotate the link to the proper voltage, then insert the end screws.
3. Tighten all three screws.

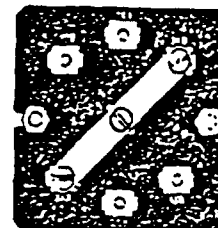


Fig. 7 - Adjustable voltage link. (On back of chassis.)

INSTALLING CHASSIS: (See Fig. 8.)

1. Open the system disconnect switch.
2. Insert the chassis ears into the sockets located above and below the terminal strip of the panel or cabinet. Press the chassis inward firmly into place.
3. Tighten the large slotted-head retaining screw near the chassis handle.
4. Loosen the relay cover retaining screws and remove the cover.
5. Remove the cardboard packing inserts and REPLACE THE COVER.

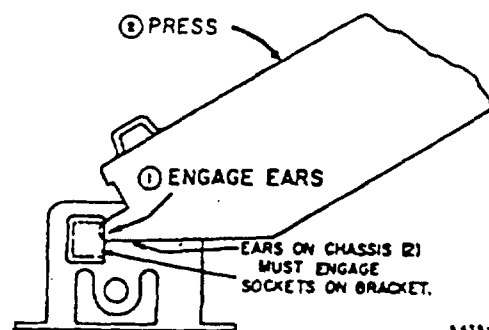
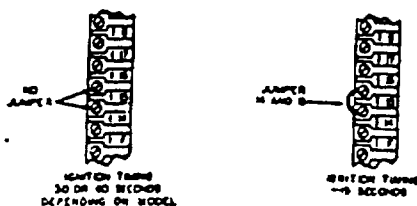


Fig. 8 - Installing chassis (bottom view with cabinet cut away).

TIMING ADJUSTMENTS

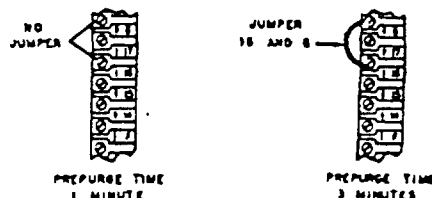
IGNITION:

Install or remove jumper at terminals 14 and 15, as shown.



PREPURGE: (1-or-3 minute model only)

Install or remove the jumper between terminals 16 and G, as shown. This adjustment does not apply to the 30-second-prepurge model.



CHECKOUT

TO CONTROL SEQUENCE MANUALLY

REMOVE TOP VACUUM TUBE T1 (114624) TO KEEP THE R478B ON CONTINUOUS PREPURGE WHILE CLEARING FUEL LINES OF AIR.

TO KEEP PILOT ON CONTINUOUSLY DURING PILOT CHECKOUT, REMOVE TOP VACUUM TUBE T1 AND DISCONNECT MAIN-FUEL VALVE WIRE FROM TERMINAL 6.

PRELIMINARY INSPECTION:

1. Power on at system-disconnect switch.
2. Wiring connections correct and tight.
3. Vacuum tubes secure in sockets.
4. Flame-detector installation completed.
5. Burner completely installed and ready to fire; fuel lines purged of air.
6. Combustion chamber and flues clear of fuel.

THEN MAKE ALL OF THE FOLLOWING TESTS.

MAIN-FLAME PHOTOCELL CHECKOUT: Use only a lead-sulfide, flame-flicker-type cell such as the C7015A. Test the installation thoroughly before the system is put into operation. Photocell performance is affected by:

1. Position, size, and burning characteristics of the flame.
2. Hot refractory.
3. Ambient temperature at photocell. (Check instructions packed with flame detector.)

To test photocell output, run the burner at high fire with jumper 17-G in place. Then plug in the voltmeter as shown in Fig. 9. The meter reading should be between 100 and 140 volts.

With the meter plugged in, remove 17-G jumper.

The meter reading may drop but the FLAME-PROVEN lamp should remain lighted. If the reading drops below 90 volts, or the FLAME-PROVEN light goes out, resight photocell and then retest.

Reconnect 17-G jumper.

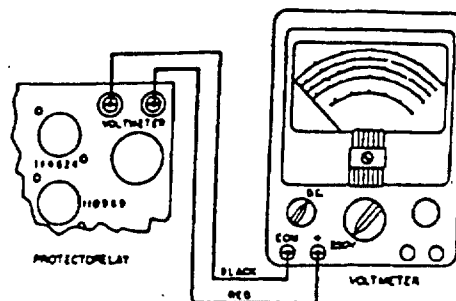


Fig. 9 — Voltmeter connections for testing the lead-sulfide photocell.

If the C7015A is also used to prove that the pilot flame is capable of lighting the main burner, make the following pilot turndown test.

PILOT TURNDOWN: Test to make certain that the main burner can be ignited by the smallest pilot flame that will prevent relay 2 from dropping out (or FLAME-PROVEN light from going out).

1. Remove vacuum tube T1.
 2. Remove the main-valve wire from terminal 6.
 3. Remove any modulating control wire from terminal 12, to keep the firing rate at low fire.
 4. Turn on the power, open the manual fuel valves, and start the system. Relay 1 should pull in and the PURGE lamp should light.
 5. Push in relay 3 manually. PILOT-IGNITION lamp should light, pilot should light, relay 2 should pull in, and the FLAME-PROVEN lamp should light.
 6. Turn the pilot down very slowly, stopping instantly when relay 2 drops out and the FLAME-PROVEN light goes out.
 7. Turn up pilot slowly until FLAME-PROVEN lamp just lights.
 8. Quickly touch the main-valve wire to terminal 6. This should cause the main burner to light immediately. If it does not, remove the wire from terminal 6 at once. Then relocate or reposition the flame detector so that relay 2 will drop out and FLAME-PROVEN light will go out before the pilot flame becomes too small to light the main burner. This usually requires resighting or relocating the flame detector farther out along the axis of the pilot flame toward the main flame. See also the instructions packed with the flame detector.
- NOTE:** The safety switch will trip, causing relays 1 and 3 to drop out and shut off the pilot light about 15 seconds after relay 2 drops out. If this occurs before the main valve wire is touched to terminal 7, it will be necessary

to wait 2 minutes for the safety-switch heater to cool, then reset this switch, restart the system, and again push in relay 3 manually before repeating step 7.

8. Repeat the testing and adjusting until it has been definitely determined that the main burner will positively be lighted with the pilot flame just large enough to keep FLAME-PROVEN lamp lighted. Repeat the lighting several times with the pilot flame at this turn-down point to make sure.

9. When this test has been completed, turn off the power, reconnect the wires to their original terminals, and replace vacuum tube T1. Turn the pilot flame back up to normal.

NOTE: Repeat ALL flame-detector tests after ALL adjustments have been completed. ALL tests must be satisfied at the FINAL flame-detector position.

PILOT-FLAME-CIRCUIT TEST:

If a flame rod is used to prove the pilot, a minimum current of 2 microamperes should flow in the pilot flame-detector circuit when the flame rod is properly installed and positioned with respect to the gas pilot flame. This may be checked with an accurate d-c microammeter (see Fig. 10). A current of less than 2 microamperes indicates improper installation or some other defect in the circuit (insufficient ground, improper detector position, poorly conducting flame, etc.) and must be corrected. After a current of at least 2 microamperes is assured, make the pilot turn-down test described above.

Hot-Refractory Hold-In: Test to make certain that the hot refractory will not cause relay 2 to remain in at the end of a normal run; this would cause safety-switch lockout.

Operate the burner until the refractory reaches its maximum temperature, then use the controller to stop the burner. Relay 2 should drop out (d-c voltmeter reading should drop to zero) within 2 to 4 seconds later; if it does not, the photocell may be affected by the hot refractory. Resight the photocell at a part of the flame having a cooler and/or more distant refractory background. Continue to test and adjust until hot-refractory hold-in is eliminated. For more information on C7015A (formerly Q283A) refer to Form 95-2123.

SAFETY LOCKOUT

Safety lockout should occur upon failure to ignite the pilot, upon failure to light the main burner, and upon loss of flame. Check each of these conditions as follows.

Failure to Ignite Pilot

- Shut off the fuel supply to both pilot and main burner.
- Turn on the electricity.

- Reset the safety switch if open.
- Start the system. PURGE and PILOT IGNITION lamps light.
- Pilot will not light. FLAME-PROVEN lamp does not light. The safety switch should trip and lock out about 15 seconds after starting the system. Alarm should sound, if used.

Failure to Light Main Flame

- Turn on the fuel supply to the pilot burner only; leave main-burner fuel supply shut off.
- Reset the safety switch.
- Start the system.
- FLAME-PROVEN lamp should glow and pilot should light, but main burner will not light. Relay 2 should drop out and FLAME-PROVEN lamp should go out within 2 to 4 seconds after PILOT-IGNITION light goes out; the safety switch should trip and lock out about 15 seconds later.

Loss of Flame

- Turn on the fuel supply to the main burner; pilot gas supply also must be on.
- Reset the safety switch.
- Start the system. Start-up should be normal and main burner should light at end of normal pre-purge period.
- Shut off the main-burner fuel supply to extinguish the main flame.
- Relay 2 should drop out within 2 to 4 seconds later, and the FLAME-PROVEN light should go out.
- The safety switch should trip and lock out about 15 seconds after FLAME-PROVEN light goes out.

NOTE: If the safety switch fails to lock out and shut down the system on any of these three tests, replace the R478B with a new one; then rerun all CHECKOUT tests from the beginning.

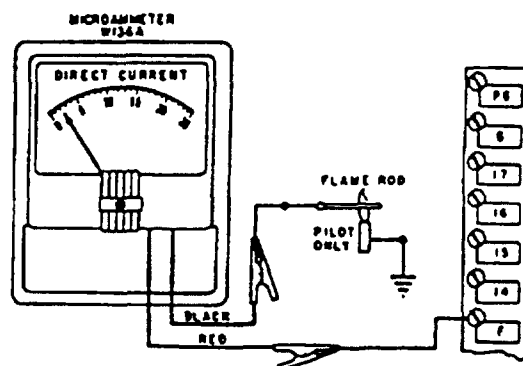


Fig. 10 — Microammeter connections for the flame-rod circuit.

OPERATION

See Fig. 11 for relay and vacuum tube locations.
See Fig. 12 for a schematic wiring diagram of the R478B, including a typical burner circuit.

NORMAL OPERATING SEQUENCE

The normal operating sequence of the R478B is as follows.

POWER OFF

Entire system is de-energized

POWER ON

Vacuum tubes T2 and T3 heat.

Flame relay 2R may pull in and instantly drop out, due to a voltage surge in the electronic network.
Component check begins. (See p. 7.)

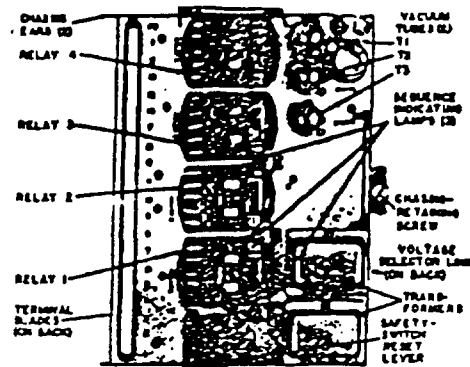
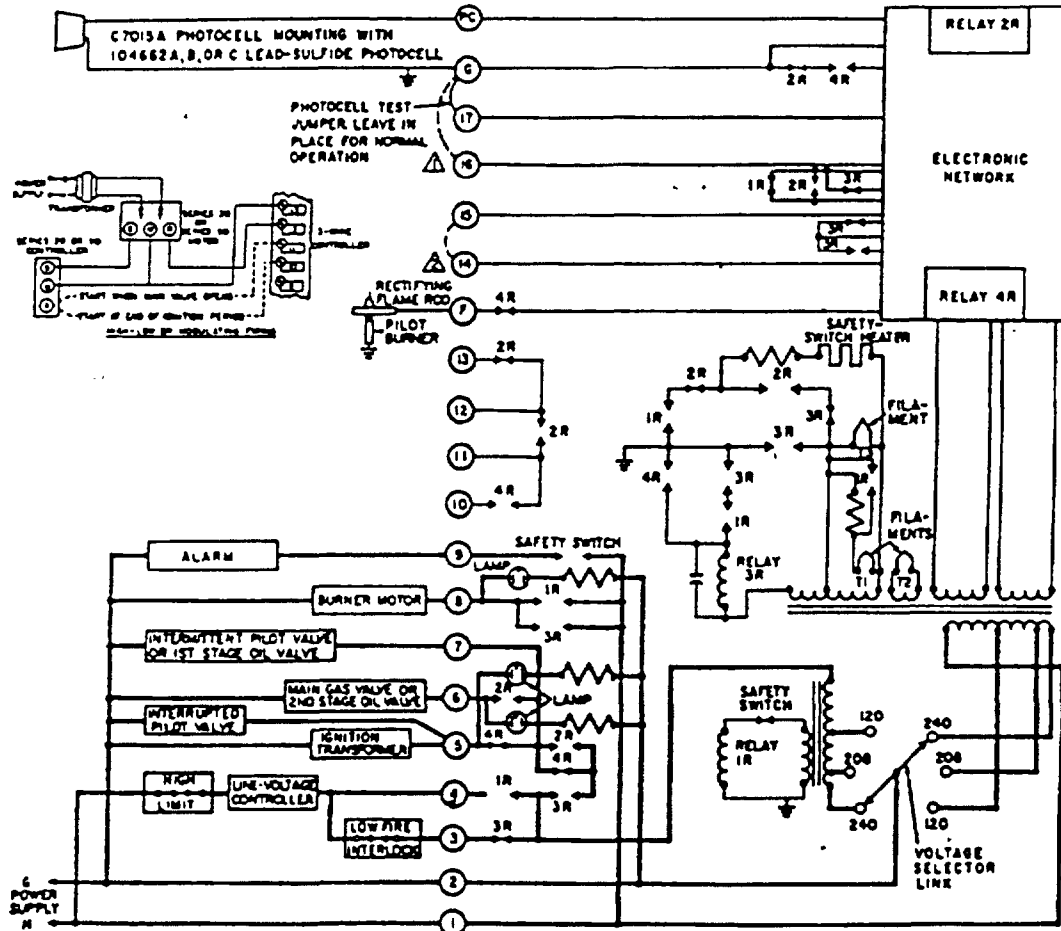


Fig. 11 — R478B with cover removed.



⚠ On "1- or 3-minute prepurge" model only, a jumper between terminals G and 16 provides 3-minute prepurge timing; no jumper, 1-minute timing.

⚠ Jumper between terminals 14 and 15 provides 15-second ignition timing; no jumper, 30- or 60-second timing, as specified on order.

Fig. 12 — Schematic of typical burner system including the R478B.

STARTING (Controller calls for heat, or START button is depressed momentarily then released.)

PURGE lamp lights.

Relay 1 pulls in.
Powers terminal 8.
Burner motor starts.
Prepurge begins.
Prepurge timing begins.

PILOT-IGNITION lamp lights after 30 seconds (or 1 or 3 minutes, depending on model and timing jumper).

Relay 3 pulls in.
Powers terminals 5 and 7.
Safety-switch heater is energized.
Ignition transformer is energized.
Pilot valve or 1st-stage oil valve opens.

WHEN FLAME IS PROVEN

FLAME-PROVEN lamp lights.

Relay 2 pulls in.
Powers terminal 8.
Main gas valve or oil valve opens.
Opens circuit between terminals 12 and 13.
Closes circuit between terminals 12 and 11.
High firing or modulating firing begins if connected to terminal 11.

PILOT-IGNITION light goes out.

Relay 4 pulls in.
De-energizes terminal 8.
Interrupted pilot valve closes, if used.
De-energizes ignition transformer.
Closes circuit between terminals 10 and 12.
High firing or modulating firing begins if connected to terminal 12.
Opens circuit to terminal 7.

STOPPING (Controller contacts open when heat demand

is satisfied, or STOP button is depressed momentarily then released.)

