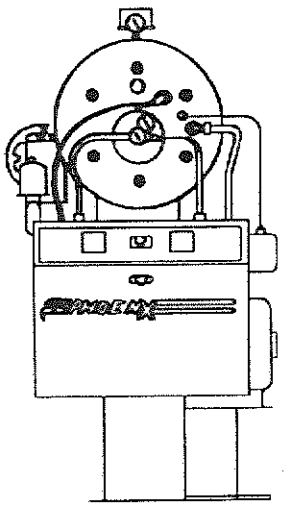
KEWANEE®



Installation, Operation and Maintenance Manual

for

PhoenX 40-800 HP

Gas/Pressure Atomized/Air Atomized Oil Burners

Thank You for Purchasing Kewanee Boiler Room Equipment

Since 1868, Kewanee has been committed to providing equipment of lasting quality and value to each of its many customers. It is our goal that every piece of Kewanee equipment purchased provides the same reliable operating excellence that was built into it by the skilled craftsmen at our Kewanee factory.

The following **Installation, Operation and Maintenance Manual for Kewanee PhoenX Burners** is designed to help you properly install, operate and care for your Kewanee equipment. We recommend that you read this manual through to familiarize yourself with its contents before installing and operating your Kewanee equipment.

Due to a wide variety of everchanging state and local codes, this manual contains information designed to show how a basic unit operates. The operation of all equipment must comply with all applicable regulations and codes by any authorities having jurisdiction. These legal requirements take precedence over anything contained herein. At Kewanee, engineering and development toward product improvements are a continuing process, therefore, the specific information in this book may be subject to change without notice.

Kewanee Boiler Room Equipment has been designed and manufactured to produce a long lifetime of dependable efficient service. All components of Kewanee equipment were chosen for their ability to enhance this design goal. Although these components provide a high degree of protection and safety during normal operating conditions, we highly advise that you pay close attention to any notes, cautions and warnings and maintain an awareness of the hazards and dangers inherent in careful handling of fuel firing devices.

In our many years in business, we have found that two things alone greatly impact the dependable operation and long life of our equipment:

- **Operator responsibility and knowledge**
- **Consistent preventive maintenance**

Operator Responsibility

It is the operator's responsibility to provide the daily care and attention required to properly maintain the boiler room equipment. This manual is intended to act as a guide and reference source for those operations, but it cannot replace the keen eye and experienced touch of a trained boiler room operator. It is recommended that a boiler room log be maintained to record daily, weekly, monthly and yearly activities as well as any unusual occurrences.

Consistent Preventive Maintenance

Regular effective maintenance is the best way to obtain the most efficient operation of Kewanee boiler room equipment. We have found that the life and efficiency of this equipment is dependent upon the consistency of care it receives. Often efficient operation is a matter of keeping the boiler clean and the firing equipment properly regulated. With proper installation, regular care and the use of Genuine Kewanee Renewal Parts, your quality Kewanee equipment will last indefinitely.

Safety Precautions and Abbreviations

It is important for all personnel operating this Kewanee product to read and fully understand the following safety precautions and abbreviations and the various sections of this manual before operating the equipment.

Failure to obey these safety precautions may result in damage to your Kewanee equipment, serious personal injury or even death.

Safety Precautions

NOTE: This safety precaution iudicates information that is vital to the operation or maintenance of your Kewanee equipment.

CAUTION: This safety precaution indicates a potentially hazardous situation which, if not avoided, could result in damage to the equipment.

WARNING!!! THIS SAFETY PRECAUTION INDICATES A POTENTIALLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

DANGER!!! This safety precaution indicates a situation which, if not followed exactly, could result in serious personal injury or death!

Abbreviations

AI	Authorized Inspector
ASME	American Society of Mechanical Engineers
BHP	Boiler Horsepower
BTU	British Thermal Unit
BTUH	British Thermal Unit per Hour
CC/Hr	Cubic Centimeters per Hour
CFH	Cubic Feed per Hour
CFM	Cubic Feet per Minute
Cu. Ft.	Cubic Feet
° F	Degrees Fahrenheit
FM	Factory Mutual
HP	Horsepower
In. Hg	Inches of Mercury
IRI	Industrial Risk Insurance
NFPA	National Fire Protection Agency
No.	Number
PHX	PhoenX Model
ppm	Parts Per Million
PSI	Pounds per Square Inch
PSIG	Pounds per Square
RPM	Revolutions per Minute
SSOV	Safety Shutoff Valve
SSU	Seconds Saybolt Universal
UL	Underwriters' Laboratory
WC	Water Column

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INSTALLATION, OPERATION AND MAINTENANCE MANUAL

For PhoenX Gas, Pressure Atomized and Air Atomized Oil Burners

Section 1

GENERAL INFORMATION

1. INTRODUCTION

This manual on Kewanee PhoenX Burners has been prepared for the purpose of assisting the installation, operating, maintenance, and service personnel.