FLAME-PROVEN light goes out.

Relay 1 drops out.
De-energizes terminals 6 and 7.
All fuel valves close.
Postpurge begins.
Relay 2 drops out.
Opens circuit between terminal 12 and terminals 10 and 11.
Closes circuit between terminals 12 and 13.
Relay 4 drops out at end of 20-second postpurge timing.
Closes circuit to terminal 7.
Relay 3 drops out.
De-energizes terminal 8.
Burner motor stops.

PURGE light goes out.

Normal cycle ends.

ELECTRONIC-COMPONENT CHECKS

The electronic network, including the flame-detector circuit, is designed so that component failure either block the starting circuit completely, or cause safety-switch lockout and stop the sequence during the prepurge period.

1. If relay 2 is held in or caused to pull in (because of a component failure) during a burner-off period safety-switch lockout occurs and the system cannot be re-started until manually reset.

2. If relay 4 does not operate during a start, the sequence cannot proceed past prepurge.

3. If relay 4 does not drop out (sticks closed) immediately after relay 3 pulls in during a normal start the ignition cannot come on; prepurge continues until safety-switch lockout occurs about 15 seconds later.

SERVICE

SCHEDULED INSPECTION AND MAINTENANCE

A schedule should be set up and followed for periodic inspection and maintenance, including burner and all other controls as well as the R478B relay. Include the following in that schedule.

1. Keep burner(s) and fuel mixture always adjusted according to the burner manufacturer's recommendations.
2. Clean the photocell lens and sight tube, and check the photocell output. See subject MAIN-FLAME PHOTOCCELL CHECKOUT.
3. If a flame-rod flame detector is used to prove pilot flame, check the flame rod and its output.
4. Install a new set of vacuum tubes every year.

NOTE: Keep the R478B powered the year around except while servicing, to prevent condensation within the cabinet.

TROUBLE SHOOTING

Every trouble-shooting job should not only result in locating and correcting the immediate cause of trouble but should include an over-all check sufficient to assure continuing good performance. Every

trouble-shooting job should begin with a recheck of all items listed under subject SCHEDULED INSPECTION AND MAINTENANCE.

Then if trouble still persists, the next step is to determine whether the trouble is in the R478B or elsewhere. Review the normal operating sequence of the R478B as given under subject OPERATION. Then check the actual operation against the normal sequence to determine how far through the sequence the R478B performs normally. Knowing the stage at which the performance deviates from normal will help in locating the trouble.

CHECKING PROCEDURE

Close the starting circuit by pressing the START button, or by raising the controller setting high enough to close the controller contacts.

A. If R478B WILL NOT START OPERATING SEQUENCE, check the following:

1. Make sure that the voltage selector on back of chassis is correctly set for the voltage supplied at terminals 1 and 2.
2. Reset the safety switch if it is open.

a. If switch cannot be reset, it probably indicates that relay 2 is holding in (FLAME-PROVEN lamp lighted) because of a flame-simulating component failure.

(1) Change vacuum tubes T2 and T3. If this does not allow safety switch to be reset, remove wires from terminals PC and O.

(a) If this allows relay 2 to drop out, trouble is outside the R478B and is in the photocell circuit.

(b) If this does not allow relay 2 to drop out, replace the R478B with a new one.

3. Jumper terminals 1 and 4.

a. If PURGE lamp then lights and burner motor starts, the trouble is outside the R478B and is in the limit circuit or the controller circuit.

(1) Remove the 1 - 4 jumper.

(2) Jumper the limit circuit and the controller circuit, in turn, to discover the one that is open.

b. If PURGE lamp does not light and burner motor does not start when terminals 1 and 4 are jumpered, remove jumper; then jumper terminals 3 and 4.

(1) If PURGE lamp then lights and burner motor starts, the trouble is outside the R478B and is in the starting interlock(s).

(a) Remove the 3 - 4 jumper.

(b) Using burner or boiler manufacturer's wiring diagram as a guide, jumper each starting interlock, in turn, to discover which one is open.

(2) If PURGE lamp does not light and burner motor does not start when terminals 3 and 4 are jumpered, the trouble is inside the R478B.

(a) Loosen the relay cover retaining screws and remove the cover.

(b) Clean the contacts of relay 3 as described under subject CLEANING CONTACTS.

(c) Replace the relay cover and tighten the retaining screws.

(d) If trouble still persists, replace the R478B with a new one.

B. If R478B WILL NOT PROGRAM, check the following:

1. If PURGE lamp lights but burner motor and/or draft fans do not run, the trouble is outside the R478B.

- a. Check motor power supply.
- b. Check motor overload protection.
- c. Check motor starter.
- d. Check motor.

2. If programming will not go beyond prepurge:

a. Clean all relay contacts as described under subject CLEANING CONTACTS.

b. Install a new 11-624 (T1) vacuum tube.

c. If trouble persists, replace the R478B with a new one.

C. IF PILOT DOES NOT LIGHT WHEN PILOT-IGNITION LAMP LIGHTS, the trouble is outside the R478B.

1. Check the pilot gas cock.
2. Check the pilot valve.
3. Check the ignition transformer.

D. IF FLAME-PROVEN LAMP DOES NOT LIGHT WHEN PILOT IS LIGHTED:

HOW TO TEST ELECTRONIC NETWORK, TUBES, AND DETECTOR

If C7015A is used to prove pilot, remove it from mounting and hold a lighted match in front of sensing cell.

1. If relay 2 then pulls in, the electronic network is in working order.

a. Clean the C7015A viewing window.

b. Clean the sighting tube, then check the flame through the tube. If flame is not steadily in view, change draft, fuel-air mixture, or sighting angle to obtain a good view.

2. If relay does not pull in under the lighted match test:

a. Change the R478B vacuum tubes.

b. If terminal Z is used, clean the contacts of relay 4 as described under subject CLEANING CONTACTS.

c. If necessary, install a new C7015A.

d. If trouble persists, replace the R478B with a new one.

E. IF FLAME-PROVEN LAMP LIGHTS BUT RELAY GOES OUT ON SAFETY AFTER PILOT-IGNITION LIGHT GOES OUT, the trouble is outside the R478B.

1. Check the main-fuel hand cock.

2. Check the main-fuel valve.

3. Check any possible interlock.

4. Check main-burner flame by looking through photocell sighting tube. If flame is floating or being blown past line of photocell sight, it is normal for R478B to shut down the burner. Problem may be corrected by one or more of the following:

a. Changing photocell line of sight. (Re-check ability of photocell to detect pilot flame. Rerun Pilot Turn-down Test.)

b. Improving fuel-air ratio of main flame.

c. Changing temperature of heavy oil (if used).

d. Improving draft.

e. Altering combustion chamber to keep main-flame front near burner.

CLEANING CONTACTS

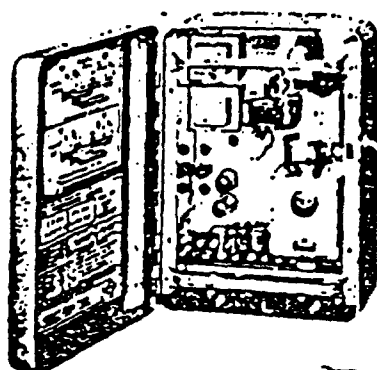
Relay contacts should be cleaned only when a careful check made as described under subject TROUBLE SHOOTING indicates the possibility of dirty contacts. Then inspect and clean the indicated contacts by spraying the contact surfaces with TV contact restorer from a plastic squeeze-bottle or an aerosol can. No rubbing of contacts is necessary. The contacts must be left clean and smooth. If more convenient, the chassis may be removed from the cabinet for cleaning and inspecting the contacts.

If any contacts are found burned to the extent that they cannot be smoothed by careful use of a contact burnishing strip, install a new R478B after first inspecting and testing the corresponding external circuit(s) for short circuits and eliminating any shorts found. Do not use a file or abrasive paper on the contacts.

Replace relay cover and tighten the cover retaining screws.



Type 26RJ8
model 6018



Scanner Type 48PT1



System FP-2
using
Type 26RJ8 - Model 6018

FLAME SAFEGUARD AND PROGRAMMING CONTROL

— for automatic burners —



Features

Fireye System FP-2 provides ignition and flame failure protection for industrial and commercial oil, gas, or combination oil/gas burners. In conjunction with operating, limit, and interlock devices it automatically programs each starting, operating, and shutdown period. The FP-2 System consists of a Type 26RJ8 programming control and a Type 48PT1 scanner which uses the "Firetron" cell to visually supervise both oil and gas flames.

The FP-2 System monitors both main and pilot flames and does not permit the main fuel valve to be energized unless pilot flame has been established and proved. With an alternate connection for burners having direct spark ignition, the unsupervised trial-for-ignition period is precisely restricted to a safe short interval.

Specifications

The 26RJ8 control programs the operation of: blower and/or burner motor, ignition system, fuel valve, and modulator system in a proper sequence which includes suitable purge periods before ignition and after burner shutdown. Additionally it is designed to de-energize all fuel valves within 1 to 4 seconds upon loss of flame signal. The control recycles automatically each time the operating or limit control closes, or after a power failure, but locks out and must be reset manually following flame failure.

The FP-2 System incorporates a safety checking circuit that is effective on every start. Any condition which will cause the flame relay to hold in during the checking period will stop the program before any ignition circuits are energized and, if sustained, will result in safety lockout.

Fireye System FP-2, consisting of Control Type 26RJ8, Model 6018, and Scanner Type 48PT1

SUPPLY VOLTAGE (selectable) at 60 cycles, 1 phase:

120 volts (Min. 102v, Max. 132v)
208 volts (Min. 177v, Max. 229v)
240 volts (Min. 204v, Max. 264v)

VOLT-AMPERE RATINGS:

26RJ8 consumption: 35va
Max. simultaneous connected load: 1965va
(See chart at right and test on pages 3 and 4 for additional rating information.)

MAXIMUM OPERATING TEMPERATURE:

Scanner Type 48PT1 125°F
Control Type 26RJ8 ambient, . 125°F

SHIPPING WEIGHT: 22 lbs.

TERMINAL RATINGS (MAX.) FOR TYPE 26RJ8 MODEL 6018

Terminal No.	Typical Load	Ratings at 120/208/240 v. 60 cy. (except as noted)			
5 or 6 or Combination	Ignition Devices	500 va Transformer, and 125 va Pilot Duty			
7	Main Fuel Valve (s)	150 va Pilot Duty			
8	Burner or Blower Motor or Starter	Ampere @	120	208	240
		Full Load	5.8	3.35	2.9
		Locked Rotor	34.8	20.0	17.4
		Alternator: 250 va Pilot Duty			
9	Alarm	50 va Pilot Duty			
10, 11, 12, 13 Combined	Modulator	125 va Pilot Duty			
		Alternator: 2a Max. @ 30 v Max. (N.E.C. Class 2)			

For alternate Ignition and Fuel Valve ratings to accommodate motorized valves or combinations of solenoid and motorized valves, consult the factory.

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Installation

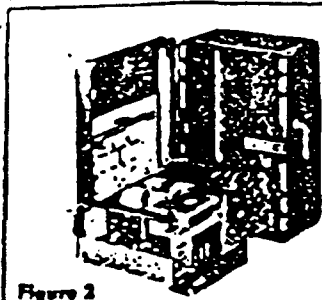


Figure 2

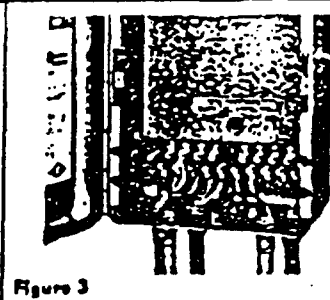


Figure 3

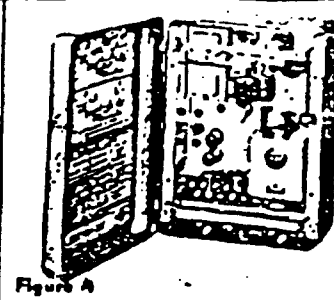


Figure 4

Installing the Type 26RJ8 Control

Loosen thumb screws at front of chassis. Pull out chassis and place on its back plate (Fig. 2). Select control mounting location on panel board or upright surface that is free from excessive vibration. Secure housing with screws or bolts using Figure 1 for drilling dimensions. After the housing is wired, (Fig. 3), replace unused knockout plugs. Plug chassis securely into housing (Fig. 4), and tighten captive thumb screws.

Control and Scanner Wiring

Make wiring connections at terminal panel at bottom of housing (Fig. 3). Separate knockouts are provided for conduit connections for line voltage, and scanner circuits. Follow approved wiring diagrams. Connect bare wire directly to screw posts -- without lugs.

Use suitable wire enclosed in rigid or flexible conduit for power connections. All wiring must comply with the National Electrical Code and local codes. Splices must be made only in troughs or junction boxes.

It is important that cross-phasing be prevented on multiphase installations. The common of all control components (magnetic starter coil, ignition transformer, pilot and main fuel valves, etc.) powered by the Type 26RJ8 Control must be connected to the common of the control -- Terminal 1 (208-240 volts), or Terminal 2 (120 volts).

The control housing must be grounded either by the normal conduit ground or by an added grounding wire. Before applying power, make sure AC Line Plug is in its proper socket.

Attach the cable supplied with the scanner to a junction box (Fig. 5). Splice the cable wires to a pair of wires not smaller than #18. Install the complete run in a separate conduit to the knockout directly under Terminal 13 of the Type 26RJ8 Control housing. Connect black wire to Terminal 14; white wire to Terminal 15. Continuous conduit bonding between scanner and control is mandatory! Scanner may be located up to 100 feet from

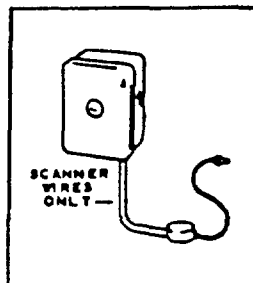


Figure 5

control. Do not pass scanner wiring through any junction box containing other wires. Do not run other wires through scanner conduit. This is a UL requirement.

Electrical Rating Considerations

Electrical ratings of Fireye controls, regardless of the terms in which they are stated, are based on normal circuit current in amperes multiplied by nominal circuit voltage, called volt-amperes and abbreviated as VA.

Other electrical rating terms must be converted to VA when computing total connected load. If stated in amperes at a given voltage, multiply volts by amperes to get VA. If stated in horsepower, use the ampere figure specified in the National Electrical Code for that single phase horsepower at the appropriate voltage and convert to VA. If the connected load is rated in watts, convert to approximate VA by dividing the rating in watts by an appropriate factor as follows:

Magnetic coil (relay, solenoid valve, etc.)	.35
Motor	.75
Resistor (electric heater, lamp, etc.)	1.00

(Example: for solenoid valve rated 14 watts, divide 14 by .35; approximate VA is 40.)

The types of load permissible under the various rating terms which may be applied to Fireye controls are as follows:

Running and Locked Rotor Amperes is a rating intended specifically for motors, but a non-pilot duty load (see below) may be applied if normal and inrush currents do not exceed running current rating. Also an indicator lamp may be combined with a motor load if the total of lamp inrush (figured at 10 times normal current) and motor locked rotor currents does not exceed the locked rotor rating.

Horsepower rating implies that running (or full load) and locked rotor amperes of a connected motor may not exceed those specified in the National Electrical Code (at the nominal supply voltage) for a single phase motor of horsepower corresponding to that specified in the rating. The non-pilot duty load and Indicator lamp options apply as above.

VA Pilot Duty rating permits the connection of relays, solenoid valves, small motors, indicator lamps, and other electrical devices under the condition that normal operating VA may not exceed the rating. Inrush (or locked rotor) VA may not exceed ten times the rating.

Electrical Rating Considerations (cont.)

VA rating not specified as pilot duty permits the connection of transformers and similar devices wherein the inrush current is not considered to exceed the normal current.