The manual information is, of necessity, general in nature since it may be modified by consulting engineers specifications, state or local codes, utility and insurance underwriter's requirements.

NOTE: Read complete manual prior to proceeding with any operations.

For additional information on these modifications, get in touch with your local Kewanee Sales representative or contact the factory direct at Kewanee Boiler Manufacturing Co., Inc., 101 Franklin Street, Kewanee, Illinois 61443, Telephone (309) 853-3541 or E-mail us at http://www.kewaneeboiler.com.

2. APPROVALS AND WARRANTY REQUIREMENTS

Kewanee PhoenX Burners which are listed by Underwriters' Laboratories, Inc., include a UL "A" label.

Kewanee units meeting the requirement of Factory Mutual Fire Insurance Companies (FM), Industrial Risk Insurers (IRI) and special State, local and utility codes are available on special order.

3. LIMITED WARRANTY

A. Warranty

Kewanee Boiler Manufacturing Company, Inc. (herein referred to as "Seller") warrants that at the time of shipment the products manufactured by it shall be merchantable, free from defects in material and workmanship, and shall possess the characteristics

represented in writing by Seller. Seller's warranty is conditioned upon the product being properly installed, maintained, and operated in a manner that does not vary materially from that under which such product is usually tested under industry standards existing at time of sale. This warranty is made to the Original Buyer and...

1. For firetube boilers and packaged firetube boiler, is for a period of 12 (twelve) months from the date the product is first placed in use or 18 (eighteen) months from date or shipment, whichever shall be less. AND/OR

2. For all other products is for a period of 12 (twelve) months from the date of shipment.

B. Warranty Adjustment

1. Seller agrees to replace or repair (at its sole option), but not install, any product of its manufacture or part or portion thereof which, upon test and examination by Seller, proves defective within the terms of the above warranty.

2. Buyer must notify Seller in writing of any claimed breach of this warranty within 30 (thirty) days of the discovery of any defect, or Buyer's warranty rights hereunder will lapse.

3. No product will be accepted for return or replacement without the written authorization of Seller. Upon such authorization, and in accordance with instructions from Seller, the product will be returned to Seller's place of manufacture, shipping charges prepaid by Buyer. Seller shall not be liable for any costs or expenses connected with warranty adjustments, except that Seller shall furnish a replacement or repair of a product or part which is proved to the satisfaction of Seller to be defective in material or workmanship as provided in the above warranty; further, Seller shall furnish to Buyer the replacement or repaired part with freight allowed (but no local cartage) inside the continental United States (excluding Alaska and Hawaii) to the first destination.

C. Exclusions from Warranty

1. The foregoing warranty is limited solely as set forth herein, and applies only for the period designated above. This warranty takes the place of and supersedes all other warranties, whether express or implied in law. There are no express warranties except those contained herein, and to the extent permitted bylaw, implied warranties or warranties of fitness for a particular purpose are excluded.

2. Except for the remedies provided by this warranty, Seller shall not be liable for any loss, damage, indirect or consequential damages of any kind, whether based upon warranty, contract or

negligence, arising in connection with the sale, use, or repair of the product. The maximum liability of Seller in connection with this limited warranty shall bot exceed the contract price for the product claimed to be defective.

3. This warranty does not extend to any product manufactured by Seller which has been subjected to misuse, misapplication, neglect, accident, improper installation, or use in violation of instruction furnished by Seller.

4. The warranty does not extend to or apply to any product which has been repaired or altered at any place other than Seller's factory or by persons not expressly approved by Seller; nor to any product, the serial number, model number, or any identification of which has been removed, defaced, or changed.

5. Components manufactured by any supplier other than Seller shall bear only those warranties made by the manufacturer of that product.

4. DAMAGES

The Seller shall have no liability for any liquidated damages, consequential damages, or penalties assessed whatsoever unless specifically agreed to in writing.