The term "inrush" as applied here relates ordinarily to a device wherein a part of the magnetic structure is free to assume two defined positions (such as a solenoid plunger) and signifies the current which flows in the short interval between energization of the coil and seating of the moveable structure in its energized position. The term also relates to resistive devices which operate at incandescent temperatures (such as a lamp) where the cold resistance is much less than the hot resistance and where accordingly the current during the short interval between energization and incandescence is considerably higher than normal operating current.

There are no universal formulas for converting one type of rating to another. Thus the VA pilot duty portion of a combination rating can not be arbitrarily increased just because the other portion (a non-pilot duty VA rating, for instance) is not being used. There is likewise no formula to convert AC ratings of isolated contacts to DC ratings. The use of contacts in DC circuits is not sanctioned unless a DC rating is specified.

The maximum simultaneous running current load on the circuit supplying the Fireye control may not exceed 2000 VA. Since the control itself is rated at up to 35 VA, the total load connected to the control (exclusive of flame failure alarm devices) may not exceed 1965 VA.

The ratings tabulated on page 1 are the maximum permissible for each terminal. In models where the total of maximum permissible loads on all terminals exceeds 1965 VA, it will be necessary to restrict the load on one or more terminals to stay within the 1965 VA limitation!

Ratings as they affect the contacts within the Fireye control are established on the assumption that no contact will be required to carry inrush currents more often than once in fifteen seconds. The use of limit, interlock, or operating control switches that do not make positive contact at closure and which give rise to "chattering" of relays within the Fireye control or of devices energized through it may lead to premature failure of switching members in the control. Similarly, the contacts can not be expected to handle short-circuit currents without possible damage. It is therefore of vital importance to make a "dry run" check of the control system (with manual fuel shut-off valves closed) following the automatic opening of a control system fuse or circuit breaker, or following any known instance of relay or switch chattering!

Because of the special hazards that could accompany welding of the contacts which control the fuel valve circuit, those contacts are made of a high weld-resistant material. As a further precaution the circuit to terminal 7 is protected by a 6 ampere fast-blow fuse. This fuse is accessible from the chassis front and is located between the test jacks. If this fuse should ever blow, do not attempt further burner operation until it has been ascertained that there is no contact damage and until the control has operated normally in a "dry run" check.

Scanner Type 48PT1

Install the Type 48PT1 Scanner as recommended by the burner manufacturer. If no instructions are provided, the scanner must be applied to facilitate monitoring of the pilot and main flames. The following description of operation of the Firetron will assist in making such an application.

Operation of Firetron Cell

The active element of the Firetron cell is a lead sulfide (PbS) semiconductor whose electrical resistance instantaneously changes in accordance with the amount of infrared and visible radiation it receives from sources within its view. Such radiation originating in a combustion chamber may consist of a steady radiation from hot refractory or metal and an average value of flame radiation which continuously fluctuates in magnitude by amount and at a rate which are functions of the type of fuel and combustion conditions.

When a DC voltage is impressed across the cell and a series resistor, the fluctuation of cell resistance corresponding to fluctuation of flame radiation produces a fluctuating voltage across the cell. This voltage is termed "flame signal" and is fed to an amplifier.

The amplifier responds to a fluctuating voltage, but not a steady one. It therefore responds to a fluctuating flame signal but not to a steady refractory signal. Further, it is "tuned" for maximum response at a frequency of 10 cycles per second (a fluctuation rate found in all flames) and has relatively little response at power line (60 cycle) and very low (1 cycle) frequencies. When amplified flame signal exceeds a given magnitude, it causes energization of a flame relay.

Whereas the system does not "detect" hot refractory, excessive steady radiation reduces flame signal. The same effect results from excessive scanner temperature. To avoid nuisance shut-downs, it is important to avoid sighting hot refractory and to keep scanner temperature low (never over 125°F).

Application Procedure - Scanner Type 48PT1—

The general instructions which follow, apply to installations of a single scanner which monitors both pilot and main flames. If separate scanners are used for pilot and main flames, consult the burner manufacturer for installation instructions.

1. Locate scanner sight tube point of entry below and close to the burner ignition assembly (Fig. 6) and drill a 7/8" hole through the boiler or furnace wall. The sight tube, a 4'-8" length of 1/2" black iron pipe, will be fixed to the hole when the proper position has been established.

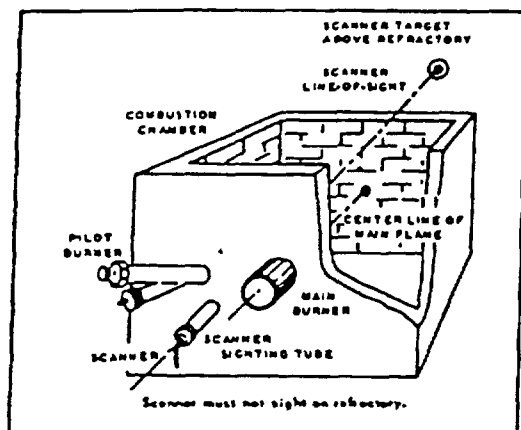


Figure 6

2. Position the scanner sight tube so that scanner line of sight will cross the intersection of pilot flame axis and main flame (Fig. 9). Tack weld the sight tube to the point of entry hole. Should it be necessary to remove refractory to obtain the proper line of sight, prepare a straight hole not less than 1-1/4" I.D. Flare this hole slightly as it enters the combustion chamber.

3. Scanner must have unobstructed view of both pilot and main flames (Fig. 7).

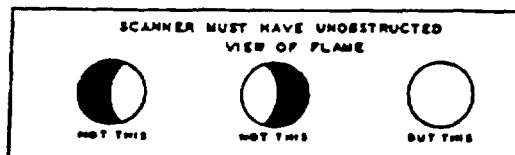


Figure 7

4. Both pilot and main flames must completely cover scanner field of view (Fig. 8).

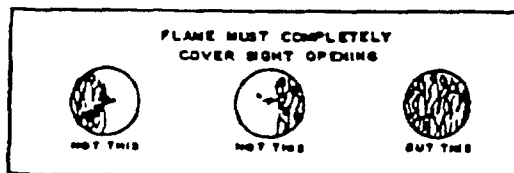


Figure 8

5. Scanner must not sight on refractory which will become incandescent during burner operation.

6. Scanner must not be allowed to exceed a temperature of 125°F.

For precise adjustment of the scanner viewing angle, Fireye Swivel Mount (Part No. 60-302) is available. If it is necessary to restrict the area the scanner views (to reduce sensitivity, or because of unsatisfactory background), use Fireye Orifice Set (Part No. 10-88).

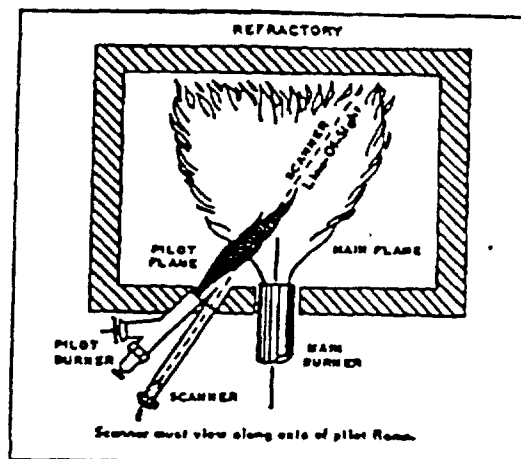


Figure 9

Keeping the Scanner Cool—

The Firetron Scanner (Temperature Limit 125°F) should never get too hot to grasp comfortably in the hand. Keep the scanner cool by one or more of the following methods (Fig. 10).

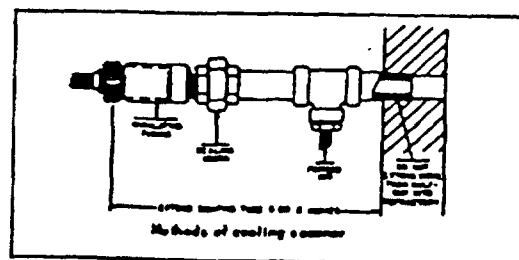


Figure 10

1. Use 6" to 8" length of pipe between scanner and hot furnace front plate.
2. Use insulating tube (Part No. 35-69) on the end of the iron pipe.
3. Force air into sighting tube.
4. Make sure sighting tube does not extend more than halfway into refractory wall.
5. Use Fireye Sealing Union (Part No. 60-801) when using method 3 above.

Relay, Lockout Switch and Timer Operation

- A. Master Relay (RL1) is located slightly above center of chassis. When all starting circuits are closed and tubes are at operating temperature, the Flame Relay (RL2) closes an initiating circuit to RL1 which then pulls in. Only with RL1 energized is power made available to the ignition and fuel valve switching circuits. RL1 remains energized from the start of a program until a limit or operating control opens or the lockout switch trips.
- B. Flame Relay (RL2) is located at top right of chassis. It initiates a program by closing in response to a checking signal. After checking signal is removed it resumes its open (de-energized) position until such time as it is re-energized in response to flame signal. It then remains energized until flame is extinguished either by opening of an operating or limit control or as the result of unstable combustion conditions.
- C. The lockout switch (LS) is located to the right
- D. The timer (K) is located at the lower right hand side of the chassis. It consists of multiple-leaf switches actuated by cams driven by a synchronous motor. The switches operate in a non-adjustable timed program to control (in association with RL1 and RL2) all external loads except alarm. The timer itself is variously controlled by RL1, RL2, and its own contacts. It may also be actuated manually (for test purposes) by a knob on the end of the cam shaft. Timer shaft position is indicated by a drum type dial.

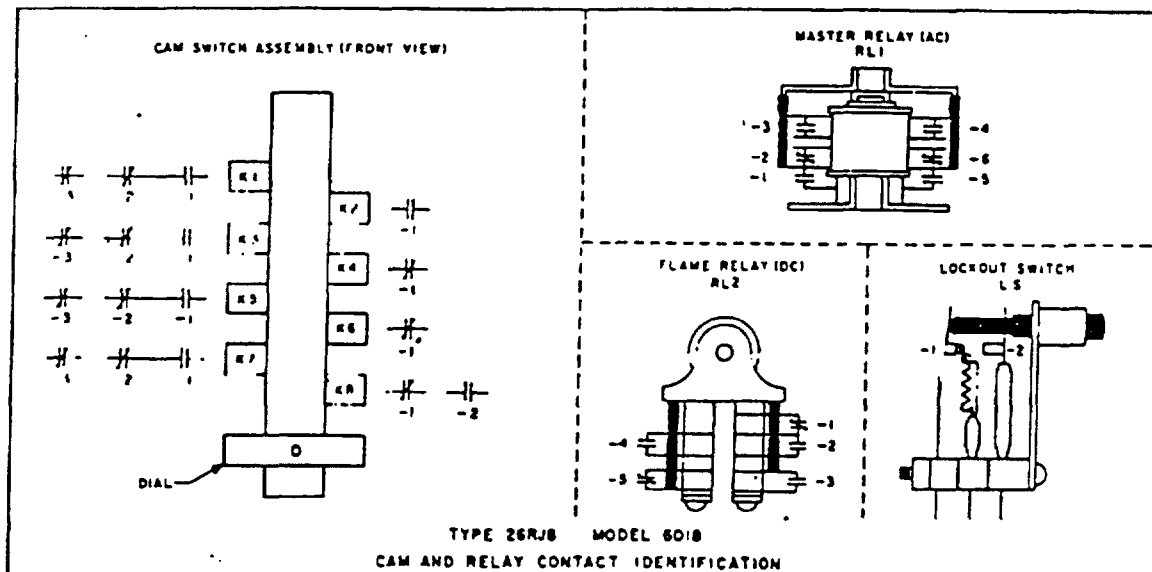


Figure 14

OPERATING SEQUENCE: FP-2 SYSTEM WITH TYPE 26RJ8 MODEL 6018

With proved pilot.		
Timer Rotation (Seconds)	Dial Indication	BURNER STARTUP Action
0	0	Operating control closes. (If power has been off, there is no action until tubes warm up). Flame relay is energized, followed by master relay, timer motor, and burner motor (Term. 8). Modulator low fire circuit (Term. 10-12) opens, high fire circuit (Term. 10-13) closes.
7		Checking signal off, flame relay should de-energize within 4 seconds.
20		Modulator high fire circuit (Term. 10-13) opens, low fire circuit (Term. 10-12) closes.
25	X	If for any reason flame relay does not drop out, timer stops until lockout switch trips. With operation normal there is no pause here.
45	1	Ignition on (terminal 5 and 6).
55	2	Fuel valve on (terminal 7) (assuming pilot is proved).
70	3	Terminal 5 ignition off. Modulator low fire circuit (Term. 10-12) opens, automatic circuit (Term. 10-11) closes.
85	4	Terminal 6 ignition off.
105	DOT	End of starting cycle; timer motor stops. Burner operates until heat demand is satisfied.
105	DOT	BURNER SHUTDOWN Operating control opens: master relay and fuel valve (Term. 7) de-energized; timer motor energized; modulator automatic circuit (Term. 10-11) opens, low fire circuit (Term. 10-12) closes.
120	0	Burner motor circuit (Term. 8) and timer motor de-energized.
		<u>System is ready for startup whenever operating control again closes.</u>
Direct spark ignition. (Terminals 6 and 7 connected together).		
Timer Rotation (Seconds)	Dial Indication	BURNER STARTUP Action
0	0	Operating control closes. (If power has been off, there is no action until tubes warm up). Flame relay is energized, followed by master relay, timer motor, and burner motor (Term. 8). Modulator low fire circuit (Term. 10-12) opens, high fire circuit (Term. 10-13) closes.
7		Checking signal off, flame relay should de-energize within 4 seconds.
20		Modulator high fire circuit (Term. 10-13) opens, low fire circuit (Term. 10-12) closes.
25	X	If for any reason flame relay does not drop out, timer stops until lockout switch trips.
45	1	Ignition (terminal 5) and fuel valve (terminal 7) energized.
55	2	No action unless flame has not been established and/or detected, in which case fuel valve and ignition are de-energized.
70	3	Terminal 5 ignition off. Modulator low fire circuit (Term. 10-12) opens, automatic circuit (Term. 10-11) closes.
105	DOT	End of starting cycle; timer motor stops. Burner operates until heat demand is satisfied.
105	DOT	BURNER SHUTDOWN Operating control opens: master relay and fuel valve (Term. 7) de-energized; timer motor energized; modulator automatic circuit (Term. 10-11) opens, low fire circuit (Term. 10-12) closes.
120	0	Burner motor circuit (Term. 8) and timer motor de-energized.
		<u>System is ready for startup whenever operating control again closes.</u>