5. VARIANCES, RETURNS AND BACK CHARGES

No claims for variances from, or shortages in, orders will be considered by the Seller unless presented to it within 30 (thirty) days after receipt of product. Any shipping weights and/or costs given or estimated herein are approximate, for the Buyer's convenience only, and not guaranteed by the Seller. Products may not be returned for credit unless and until the Seller has agreed in writing to accept them. When returns are accepted, a full credit shall be given, less deductions for missing parts, inbound freight and a restocking charge of 25% (percent). All transportation costs for returned products must be paid by the Buyer. Back charges will not be accepted, a full credit shall be given, less deductions for missing parts, inbound freight and a restocking charge of 25% (percent). All transportation costs for returned products must be paid by the Buyer. Back charges will not be accepted without written authorization from the company. The Seller must have in writing a description of any work to be done and an estimate of the cost, thereof, before any back charges is authorized.

6. TESTS

If tests are requested by the Buyer to determine the performance of products covered in the Seller's quotation form, the test procedure to be used must be acceptable to the Seller, and the Buyer agrees to pay to the Seller the cost of any such tests.

7. PRODUCT CHANGES

Factors beyond the control of Seller and the need for continuing improvement require the making of changes in products from time to time. The Seller reserves the right to make reasonable changes in products of any kind without notice, and to deliver revised designs or models of products against any order, unless this right is specifically waived by Seller in writing. The Seller shall have no responsibility whatsoever with respect to changes made by the manufacturer of products sold but not manufactured by the Seller.

8. START-UP AND/OR SERVICE

Whenever an order includes start-up and/or service agreements, the Seller shall not be obligated to provide either start-up, warranty parts or service as long as payment terms are in default.

9. BASIC DESCRIPTION

The PHX-40 through PHX-800 burners designed for gas are radial port type with a specially designed burner head to insure flame retention, stability, and quietness of operation. Burner mounting refractories are specifically designed for each boiler application.

The PHX-40 through PHX-800 burners designed for oil are available for pressure atomized firing of No. 2 fuel oil through 250 HP and air atomized firing of No. 2, 4, 5, and 6 oil. (Air atomized fuel oil not available on PHX-40 through PHX-80.)

On all units using No. 2 oil, the oil pump runs only during the normal firing cycle. On all units using No. 4, 5, or 6 oil, the oil pump runs continuously to provide a constant supply of hot oil at the automatic oil valve for smooth burner ignition. The PHX-60 through PHX-800 burners are available for combination firing of gas and No. 2, 4, 5 and 6 fuel oils as applicable.

All burners are designed for fully modulated firing with low fire start. The PHX-60, PHX-70 and PHX-80 burners are standard in high-low firing on gas and No. 2 pressure atomized oil only, with modulation optional. PHX-40 and PHX-50 are standard in on/off (low fire start where required).

Combustion air is supplied by a forced draft fan running at nominal 3600 RPM. The design of the burner head gives an intimate mixture of the fuel and air for complete combustion. An electric ignited gas pilot is standard for all fuels. The fuel metering valves on modulating units are cam-controlled to assure proper proportioning of the fuel and air throughout the entire firing range. A modutrol motor, signaled by a boiler-mounted pressure or temperature control, operates the inlet damper and the fuel metering valves. An electronic flame safeguard programming control to provide prepurge, postpurge and pilot and main flame supervision is standard.

Although the burner is considered "automatic" in its operation, the operator must become familiar with the functions and maintenance of the various controls, valves,

instruments, etc., which affect the safety and efficiency of the unit's 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.

The burner mounting refractory is an integral part of the burner's combustion system design. Only Kewanee Supplied burner mounting refractories should be used with Kewanee PhoenX burners.

Section 2

BASIC DESCRIPTION - GENERAL ASSEMBLY DETAILS

1. PHX-40 AND PHX-50 BURNERS

The general assembly drawing for a PHX-40 or PHX-50 burner as built for modulation firing rate control, is shown in Figure 1, a data sheet giving the burner's specifications is in Figure 2.

The blower housing, plenum, and gas manifold are fixture welded as a single unit. The oil pump is mounted on the inlet air damper, and is directly driven by the blower motor via a coupling which is accessible inside the inlet damper. The

modulating motor, characterizing cam and oil metering valve are all mounted on a bracket attached to the side of the plenum. The modulating motor drives the air damper directly from the cam drive shaft, and drives the gas butterfly valve and oil metering valve through cam controlled linkages.

When the PHX-40 or PHX-50 burners are built in standard On-Off firing configuration, the modulating motor, cam and metering valves are not provided. When they are built in Low Fire Start or High - Low firing configurations, a two position motor is provided for air damper and butterfly valve control, and an oil pressure regulator and valve arrangement is provided for oil firing rate control.

Oil safety shut off solenoid valves are mounted on the back of the electrical cabinet. Only pressure atomizing oil systems are offered for these burners. The standard offering is based on simplex oil nozzles, however, return flow nozzles are used in a model designed for meeting new York City's Bureau of Air Resources Code.

The electrical cabinet can be mounted on the top of the plenum as shown, or alternatively on the front of the blower housing just below the plenum cover. Either Natural Gas or Propane can fuel the pilot and main flame of these burners, however gas orifices and controls may differ between the natural gas and propane models.

GENERAL ASSEMBLY DRAWING

PHX-40 and PHX-50 Burners
(Shown with Optional Modulating Controls)

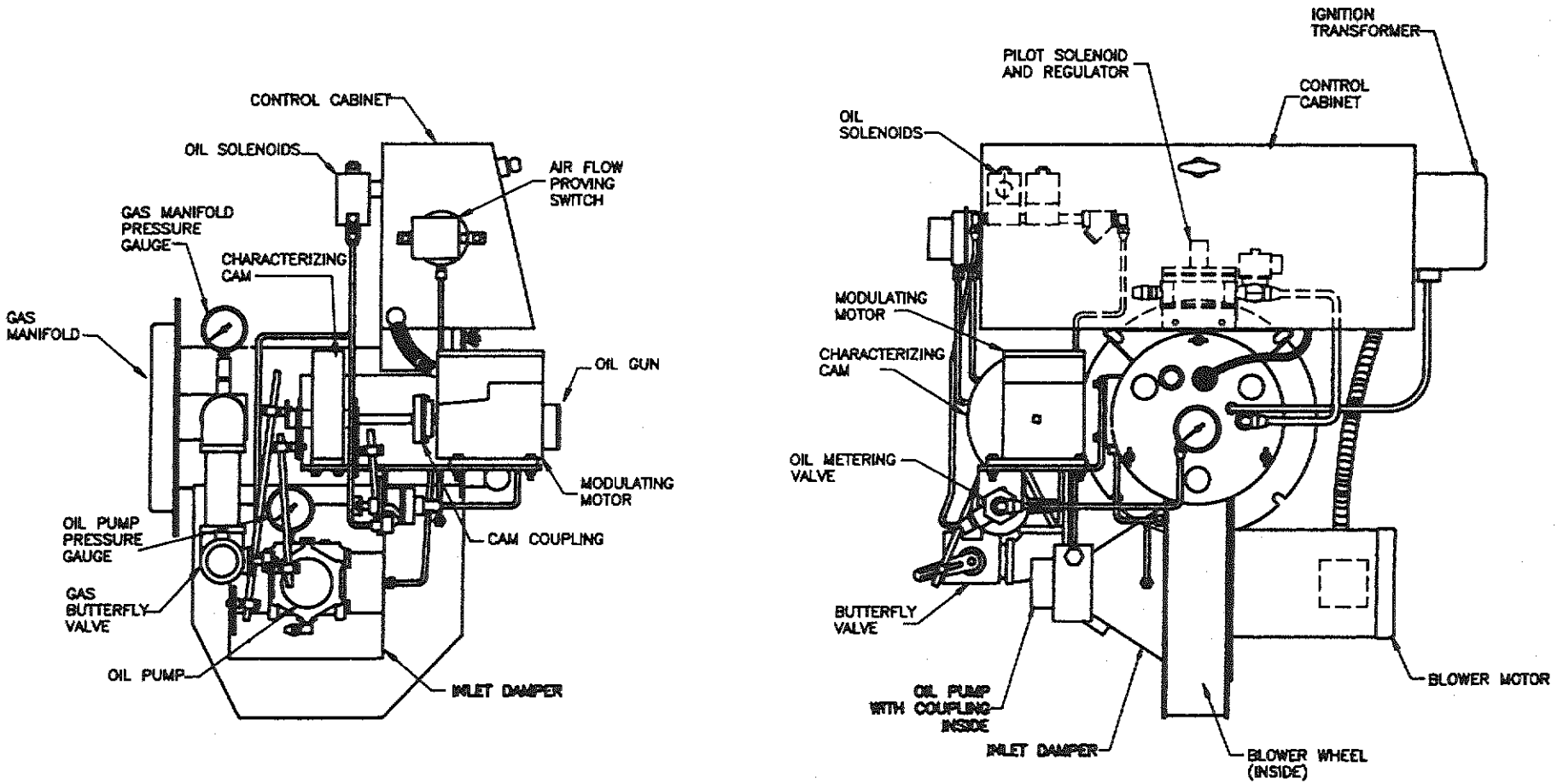

Figure 1

DATA SHEET

PHX-40 and PHX-50 Burners

	PHX-40	PHX-50
Nominal Air Flow CFM: (@ 20% Excess Air)	345	345
Blower Wheel Type	Forward Curve	Forward Curve
Blower Wheel: Diameter x Width	7 x 2	8.25 x 1.75
Blower Wheel: Static Pressure @ CFM	3.62" WC @ 345	7.36" WC @ 430
Blower Motor: HP	1/2 HP	1 HP
Blower Motor: RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	56C	56C
Air Damper: (Number of Vanes)	(1)	(1)
Area H x W	4.5 x 8.5	4.5 x 8.5
Burner Head Throat Diameter	7.50"	7.50"
Nominal Air Velocity Thru Diffuser	105 Ft./Sec.	105 Ft./Sec.
Burner Head Attachment to Plenum	Welded	Welded
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	11.5	14.4
Oil Nozzle Type	Simplex	Simplex
Standard Make/Spray Pattern	Delavan B	Delavan B
Approved Makes/	Monarch PLP/	Monarch PLP/
Spray Patterns	Hago P	Hago P
Oil Nozzles: (Quantity) GPH x Spray Angle	(3) 2.5 x 60°	(3) 3.0 x 60°
Oil Pump Capacity: GPH @ PSI	14 @ 300	23 @ 300
Oil Pump Mounting: Direct Drive/Remote	Direct Drive	Direct Drive