Schematic Circuit

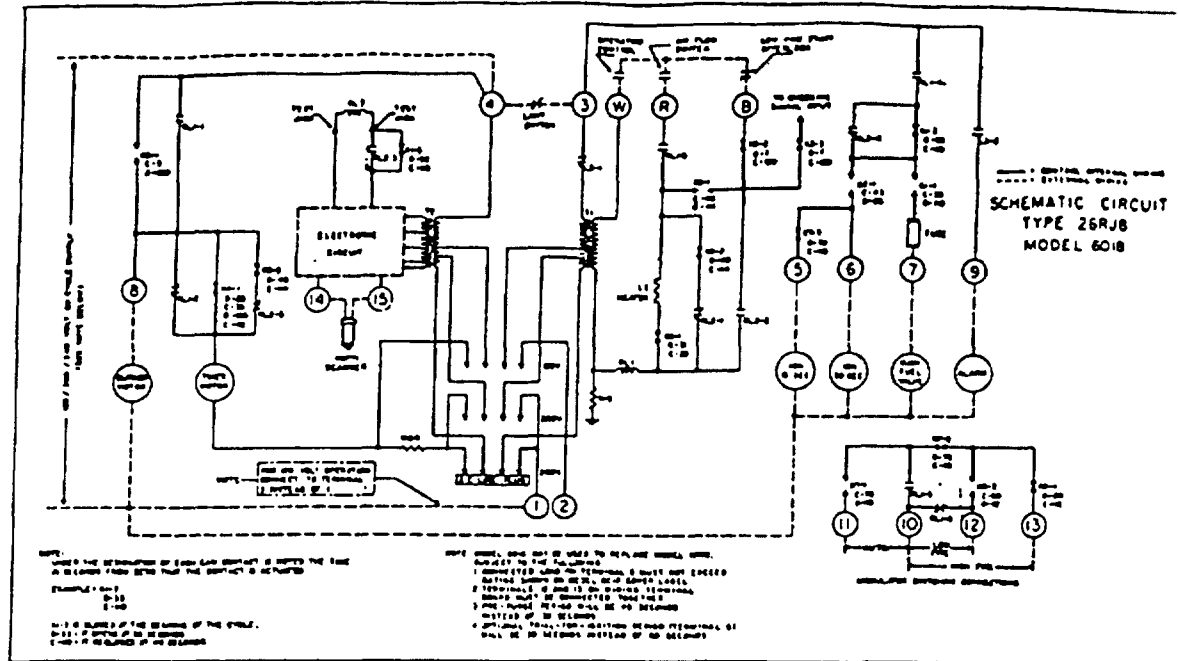


Figure 15

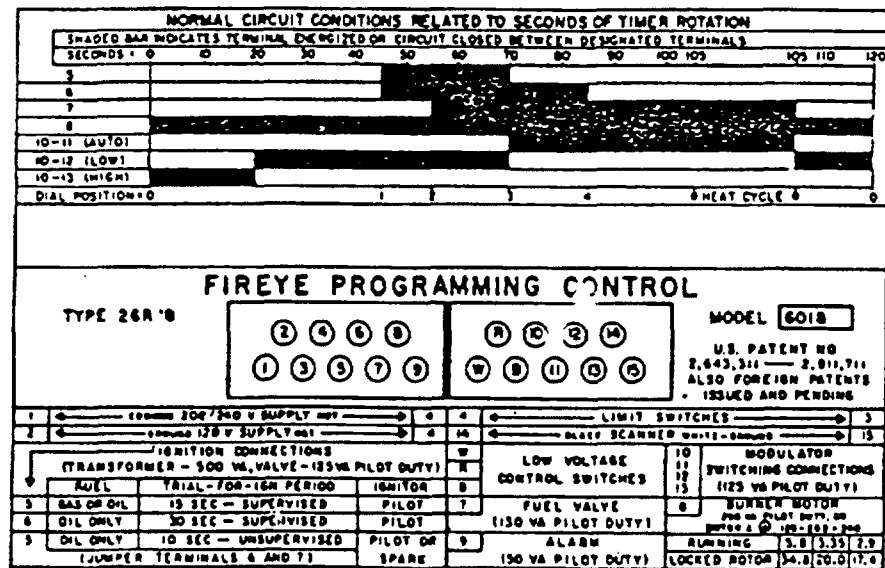


Figure 16

Installation Testing

Test Accessories

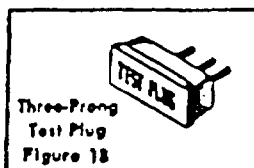
The following test equipment is recommended for checking out new installations and routine troubleshooting:

1. DC Voltmeter (1000 ohms per volt or greater). Range: 0-150 volts (Fig. 17). Any good multimeter is suitable and can be used to measure AC and DC voltages, check for continuity, short circuits, and grounds. The DC voltmeter leads plug into test jacks on the control chassis. For satisfactory operation, the meter will read zero volts with no flame present and steady 60 to 100 volts when the scanner "sees" a flame. AC line and load voltages may be checked at the exposed terminals at the bottom of the chassis.



Test Multimeter
Figure 17

2. Three-prong Test Plug (Fig. 18, Part No. 10-90) replaces the AC Line Plug in the 26RJ8 Control Chassis, electrically disconnects the timer motor, permitting manual control of the firing cycle.



Three-Prong Test Plug
Figure 18

3. Flame Signal Attenuator. Directly above the vacuum tubes on the chassis is a recessed pin, which when grounded to the chassis by a clip cord (Fig. 19), will reduce the sensitivity of the flame signal amplifier 40% for test purposes.

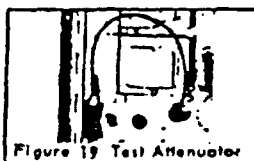


Figure 19 Test Attenuator

For Burner with Pilot Ignition

Checking Scanner Viewing of Pilot Flame

1. Make sure that control and scanner have been properly installed and wired in accordance with the preceding instructions.
2. With power OFF, replace AC Line Plug with Three-Prong Test Plug.
3. (Optional) Ground the attenuator pin to the chassis.
4. Plug DC Voltmeter leads into test jacks on control chassis (Red-plus; Black-minus).
5. Rotate timer knob until "O" appears on timer dial.
6. Turn power ON. Wait until the tubes warm up and both relays are energized.
7. Rotate timer to dial position "X". Wait until the flame relay (RL2) is de-energized.
8. Rotate timer to dial position "1". Make sure ignition is energized. If pilot does not ignite within 15 seconds, turn burner switch off and repeat from step 5 except allow 15 to 20 seconds purge time between steps 7 and 8. Repeat as necessary until pilot flame is established.
9. Observe reading on voltmeter. Reading should be steady, between 60 and 100 volts, dc. If the reading fluctuates, it will be necessary to adjust the pilot flame and/or scanner viewing angle. Continue adjustment until steady, correct reading is obtained.

NOTE

If pilot flame is not detected within about 60 seconds, control will lock out, making it inoperative. It will be necessary to allow two or three minutes for the thermal element to cool and to reset the control manually. Then repeat from step 5.

Checking Scanner Viewing of Main Flame

10. Turn power OFF. Replace 3 prong test plug with 4 prong AC line plug.
11. Reset timer to "O" and turn power ON.

12. As dial reaches position "2", watch for establishment of main flame. If flame is not established within about 5 seconds, turn burner switch OFF, then return to ON and allow control to recycle normally for a new lighting trial. (Note: On an initial starting attempt, portions of fuel lines may be empty and require "bleeding" time. It is better to accomplish this with repeated short lighting-trial periods with intervening purge periods than to risk prolonged fuel introduction at a time when burner adjustments have not been completed and the minimum pilot test has not been conducted. Do not repeat unsuccessful lighting attempts without rechecking burner and pilot adjustments if lighting does not occur within 5 seconds after fuel introduction is verified or can be reasonably assumed.)

13. When main flame is established, leave burner on and let timer progress until ignition shuts off (either dial position "3" or "4" as the case may be). If scanner main flame sighting is reasonably good, the flame relay will stay energized, main flame will stay lit, and the timer will progress to dial "dot" position and stop. If flame goes out due to instability without ignition, readjust burner and repeat from step 11. If flame is stable but flame relay drops out because of poor sighting, realign scanner sight tube and repeat from step 2.

14. With step 13 completed and burner remaining lit with timer at "dot" position, readjust burner as necessary for correct flame size and optimum combustion, then recheck for proper lighting. If scanner is properly sighted, the DC voltmeter will now register a steady 60 volts or more with pilot flame only and with main flame only. Repeat scanner and burner adjustments as necessary to obtain this condition if it does not exist initially.

15. With all steps through 14 satisfactorily completed, remove attenuator connection (if used) and proceed with minimum pilot test.

Minimum Pilot Test

This test assures that the scanner will not detect flame too small to light off the main flame. It must be made (a) on every new installation, and (b) following any change of scanner location or viewing angle. Do not conduct this test with the attenuator pin grounded!

16. Repeat steps 2, 5, 6 and 7, then advance timer to dial position "1" so that pilot ignites.
17. Reduce the size of the pilot until the flame relay is observed to drop out, then slowly increase the size of pilot flame just to the point where the flame relay pulls in. This is called minimum pilot. (Note Figs. 20, 21, 22)
18. Advance timer to dial position "2" to energize main fuel valve. CAUTION: If main flame does not ignite in approximately the same time as it did with normal full pilot flame, immediately turn the burner switch OFF! Realign the scanner sighting tube so that detection requires a larger pilot flame and repeat minimum pilot test. Repeat this process until main flame lights reliably on several trials.

19. After minimum pilot test is completed, increase pilot flame to normal size.

Checking Detection with Hot Combustion Chamber

With all the above outlined tests and final burner adjustments completed, operate the burner (observing manufacturers warm-up instructions) until combustion chamber is at maximum expected temperature. Recheck for adequate signal with main flame only and with pilot only. If steady output voltage of 60 or more volts DC is not measured at the test jacks, realign scanner sighting to obtain suitable output voltage and then repeat all steps through 19.

For Burner with Spark Ignition (No Pilot)

Checking Scanner Viewing of Main Flame

1. Proceed according to steps 1, 3, 4 and 8 as outlined above.
2. Turn power ON. After tubes warm up, relays will pull in and timer will start.

3. As timer reaches dial position 1, watch for main flame to be established. If flame is not established by the time dial position "2" is reached, turn burner switch OFF and then ON again and allow control to recycle normally. CAUTION: If fuel is observed to enter combustion chamber and ignition does not occur at once, shut burner switch OFF and check electrode settings. Do not repeat ignition attempts unless a good spark can be observed in a position where the fuel will be readily ignited.

4. If scanner sighting is correct, DC voltmeter will register steady 60 volts or more. If it does not, shut burner OFF, realign scanner, and repeat the check. If voltmeter registers satisfactorily until ignition shuts off at dial position 3, and then reading becomes unsteady, readjust burner to obtain stable flame both with and without ignition on.

5. Remove attenuator connection (if used).

Checking Pilot Flame Failure Protection

1. Shut off the fuel to the pilot burner.
2. Start the control cycle.

3. After 45 seconds' purge period, the pilot assembly will be energized.

4. Because no pilot flame is detected, the pilot assembly will shut off after 10 seconds. The main fuel valve will not be energized.

5. The programming timer will complete its cycle during which time the lockout switch will trip, effecting a safety lockout and actuating the alarm (if used).

Checking Main Flame Failure Protection

1. Start the burner in the normal manner.
2. After the startup programming has been completed, shut off the main fuel supply.
3. Immediately after the flame fails, the main fuel valve will close and after approximately 60 seconds, the lockout switch will trip, actuating the alarm.
4. Following a 15 second post purge or spin-down period, the blower motor will stop.
5. The lockout switch may be reset after allowing the thermal element to cool (approximately 2 minutes).

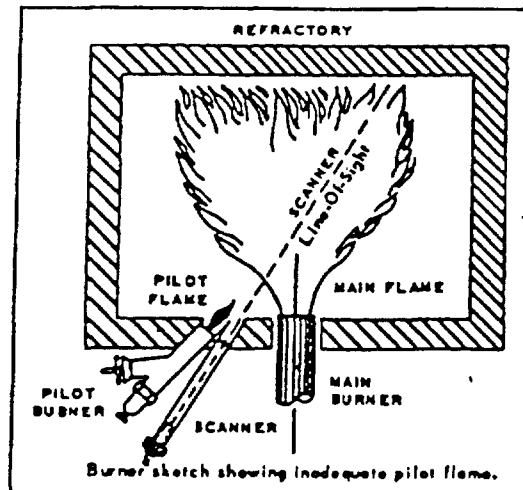


Figure 20

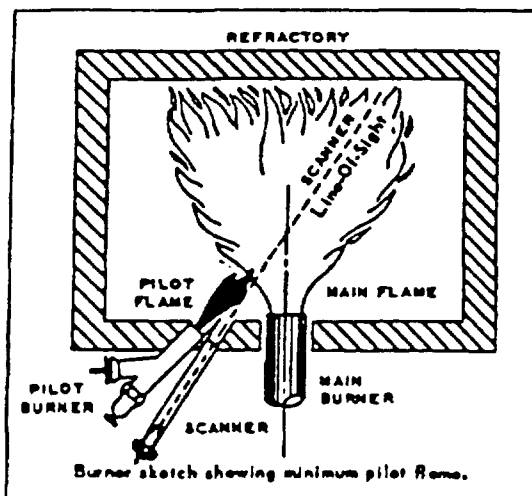


Figure 21

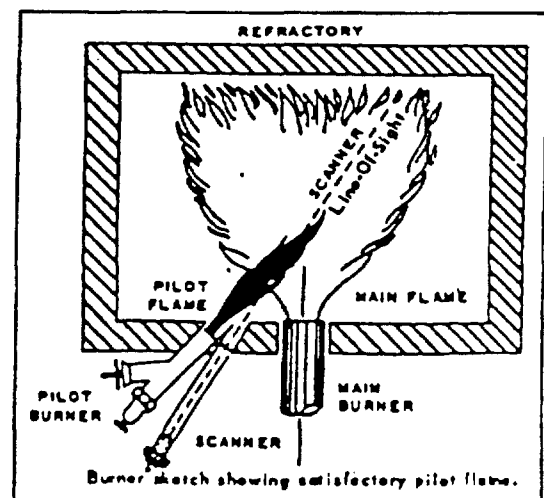


Figure 22

Troubles in FP-2 System installations can be readily isolated by following the approved procedure in the sequence given below. Before beginning any troubleshooting, however, make sure that:

Installation and wiring has been made in accordance with instructions in this bulletin.

2. Chassis is securely plugged in and thumbscrews tightened; AC line plug is in proper socket; lockout switch is reset.

In the following tabulation, troubles appear within boxes, and possible causes are listed below the boxes.

CONDITION: Zero voltage at Terminals 1 and 4 (208-240 volt installation) or at Terminals 2 and 4 (120 volt installation).

1. Disconnect Switch off.
2. Blown fuse.
3. Broken wire.
4. Incorrect wiring.

CONDITION: Insufficient voltage at Terminals 1 and 4 or 2 and 4.

1. Minimum operating voltage is 177 volts for 208 volt connection; 204 volts for 240 volt connection; 102 volts for 120 volt connection.

CONDITION: Zero voltage at Terminals 1 and 3 (208-240 volt installation) or at Terminals 2 and 3 (120 volt installation).

1. Open limit switch circuit (Pressure, LWCO etc.).
2. Broken wire.
3. Motorized stack damper control in closed position.
4. Incorrect wiring.

CONDITION: Flame relay RL2 does not pull in at startup.

1. Vacuum tubes not warmed up.
2. Defective vacuum tube.
3. Timer dial not at "O" position.
4. Lockout switch is tripped.
5. W to B circuit open (operating controls and starting sterlocks.)
6. Poor connection at plug-in jacks. Check to make sure they are not spread open.
7. Relay armature blocked open.
8. Contacts LS-1, KI-3, K3-2, or K3-3 open or dirty.
9. Defective programming control; replace.

CONDITION: Master relay (RL1) does not pull in.

1. Flame relay does not pull in. See check list above.
2. RL2-2 contacts open or dirty.
3. RL1 armature may be mechanically stuck open.
4. Defective programming control; replace.

CONDITION: Master relay pulls in but timer does not start.

1. Contacts RL1-1 or K4-1 are dirty or open.
2. Timer motor is mechanically bound; check by rotating timer knob.
3. Defective programming control; replace.

CONDITION: Programming timer starts. Blower motor does not start.

1. Insufficient voltage between Terminals 1 and 8 (208-240 volt operation) or 2 and 8 (120 volt operation).
2. Blown motor fuse.
3. Motor starter overloads tripped.
4. Burner motor incorrectly wired.
5. Defective motor or starter.

CONDITION: Modulator motor does not drive toward open-damper position.

1. Modulator motor not powered.
2. Linkage jammed.
3. Incorrect wiring.
4. Contacts RL1-5, K7-2, K8-1 dirty or open.
5. Contacts RL1-6 do not open.
6. Defective modulator equipment.

CONDITION: Flame relay RL2 does not drop out before "X" appears on timer dial.

1. Incorrect scanner wiring.
2. Scanner sees flame caused by leaky fuel valves, burning carbon, or soot, or an adjacent burner in multiple burner installations.
3. Flame relay is mechanically held in.
4. Defective vacuum tube.
5. Contacts K3-2 or K3-3 do not open.
6. Defective control or scanner.

CONDITION: Master relay drops out after timer starts.

1. Contacts RL1-3, K8-1 dirty or open.
2. Air flow switch is not closed (W to R).
3. Lockout switch heater is open.

CONDITION: Modulator motor does not drive toward closed-damper position at about 20 seconds.

1. Modulator motor not powered.
2. Linkage jammed.
3. Incorrect or faulty wiring.
4. Contacts RL1-5, K7-2, K8-2 dirty or open.
5. Defective modulator equipment.

CONDITION: Timer dial reaches position "1". Pilot flame is not established.

1. Insufficient voltage between Terminals 1 and 5, 6 (208-240 volt operation) or 2 and 5, 6 (120 volt operation).
2. Contacts RL1-4, KI-2, K2-1 or K7-3 dirty or open.
3. Defective gas valve.
4. Defective ignition transformer or electrode.
5. Improper electrode setting.
6. Plugged pilot burner.
7. Insufficient gas pressure.
8. Improper pilot burner adjustment.
9. Ignition assembly incorrectly wired.

CONDITION: Flame relay (RL2) does not pull in when pilot flame lights.

1. Pilot flame too small. Make sure gas pressure is not less than that specified for the pilot burner.
2. Scanner sight tube obstructed, or scanner lens dirty.
3. Scanner sighting is incorrect.
4. Scanner is incorrectly wired—correct wiring is white wire to Terminal 15; black wire to Terminal 14.
5. Scanner is too hot.
6. Scanner views hot refractory.
7. Flame relay is mechanically bound.
8. Defective tube or cell, or tubes reversed.
9. Contacts KI-3, dirty or open.
10. Defective scanner.
11. Defective control.

CONDITION: Timer dial reaches position "2". Main fuel valve stays shut.

1. Insufficient voltage between Terminals 1 and 7 (208-240 volt operation) or 2 and 7 (120 volt operation).
2. Contacts RL2-3, RL2-4 or KI-1 dirty or open.
3. Defective valve.
4. Incorrect wiring.
5. Pilot flame not detected.
6. Blown fuel valve circuit fuse.

CONDITION: Fuel valve is energized. Main flame does not light off.

1. Inadequate pilot.
2. Incorrect burner adjustment.
3. No main fuel.

CONDITION: Main flame lights and then goes out.

1. Lockout switch has tripped. Allow to cool for two minutes and reset.

Service

2. Limit, operating control circuit, or air flow switch open.
3. Contacts RL2-2, K3-1 dirty or open.
4. Scanner is "blinded" by too bright reflection of flame on inside surface of sighting tube, or by sighting incandescent refractory. If scanner is correctly installed, restrict view with orifice in sighting tube.

CONDITION: Timer dial reaches position "3" or "4". Pilot flame does not go out.

1. Gas pilot valve is stuck open.
2. Contacts K7-3 or K2-1 are stuck closed.
3. Control circuit wiring is incorrect or cross-phased.

CONDITION: Timer dial reaches position "3". Modulator motor does not respond to modulation controller.

1. Modulator motor not powered.
2. Setting of modulation controller incorrect.
3. Linkage jammed.
4. Incorrect wiring.
5. Contacts K7-1, RL1-5 dirty or open.
6. Defective modulator equipment.

CONDITION: Main flame goes out when pilot shuts off.

1. Scanner does not "see" main flame.
2. Incorrect burner adjustment.
3. Incorrect wiring to solenoid fuel valve.

Maintenance

Firetron Cell: Estimated life 20,000 hours, when operated within ambient temperature limits. The scanner lens should be cleaned as often as operating conditions demand.

Tubes: Types 12AX7; 12BH7A; have an estimated life of 10,000 hours. Annual replacement recommended. Replacement tubes are available from local radio tube supply sources.

Fuel Valve Fuse: 6 ampere, 250 volt, Type JAG fast blow. Do not substitute (except for smaller ampere rating if desired) and do not renew without observing procedure described on.

Guarantee

We guarantee to replace or, at our option, repair any products or parts thereof (except fuses, electronic tubes and cells) which are found defective in material or workmanship within one year from date of shipment. Our obligation with respect to such products or parts shall be

CONDITION: Timer does not stop at "dot".

1. Contacts K4-1 or RL1-2 stuck closed.

CONDITION: Timer does not rotate to "0" when operating or limit control opens.

1. Contacts RL1-2 or K3-1 dirty or open.
2. Limit switches incorrectly wired.

CONDITION: During post purge period modulator motor does not drive toward damper-closed position.

1. Modulator motor not powered.
2. Linkage jammed.
3. Incorrect wiring.
4. Contacts RL1-6 dirty or open.
5. Defective modulator equipment.

CONDITION: Timer does not stop at "0".

1. Contacts RL1-1 or K3-1 stuck closed.
2. Control circuit wiring cross-phased.
3. Limit or operating switch circuit closed.

CONDITION: Burner motor does not stop when time dial reaches "0".

1. Contacts RL1-1 or K3-1 stuck closed.
2. Control circuit wiring cross-phased.
3. Limit or operating switch circuit closed.
4. Motor starter is mechanically stuck.
5. Motor starter is incorrectly wired.

Contacts: All relay contacts are designed with adequate wiping action for self cleaning under normal conditions. In atmospheres carrying excessive dust or oily vapors, contacts may require occasional cleaning. Use only fine grade of crocus cloth for cleaning. Do not file.

Humidity Effects: To protect against high resistance leakage in the electronic circuit resulting from high humidity, it is recommended that the 26RJ8 Control be left powered continually even when not in operation. If it is necessary to shut down completely for an extended period, power should be turned on for 48 hours before putting the control back in operation.

limited to replacement or repair f.o.b. Cambridge, Mass. and in no event shall we be liable for consequential or special damages, or for transportation, installation, adjustment, or other expenses which may arise in connection with such products or parts.

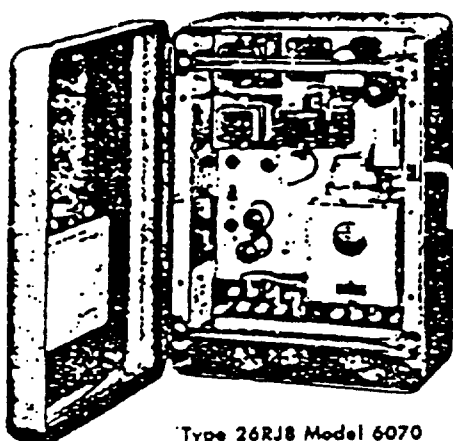


COMBUSTION CONTROL DIVISION ELECTRONICS CORPORATION OF AMERICA

One Memorial Drive, Cambridge 42, Massachusetts

IN CANADA: Electronics Corporation of America (Canada) Ltd.

104 Advance Road, Toronto 18, Ontario



Type 26RJ8 Model 6070



Scanner Type 48PT1



System FP-2

using

Type 26RJ8 - Model 6070



Model 6070 is specifically designed to comply with FIA Requirements for automatic gas or oil fired burners.

C.S.A. File # 7989

FEATURES

Fireye System FP-2 provides ignition and flame failure protection for industrial and commercial oil, gas, or combination oil/gas burners. In conjunction with operating, limit, and interlock devices, it automatically programs each starting, operating, and shutdown period. The FP-2 System consists of a Type 26RJ8 programming control and a Type 48PT1 scanner which uses the "Fireye" cell to supervise visually both oil and gas flames.

The FP-2 System monitors both main and pilot flames and does not permit the main fuel valve to be energized unless pilot flame has been established and proved. With an alternate connection for burners having direct spark ignition, the unsupervised trial-for-ignition period is precisely restricted to a safe short interval.

The 26RJ8 control programs the operation of blower and/or burner motor, ignition system, fuel valve, and modulator system in a proper sequence which includes suitable purge periods before ignition and after burner shutdown. Additionally, it is designed to de-energize all fuel valves within 1 to 4 seconds upon loss of flame signal. The control recycles automatically each time the operating or limit control closes, or after a power failure, but locks out and must be reset manually following flame failure, or opening of the running interlock circuit during a firing period.

The FP-2 System incorporates a safety checking circuit that is effective on every start. Any condition which will cause the flame relay to hold in during the checking period will stop the program before any ignition circuits are energized and, if sustained, will result in safety lockout.

SPECIFICATIONS

FIREYE System FP-2, consisting of Control Type 26RJ8, Model 6070, and Scanner Type 48PT1

SUPPLY VOLTAGE:

120 volts (Min. 102v, Max. 132v)
at 60 Hz, 1 phase

VOLT-AMPERE RATINGS:

26RJ8 consumption: 35va
Max. simultaneous connected load: 1965va
(See chart at right and text on pages 3 and 4 for additional rating information.)

MAXIMUM OPERATING TEMPERATURE:

Scanner Type 48PT1 125°F
Control Type 26RJ8 ambient, 125°F

SHIPPING WEIGHT: 22 lbs.

TERMINAL RATINGS (MAX.) FOR TYPE 26RJ8 MODEL 6070

Terminal	Typical Load	Maximum Rating at 120-60Hz	Alternate Rating at 120-60Hz using Wire Rated at 75°C or Higher for Chassis Connection
5 or 6 or Combination	Ignition Transformer Gas Pilot Valve	500va (Transformer) 125va Pilot Duty or 300va (Transformer) 65va Pilot Duty 460va Opening Motorized Valve 120va Holding 550va L.R.	500va (Transformer) 50va Pilot Duty or 300va (Transformer) 125va Pilot Duty
7	Main Fuel Valve	130va Pilot Duty or 65va Pilot Duty 460va Opening Motorized Valve 120va Holding	250va Pilot Duty or 65va Pilot Duty 1250va Opening Motorized Valve 500va Holding
A	Burner Motor Blower Motor Motor Starter	3.8 amps - Full Load 36.8 amps - Locked Rotor or 350va Pilot Duty	
9	Alarm	50va Pilot Duty	
10, 11, 12, 13	Modulator	125va Pilot Duty = 120 volts or 2 amps = 30 volts AC maximum (N.E.C. Class 2)	

Select ALL Terminal Ratings from ONE Column, either A or B.
Total connected load not to exceed 1000va.

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MOUNTING AND OUTLINE DIMENSIONS

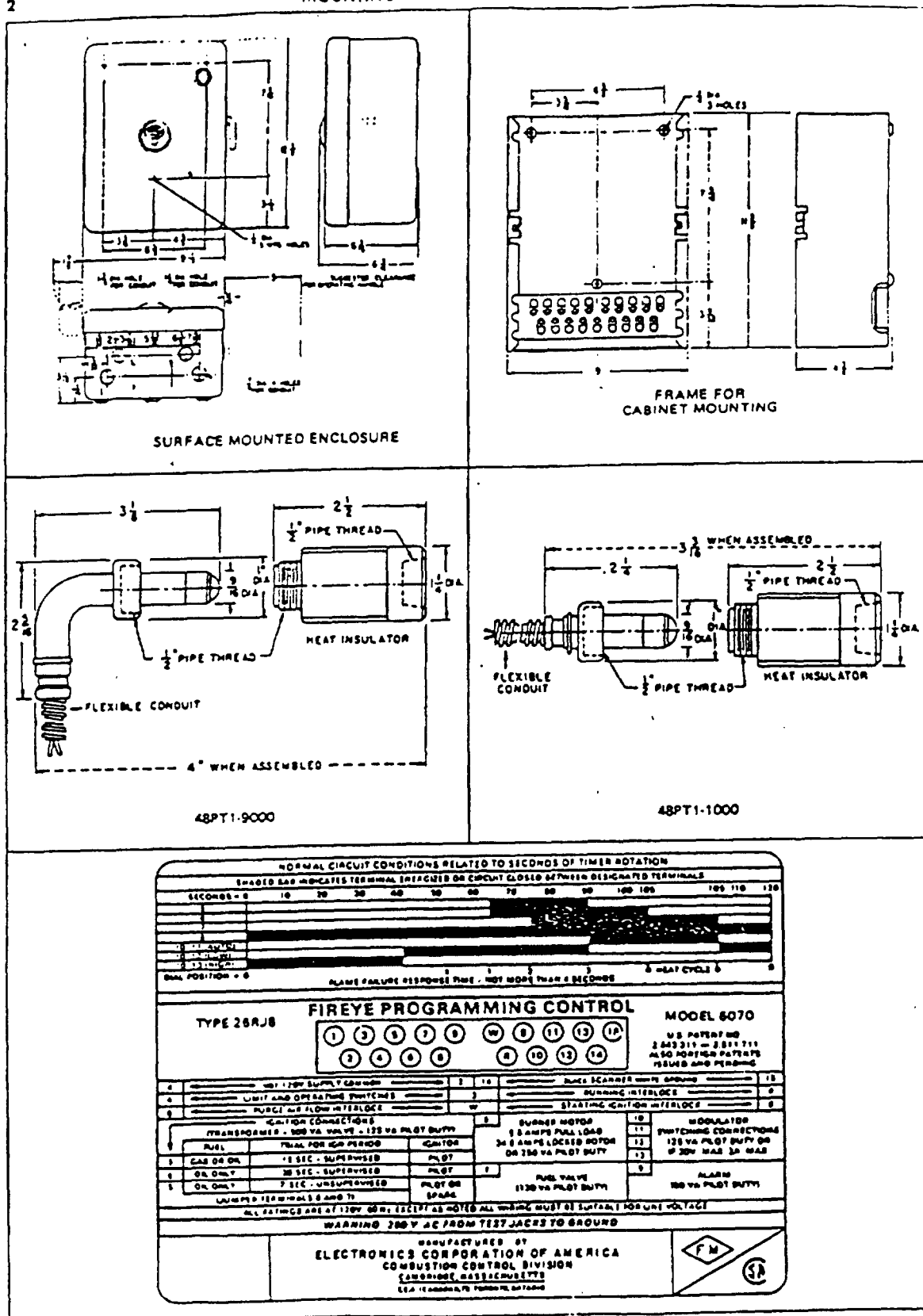


Figure 1

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INSTALLATION

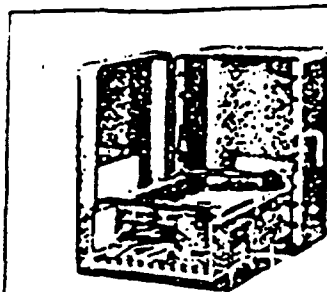


Figure 2

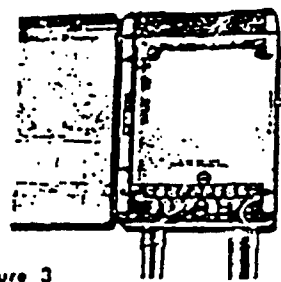


Figure 3

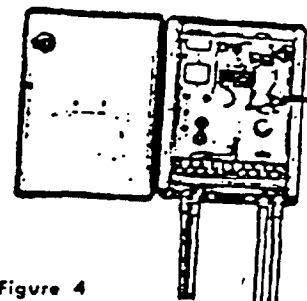


Figure 4

Installing the Type 26RJ8 Control

Loosen thumb screws at front of chassis. Pull out chassis and place on its back plate (Fig. 2). Select control mounting location on panel board or upright surface that is free from excessive vibration. Secure housing with screws or bolts using Figure 1 for drilling dimensions. After the housing is wired (Fig. 3), replace unused knockout plugs. Plug chassis securely into housing (Fig. 4), and tighten captive thumb screws.

Control and Scanner Wiring

Make wiring connections at terminal panel at bottom of housing (Fig. 3). Separate knockouts are provided for conduit connections for line voltage, and scanner circuits. Follow approved wiring diagrams. Connect bare wire directly to screw posts — without lugs.

Use suitable wire enclosed in rigid or flexible conduit for power connections. All wiring must comply with the National Electrical Code and local codes. Splices must be made only in troughs or junction boxes.

The control housing must be grounded either by the normal conduit ground or by an added grounding wire.

Attach the cable supplied with the scanner to a junction box. Splice the cable wires to a pair of wires not smaller than #18. Install the complete run in a separate conduit to the knockout directly under Terminal 15 of the Type 26RJ8 Control housing. Connect black wire to Terminal 14; white wire to Terminal 15. Continuous conduit bonding between scanner and conduit bonding between scanner and control is mandatory! Scanner may be located up to 100 feet from control. Do not pass scanner wiring through any junction box containing other wires. Do not run other wires through scanner conduit. This is a UL requirement.

Electrical Ratings:

"VA" ratings (not specified as pilot duty) permit the connection of transformers and similar devices whose inrush current is approximately the same as their running current.

"VA pilot duty" ratings permit the connection of relays, solenoid valves, lamps, etc. whose total operating load does not exceed the published rating and

whose total inrush current does not exceed 10 times the rating.

"Running and locked rotor" ratings are intended for motors. VA and VA (pilot duty) loads may be added to a motor load provided the total load does not exceed the published rating.

To convert from watts to volt-amperes or horsepower, etc., refer to the National Electric Code Handbook.

All published ratings apply to AC loads. For DC ratings, consult the factory.

Published load ratings assume that no contact be required to handle inrush current more often than once in 15 seconds. The use of control switches, solenoids, relays, etc. which chatter will lead to premature failure of switches in the Fireye control. Similarly, the contacts cannot be expected to handle short circuit currents without damage. It is important to run through a test operation (with fuel shut off) following the tripping of a circuit breaker, a blown fuse or any known instance of chattering.

Because of special hazards that could accompany fusing of the fuel valve circuit contacts, they are constructed of weld resistant material.

Operation of FIRETRON Cell

The active element of the FIRETRON cell is a lead sulfide (PbS) semiconductor whose electrical resistance instantaneously changes in accordance with the amount of infrared and visible radiation it receives from sources within its view. Such radiation originating in a combustion chamber may consist of a steady radiation from hot refractory or metal and an average value of flame radiation which continuously fluctuates in magnitude by an amount and at a rate which are functions of the type of fuel and combustion conditions.

When a DC voltage is impressed across the cell and a series resistor, the fluctuation of cell resistance corresponding to fluctuation of flame radiation produces a fluctuating voltage across the cell. This voltage is termed "flame signal" and is fed to an amplifier.

The amplifier responds to a fluctuating voltage but not a steady one. It therefore responds to a fluctuating flame signal but not to a steady refractory signal. Fur-

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ther, it is "tuned" for maximum response at a frequency of 10 cycles per second (a fluctuation rate found in all flames) and has relatively little response at power line (60 cycles) and very low (1 cycle) frequencies. When amplified flame signal exceeds a given magnitude, it causes energization of a flame relay.

Whereas the system does not "detect" hot refractory, excessive steady radiation reduces flame signal. The same effect results from excessive scanner temperature. To avoid nuisance shutdowns, it is important to avoid sighting hot refractory and to keep scanner temperature low (never over 125°F).

Application Procedure - Scanner Type 48PT1

The general instructions which follow, apply to installations of a single scanner which monitors both pilot and main flames. If separate scanners are used for pilot and main flames, consult the burner manufacturer for installation instructions.

1. Locate scanner sight tube point of entry below and close to the burner ignition assembly (Fig. 5) and drill a $\frac{1}{4}$ " hole through the boiler or furnace wall. The sight tube, a 4"-8" length of $\frac{1}{2}$ " black iron pipe, will be fixed to the hole when the proper position has been established.

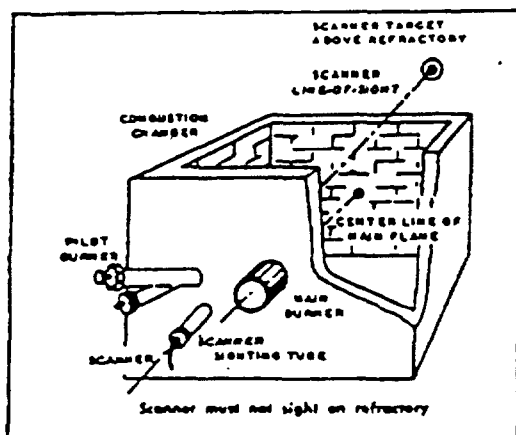


Figure 5

2. Position the scanner sight tube so that scanner line of sight will cross the intersection of pilot flame axis and main flame (Fig. 14). Tack weld the sight tube to the point of entry hole. Should it be necessary to remove refractory to obtain the proper line of sight, prepare a straight hole not less than $\frac{1}{4}$ " I.D. Flare this hole slightly as it enters the combustion chamber.

3. Scanner must have unobstructed view of both pilot and main flames (Fig. 6).

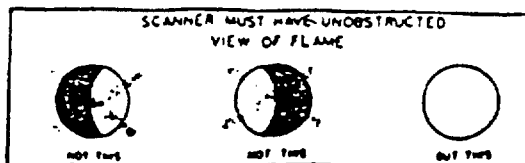


Figure 6

4. Both pilot and main flames must completely cover scanner field of view (Fig. 7).



Figure 7

5. Scanner must not sight on refractory which will become incandescent during burner operation.

6. Scanner must not be allowed to exceed a temperature of 125°F.

For precise adjustment of the scanner viewing angle, **Fireye Swivel Mount** (Part No. 60-302) is available. If it is necessary to restrict the area the scanner views (to reduce sensitivity, or because of unsatisfactory background), use **Fireye Orifice Set** (Part No. 10-88).

Keeping the Scanner Cool

The Firetron Scanner (Temperature Limit 125°F.) should never get too hot to grasp comfortably in the hand. Keep the scanner cool by one or more of the following methods (Fig. 8).

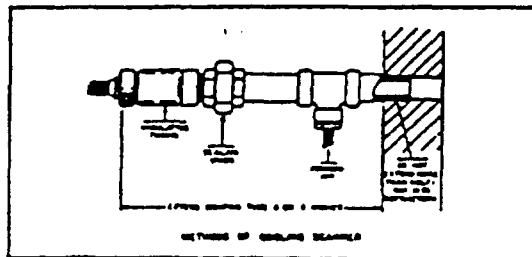
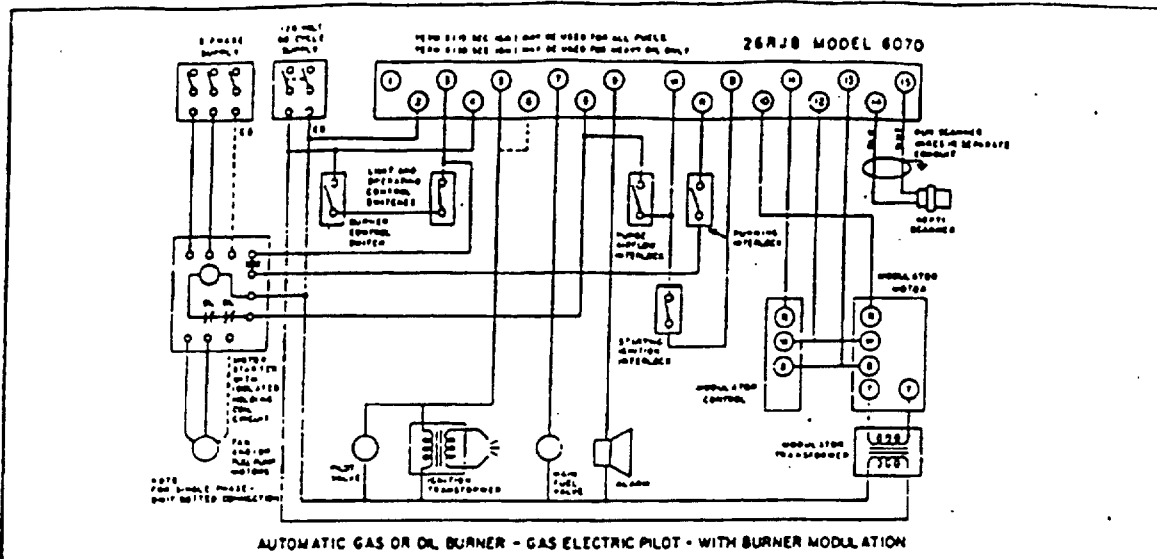
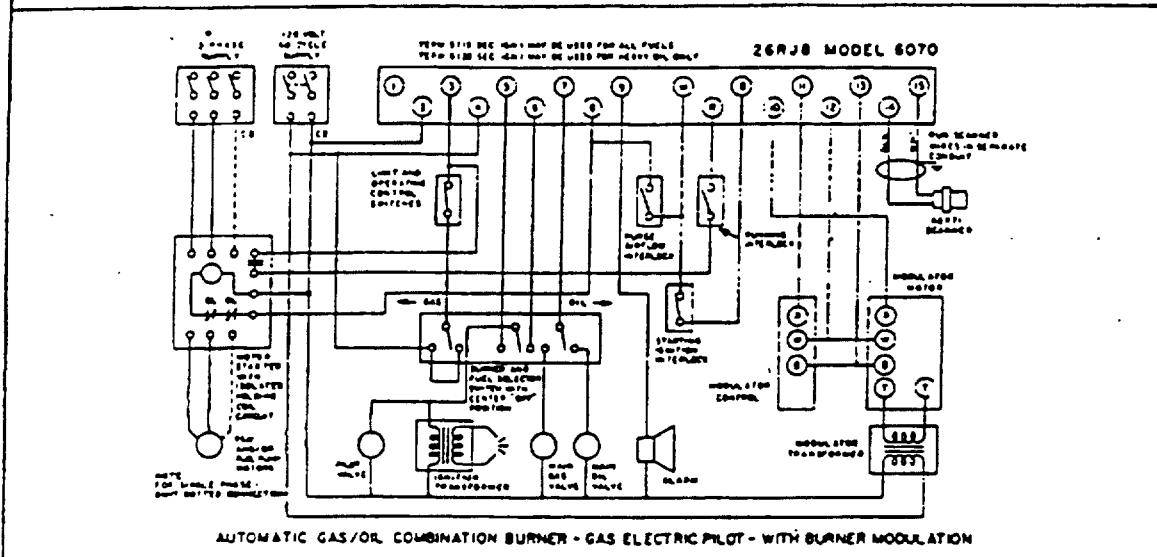


Figure 8

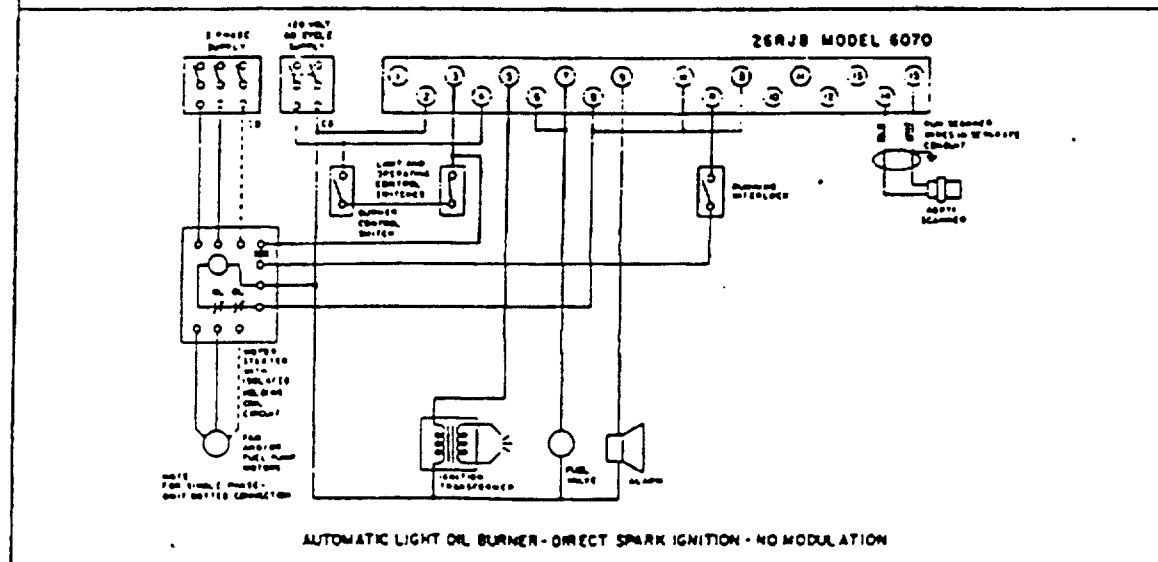
1. Use 6" to 3" length of pipe between scanner and hot furnace front plate.
2. Use insulating tube (Part No. 35-69) on the end of the iron pipe.
3. Force air into sighting tube.
4. Make sure sighting tube does not extend more than halfway into refractory wall.
5. Use **Fireye Sealing Union** (Part No. 60-801) when using method 3 above.



AUTOMATIC GAS OR OIL BURNER - GAS ELECTRIC PILOT - WITH BURNER MODULATION

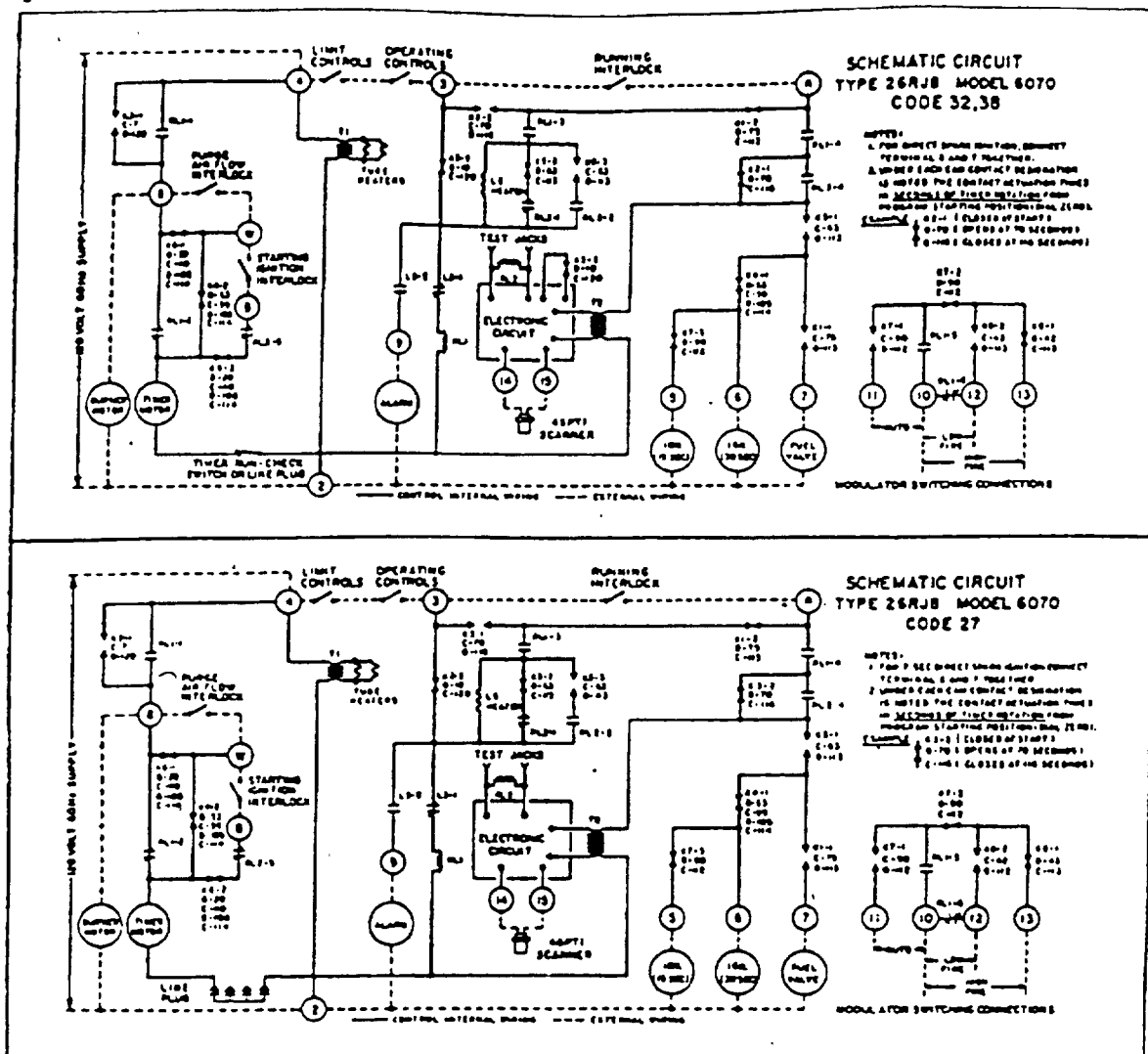


AUTOMATIC GAS/OR COMBINATION BURNER - GAS ELECTRIC PILOT - WITH BURNER MODULATION



AUTOMATIC LIGHT OIL BURNER - DIRECT SPARK IGNITION - NO MODULATION

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RELAY, LOCKOUT SWITCH AND TIMER OPERATION

- Master Relay (RL1) is located slightly above center of chassis. When all starting circuits are closed RL1 pulls in. Only with RL1 energized is power made available to the ignition and fuel valve switching circuits. RL1 remains energized from the start of a program until a limit or operating control opens or the lockout switch trips.
- Flame Relay (RL2) is located at top right of chassis. It is energized in response to flame signal. As long as there is a call for heat it remains energized unless there is loss of flame signal or unless the running airflow switch or a limit control opens.
- The lockout switch (LS) is located to the right of RL2 on the chassis. It trips (contacts transfer to safety position) if RL2 assumes and holds its energized position prior to "ignition on" or if RL2

assumes its de-energized position due to ignition failure, flame failure, or opening of the running airflow switch after main flame is established. It is a thermally actuated device which trips after its heater is continuously energized for about one minute. Its contacts will not automatically release from the safety position and must be manually reset after a cooling period of two or more minutes.

- The timer (K) is located at the lower right hand side of the chassis. It consists of multiple-leaf switches actuated by cams driven by a synchronous motor. The switches operate in a non-adjustable timed program to control (in association with RL1, and RL2) all external loads except alarm. The timer itself is variously controlled by RL1 and RL2 and its own contacts. Timer shaft position is indicated by a drum-type dial.

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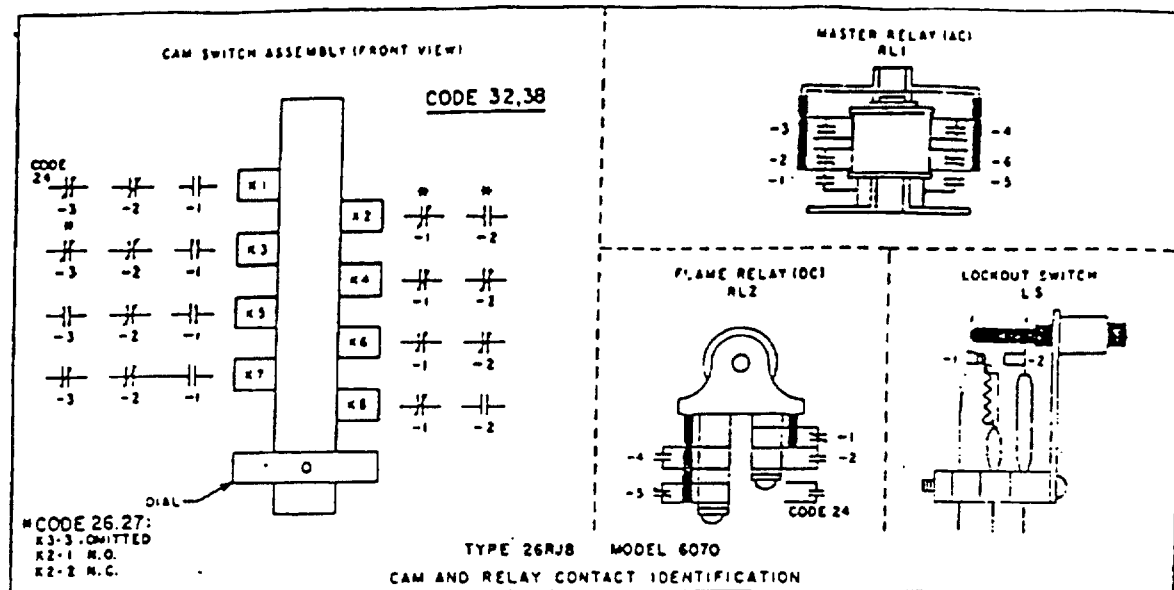


Figure 14

TIMING SEQUENCE: FP-2 SYSTEM WITH TYPE 26RJ8 MODEL 6070

Gas or oil proven pilot. (No connection between terminals 6 and 7)		For unproven pilot or direct spark ignition (Terminals 6 and 7 jumpered) differences in operation are marked with asterisk (*).
Timer Rotation (Seconds)	Dial Indications	<u>BURNER STARTUP</u> Action
0	0	Operating control closes. Master relay, timer motor and burner motor (terminal 8) ; also flame relay on Code 32 & 38 units become energized. Modulator control switches go to high fire position (10-12 opens, 10-13 closes).
10	-	Running interlock (3-R) circuit must be closed at this point and throughout remainder of heating cycle. Interruption prior to Dial 2 results in control recycle. Interruption after Dial 2 results in safety lockout. Checking signal K3-3 opens, flame relay de-energizes. Should flame relay remain energized, RL2-5 opens, timer stops at 53 seconds, safety lockout will occur.
20	-	Purge air flow interlock (terminal 8 to W closed) must be satisfied for cycle to continue.
42	-	Modulator control switches go to low fire position (10-13 opens, 10-12 closes).
53	X	If, for any reason, flame relay holds in, cycle timer motor stops until lockout switch trips. If starting ignition interlock (W to B closed) is not satisfied, timer motor stops until interlock is satisfied.
63	1	Ignition (terminals 5 and 6) on. *Terminals 5, 6 and 7 (Fuel valve) energized.
70	-	*No action unless flame has not been established and/or detected, in which case fuel valve and ignition are deenergized.
75	2	Fuel valve (terminal 7) on (provided pilot is proven).
90	3	Terminal 5 ignition off. Modulator control switches go to demand position. (10-12 open, 10-11 closed).
105	DOT (Index)	Terminal 6 ignition off. End of initiating cycle; timer motor stops. Burner operates until heat demand is satisfied. *Terminal 6 remains energized.
		<u>BURNER SHUTDOWN</u>
105	DOT (Index)	Operating control opens: master relay and fuel valve (terminal 7) deenergized; timer motor becomes energized. Modulator control switches go to low fire position (10-11 open, 10-12 closed).
120	0	Burner motor (terminal 8) circuit and cycle timer motor deenergized.
		System is ready for startup whenever operating control closes again.

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INSTALLATION TESTING

Test Accessories

The following test equipment is recommended for checking out new installations and routine troubleshooting: 1. DC Voltmeter (1000 ohms per volt or greater). Range: 0-150 volts (Fig. 9). Any good multimeter is suitable and can be used to measure AC and DC voltages, check for continuity, short circuits, and grounds. The DC voltmeter leads plug into test jacks on the control chassis. For satisfactory operation, the meter will read zero volts with no flame present and steady 90 to 110 volts when the scanner "sees" a flame. AC line and load voltages may be checked at the exposed terminals at the bottom of the chassis.



Test Multimeter
Figure 9

2. Test Switch (Figure 10) when in "check" position, electrically disconnects the timer motor, permitting manual control of timer.

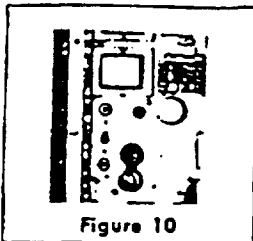


Figure 10

NOTE: Removing the A.C. line plug (in units so equipped) performs the same electrical function as turning the test switch to "check" position.

3. Flame Signal Attenuator. Directly above the vacuum tubes on the chassis is a recessed pin, which when grounded to the chassis by a clip cord (Fig. 11), will reduce the sensitivity of the flame signal amplifier 40% for test purposes.

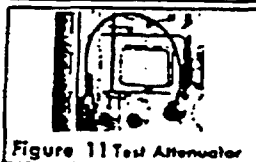


Figure 11 Test Attenuator

For Burner with Pilot Ignition

Checking Scanner Viewing of Pilot Flame

1. Make sure that control and scanner have been properly installed and wired in accordance with the preceding instructions.
2. (Optional) Ground the attenuator pin to the chassis.
3. Plug DC Voltmeter leads into test jacks on control chassis (Red-plus; Black-minus).
4. Turn burner switch on. Let timer progress normally from dial "O" past dial "X". As it nears dial "1", grasp the AC line plug (located at top left of chassis) ready to withdraw it, on units so equipped.
5. When timer has slightly passed dial "1" and ignition is energized, place the test switch in the "check" position. If pilot flame is not established within 15 seconds, turn burner switch off, place the test switch in "run" position, turn burner switch back on and repeat from step 4. Repeat as necessary until pilot flame is established.
6. Observe reading on voltmeter. Reading should be steady, between 90 and 110 volts DC. If the reading fluctuates, it will be necessary to adjust the pilot flame and/or scanner viewing angle. Continue adjustment until steady, correct reading is obtained.

Checking Scanner Viewing of Main Flame

7. Turn burner switch "off", place test switch in "run" position, return burner switch to "on", and let control recycle normally.

NOTE:

If pilot flame is not detected within about 60 seconds,

control will lock out, making it inoperative. It will be necessary to allow two or three minutes for the thermal element to cool and to reset the control manually. Then repeat from step 4.

8. As dial reaches position "2", watch for establishment of main flame. If flame is not established within about 5 seconds, turn burner switch OFF, then return to ON and allow control to recycle normally for a new lighting trial.

NOTE: On an initial starting attempt, portions of fuel lines may be empty and require "bleeding" time. It is better to accomplish this with repeated short lighting-trial periods with intervening purge periods than to risk prolonged fuel introduction at a time when burner adjustments have not been completed and the minimum pilot test has not been conducted. Do not repeat unsuccessful lighting attempts without rechecking burner and pilot adjustments if lighting does not occur within 5 seconds after fuel introduction is verified or can be reasonably assumed.

9. When main flame is established, leave burner on and let timer progress until ignition shuts off (either dial position "3" or "dot"). If scanner main flame sighting is reasonably good, the flame relay will stay energized, main flame will stay lit, and the timer will stop at "dot" position. If flame goes out due to instability without ignition, readjust burner and repeat light-off procedure.

10. With step 9 completed and burner remaining lit with timer at "dot" position, readjust burner as necessary for correct flame size and optimum combustion, then recheck for proper lighting. If scanner is properly sighted, the DC voltmeter will now register a steady 90 volts or more with pilot flame only and with main flame only. Repeat scanner and burner adjustments as necessary to obtain this condition if it does not exist initially.

11. With all steps through 10 satisfactorily completed, remove attenuator connection (if used) and proceed with minimum pilot test.

Minimum Pilot Test

This test assures that the scanner will not detect flame too small to light off the main flame. It must be made (a) on every new installation, (b) following any change of scanner location or viewing angle, and (c) following replacement of the scanner cell. Do not conduct this test with the attenuator pin grounded!

12. Repeat step 4. When the timer has slightly passed dial "1" and the pilot is ignited, place the test switch in the "check" position to stop the timer.

13. Reduce the size of the pilot until the flame relay is observed to drop out, then slowly increase the size of pilot flame just to the point where the flame relay pulls in. This is called minimum pilot. (Note Figs. 12, 13, 14).

14. Repeat step 7. When timer reaches dial position "2", watch for main flame to light. CAUTION: If main flame does not ignite in approximately the same time as it did with normal full pilot flame, immediately turn the burner switch OFF! Realign the scanner sighting tube so that detection requires a larger pilot flame and repeat minimum pilot test. Repeat this process until main flame lights reliably on several trials.

15. After minimum pilot test is completed, increase pilot flame to normal size.

A5 000166

INSTALLATION TESTING

Checking Detection with Hot Combustion Chamber

With all the foregoing tests and final burner adjustments completed, operate the burner (observing manufacturer's warm-up instructions) until combustion chamber is at maximum expected temperature. Recheck for adequate signal with main flame only and with pilot only. If steady output voltage of 90 or more volts DC is not measured at the test jacks, realign scanner sighting to obtain suitable output voltage and then repeat all steps through 15.

For Burner with Spark Ignition (No Pilot)

Checking Scanner Viewing of Main Flame

1. Proceed according to steps 1, 2 and 3 as outlined previously.
2. Turn burner switch ON. Master relay will pull in and timer will start.
3. As timer reaches dial position 1, watch for main flame to be established. If flame is not established by the time dial position "2" is reached, turn burner switch OFF and then ON again and allow control to recycle normally.

CAUTION: If fuel is observed to enter combustion chamber and ignition does not occur at once, shut burner switch OFF and check electrode settings. Do not repeat ignition attempts unless a good spark can be observed in a position where the fuel will be readily ignited.

4. If burner ignites and burns properly, DC voltmeter will register a steady 90 volts or more. If voltmeter registers satisfactorily until ignition shuts off at dial position 3, and then reading becomes unsteady, readjust burner to obtain stable flame both with and without ignition on.

Checking Pilot Flame Failure Protection

1. Shut off the fuel to the pilot burner.
2. Start the control cycle.
3. After 65 seconds' purge period, the pilot assembly will be energized.
4. Because no pilot flame is detected, the pilot assembly will shut off after 10 seconds. The main fuel valve will not be energized.

5. The programming timer will complete its cycle during which time the lockout switch will trip, effecting a safety lockout and actuating the alarm (if used).

Checking Main Flame Failure Protection

1. Start the burner in the normal manner.
2. After the startup programming has been completed, shut off the main fuel supply.
3. Immediately after the flame fails, the main fuel valve will close and after approximately 60 seconds the lockout switch will trip.
4. Following a 15-second post purge or spin-down period, the blower motor will stop, and the alarm will be actuated.
5. The lockout switch may be reset after allowing the thermal element to cool (approximately 2 minutes).

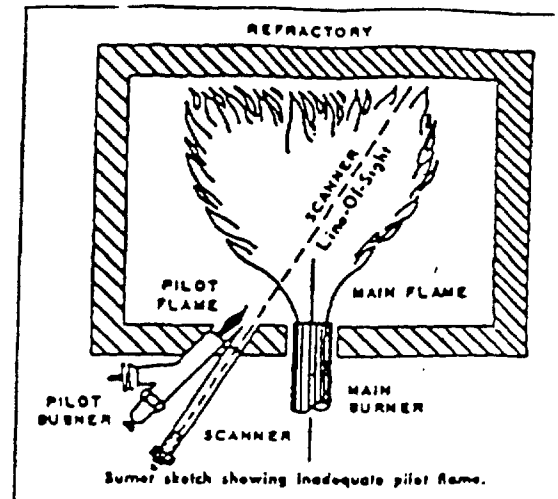


Figure 12

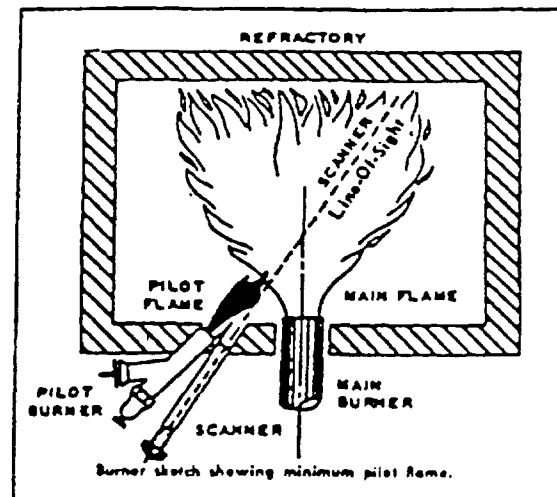


Figure 13

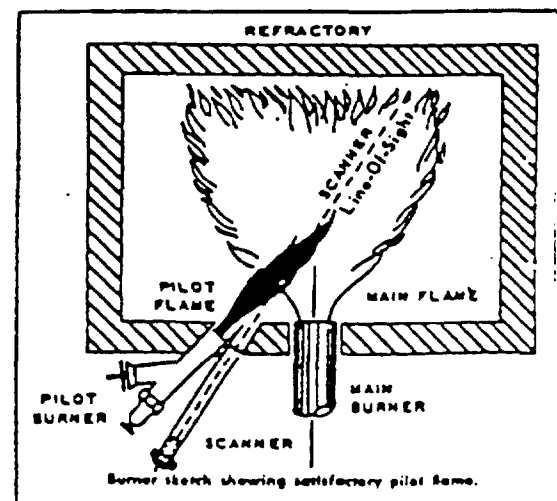


Figure 14

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SERVICING

Troubles in FP-2 System installations can be readily isolated by following the approved procedure in the sequence given below. Before beginning any trouble-shooting, however, make sure that:

1. Installation and wiring have been made in accordance with instructions.
2. Chassis is securely plugged in and thumbscrews tightened; test switch is in "run" position, lockout switch is reset.

In the following tabulation, troubles appear within boxes and possible causes are listed below the boxes.

CONDITION: Zero voltage at terminals 2 and 4.

1. Disconnect Switch Off.
2. Blown fuse.
3. Broken wire.
4. Incorrect wiring.

CONDITION: Insufficient voltage at Terminals 2 and 4.

1. Minimum operating voltage is 102 volts.

CONDITION: Zero voltage at terminals 2 and 3.

1. Open limit switch circuit (Pressure, LWCO etc.)
2. Broken wire.
3. Incorrect wiring.

CONDITION: Master relay (RL1) does not pull in.

1. Timer not at dial zero position.
2. Lockout switch tripped.
3. RL1 armature may be mechanically stuck open.
4. Limit or operating controls open.
5. Contacts K3-2 or LS-1 open or dirty (Code 32 & 38).
6. Contacts K2-2 or LS-1 open or dirty (Code 27).
6. Inoperative programming control; replace.

CONDITION: Master relay pulls in but timer does not start.

1. Contacts RL1-1, K6-1 or K4-2 are dirty or open.
2. Timer motor is mechanically bound; check by rotating timer dial.
3. Inoperative programming control; replace.

CONDITION: Programming timer starts. Blower Motor does not start.

1. Insufficient voltage between Terminals 2 and 8.
2. Blown motor fuse.
3. Motor Starter overloads tripped.
4. Burner motor incorrectly wired.
5. Inoperative motor or starter.

CONDITION: Modulator motor does not drive toward open-damper position.

1. Modulator motor not powered.
2. Linkage jammed.
3. Incorrect wiring.
4. Contacts RL1-5, K7-2, K8-1 dirty or open.
5. Contacts RL1-6 do not open.
6. Inoperative modulator equipment.

CONDITION: Master relay drops out at 10 seconds.

1. Running interlock circuit is not closed.
2. Contacts K1-2, RL1-3 dirty or open.

CONDITION: Timer stops between 20 and 40 seconds after dial zero.

1. Purge airflow interlock circuit (8-W) open.

CONDITION: Timer stops when "X" appears in timer window.

1. Starting interlock circuit (W-B) open.
2. Flame relay (RL2) holds in due to incorrect scanner wiring (see page 3) or residual flame in combustion chamber.
3. K3-3 does not open at 10 seconds (Code 32 & 38 only).
4. RL2-5, K6-2 open or dirty.
5. Inoperative programming control.

CONDITION: RL1 drops out prior to timer dial position "2".

1. Momentary or sustained opening of limit circuit (4-3).
2. Running airflow switch circuit (3-R) open.
3. Contacts RL2-2 or RL1-3, K1-2 open or dirty (Code 32 & 38).
4. Lockout switch heater open.
5. Lockout switch tripped.

CONDITION: Modulator motor does not drive toward closed-damper position at about 42 seconds.

1. Modulator motor not powered.
2. Linkage jammed.
3. Incorrect or faulty wiring.
4. Contacts RL1-5, K7-2, K8-2 dirty or open.
5. Inoperative modulator equipment.

CONDITION: Timer dial reaches position "1". Pilot flame is not established.

1. Insufficient voltage between Terminals 2 and 5 or 6.
2. Contacts RL1-4, K5-1, K1-2, K4-1 or K7-3 dirty or open.
3. Inoperative gas valve.
4. Inoperative ignition transformer or electrode.
5. Improper electrode setting.
6. Plugged pilot burner.
7. Insufficient gas pressure.
8. Improper pilot burner adjustment.
9. Ignition assembly incorrectly wired.

CONDITION: Flame relay (RL2) does not pull in when pilot flame lights.

1. Pilot flame too small. Make sure gas pressure is not less than that specified for the pilot burner.
2. Scanner sight tube obstructed, or scanner lens dirty.
3. Scanner sighting is incorrect.
4. Scanner is incorrectly wired — correct wiring is white wire to Terminal 15; black wire to Terminal 14.
5. Scanner is too hot.
6. Scanner views hot refractory.
7. Flame relay is mechanically bound.
8. Inoperative tube or cell, or tubes reversed.
9. Inoperative Scanner.
10. Inoperative control.

CONDITION: Timer dial reaches position "2". Main fuel valve stays shut.

1. Insufficient voltage between Terminals 2 and 7.
2. Contacts RL1-3, RL2-4 or K1-1 dirty or open.
3. Inoperative valve.
4. Incorrect wiring.
5. Pilot flame not detected.
6. Running interlock circuit 3-R open.

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CONDITION: Fuel valve is energized. Main flame does not light off.

1. Inadequate pilot.
2. Incorrect burner adjustment.
3. No main fuel.

CONDITION: Main flame lights and then goes out.

1. Lockout switch has tripped. Allow to cool for two minutes and reset.
2. Limit and operating control circuit or air flow switch open.
3. Contacts RL2-2, K5-2 dirty or open.

CONDITION: Lockout process initiated at or after dial position "2".

1. Ignition failure.
2. Flame failure.
3. Inadequate flame signal.
4. Running switch circuit (3-R) open.

CONDITION: Timer dial reaches position "3" or "dot". Pilot flame does not go out.

1. Gas pilot valve is stuck open.
2. Contacts K7-3 or K4-1 do not open.
3. Control circuit wiring is incorrect.

CONDITION: Timer dial reaches position "3". Modulator motor does not respond to modulation controller.

1. Modulator motor not powered.
2. Setting of modulation controller incorrect.
3. Linkage jammed.
4. Incorrect wiring.
5. Contacts K7-1, RL1-5 dirty or open.
6. Inoperative modulator equipment.

CONDITION: Main flame goes out when pilot shuts off.

1. Scanner does not "see" main flame.
2. Incorrect burner adjustment.
3. Incorrect wiring to main fuel valve.

CONDITION: Timer does not stop at "dot".

1. Contacts K4-2 or RL1-2 stuck closed.

CONDITION: Timer does not rotate to "O" when operating or limit control opens.

1. Contacts RL1-2 or K3-1 dirty or open (Code 32 & 38).
2. Contacts RL1-2 or K2-1 dirty or open (Code 27).
3. Limit switches incorrectly wired.

CONDITION: During post purge period modulator motor does not drive toward damper-closed position.

1. Modulator motor not powered.
2. Linkage jammed.
3. Incorrect wiring.
4. Contacts RL1-6 dirty or open.
5. Inoperative modulator equipment.

CONDITION: Timer does not stop at "O".

1. Contacts RL1-1 or K3-1 stuck closed (Code 32 & 38).
2. Contacts RL1-2 or K2-1 stuck closed (Code 27).
3. Limit and operating switch circuit closed.

CONDITION: Burner motor does not stop when timer dial reaches "O".

1. Contacts RL1-1 or K3-1 stuck closed (Code 32 & 38).
2. Contacts RL1-1 or K2-1 stuck closed (Code 27).
3. Limit and operating switch circuit closed.
4. Motor starter is mechanically stuck.
5. Motor starter is incorrectly wired.

MAINTENANCE

Fueltron Cell: Estimated life 20,000 hours, when operated within ambient temperature limits. The scanner lens should be cleaned as often as operating conditions demand.

Tubes: Types 12AX7; 12BH7A; have an estimated life of 10,000 hours. Annual replacement recommended. Replacement tube kits are available from E.C.A. distribution. E.C.A. part #129-62.

Contacts: All relay contacts are designed with adequate wiping action for self cleaning under normal conditions. In atmospheres carrying excessive dust or oily vapors, contacts may require occasional cleaning. Use a burnishing tool or fine grade of crocus cloth for cleaning. Never file, sandpaper or apply liquid or aerosol spray cleaners.

Humidity Effects: To protect against high resistance leakage in the electronic circuit resulting from high humidity, it is recommended that the 26RJ8 Control be left powered continually even when not in operation. If it is necessary to shut down completely for an extended period, power should be turned on for 48 hours before putting the control back in operation.

Rotation: It is recommended that units purchased as spares be rotated periodically, so that each unit will be placed in operation at least every 90 days, to ascertain that the spare unit is in working order. This will prevent possible deterioration of a unit stored over a period of years.

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AS 000169

SUGGESTED SPECIFICATIONS FOR FLAME SAFEGUARD CONTROL FOR AUTOMATIC COMMERCIAL-INDUSTRIAL BURNERS

GENERAL

1. Each automatically fired burner shall be equipped with a UL listed and FM approved Electronic Flame Safeguard and Programming Control having the following functions:
 - a. The control shall accomplish a safe start component check during each start, which will prevent the burner from firing under any condition which causes the flame relay to assume and hold its energized position due to the presence of an actual flame, a flame simulating component failure or mechanical failure.
 - b. A purge period to purge the combustion chamber and heat exchanger at a minimum rate of 60% of maximum air flow, for sufficient time to accomplish 4 air transfers of the entire volume shall be provided. The control system shall be interlocked to prevent the burner from firing until the desired purge is accomplished.
 - c. A pilot proving period of not more than 10 sec. prior to energizing the main fuel valve shall be provided.
 - d. Limited trial-for-ignition of main flame, 15 sec. maximum for gas or light oil, 30 sec. maximum for heavy oil shall be provided.
 - e. Safety shutdown shall be accomplished within 4 sec. following a flame failure, loss of minimum combustion air flow or the opening of any running interlock.
 - f. A post-purge period of not less than 15 sec. shall be accomplished following each normal shutdown and not less than 60 sec. following a safety shutdown.
 - g. The control system shall recycle automatically under control of the operating control, and when power is restored following power failure. Manual reset shall be required following any safety lockout.
2. The control shall permit direct connection of safety limit switches, operating controls, starting interlocks, air flow switches, fuel temperature and pressure switches, running interlocks and lockout alarms.
3. The pilot and main flames shall be monitored by an infrared-sensitive flame scanner sensitive to flame radiation. The scanner shall not be actuated by hot refractory or any other source of infrared radiation.

MECHANICAL and ELECTRICAL

4. The control system shall be designed for 120 volt operation with one side grounded. All switching shall be accomplished in the hot circuit. The following shall be furnished:
 - a. The program timing shall be accomplished by cam driven heavy duty switch assembly readily accessible for inspection. The timing periods must not vary more than 5% through an ambient temperature range of 0°F to 125°F and through a supply voltage range of plus 10% or minus 15% of nominal line voltage.
 - b. The contacts in the fuel valve circuit shall be of a weld-resistant tungsten alloy material.
 - c. The safety lockout switch shall be temperature compensated and contain alarm contacts rated at not less than 50 va at 120 volts ac.
 - d. The flame relay circuit of the flame safeguard control must incorporate a latch circuit which prevents the flame relay from becoming re-energized following a safety shutdown, until a lockout has occurred and manual reset has initiated a complete restart.
 - e. All wiring in the control must be rated for 90° centigrade continuous duty.
 - f. A means for signal attenuation shall be provided for test purposes, and test jacks shall be provided for the direct connection of a DC voltmeter to measure flame relay performance.
 - g. The control chassis shall be of plug in design to facilitate replacement without disconnecting any external wiring.
 - h. The scanner shall mount directly with a threaded fitting on a 1/2" NPT pipe. It shall contain the lead sulfide cell and a focusing lens and be furnished complete with a heat insulator.
 - i. Both the scanner and the control shall be rated for an ambient temperature limit of 125°F.
5. The flame safeguard control system shall be Fixxyx FP-2, Model 6070.



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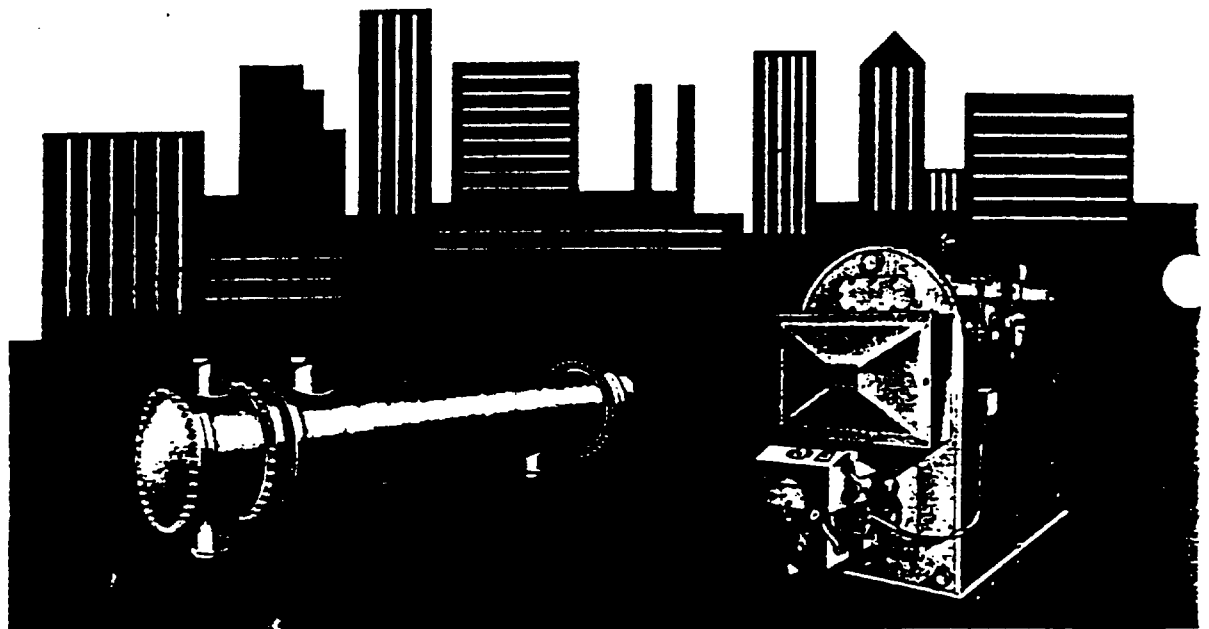
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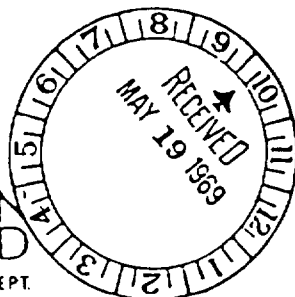
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