Oil Pressure Regulator: In Pump/Separate	In Pump	In Pump
Regulated Oil Pressure	300 PSI	300 PSI

	PHX-40	PHX-50
Gas Firing Rate (Nat. Gas @ 80% Eff.)	1,674	2,092
Gas Orifices: Body Size	1/4 - 18 NPT	1/4 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(12) .257	(12) .290
Nominal Gas Velocity Thru Orifices	106.4 Ft./Sec.	104.4 Ft./Sec.
Butterfly Valve Pipe Size	1-1/2"	1-1/2"
Gas Head Pressure (@ 0.0" Furnace Pressure)	2.3" WC	2.2" WC
Standard Firing Rate Control System	On/Off w/LFS	On/Off w/LFS
Optional Firing Rate Control System	Hi/Low w/LFS	Hi/Low w/LFS
Optional Firing Rate Control System	Modulation	Modulation
Standard Turndown Ratio Gas (Oil)	3 : 1 (1.73 : 1)	3 : 1 (1.73 : 1)
Standard Ignition System -		
Gas or Combination Gas/Oil	Gas Pilot	Gas Pilot
Std Ignition System - Oil	Direct Spark	Direct Spark
Optional Ignition System - Oil	Gas Pilot	Gas Pilot
Standard Main Power Supply	115 / 1 / 60	115 / 1 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2 Oil	Nat. Gas, LP, #2 Oil
Code Constructions Available	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI

Figure 2

2. PHX-60 THROUGH PHX-125 BURNERS

The general assembly drawing for PHX-60 through PHX-125 burners as built for modulation firing rate control, is shown in Figure 3, a data sheet giving the burner's specifications is in Figures 4 and 5.

The blower housing and plenum are fixture welded as a single unit. The gas manifold is built separately and mounted to the front of the plenum. The oil pump is belt driven off the outboard end of the blower motor on all models except the PHX-125, which uses a remote pump set. The modulating motor is mounted on the electrical cabinet. The characterizing cam and oil metering valve are mounted on brackets attached to the side of the plenum and the air inlet damper. The modulating motor drives the air damper directly from the cam drive shaft, and drives the gas butterfly valve and oil metering valve through cam controlled linkages.

When the PHX-60 or PHX-80 burners are built in standard High - low firing configuration, a two position motor is provided for air damper and butterfly valve control, and an oil pressure regulator and valve arrangement is provided for oil firing rate control.

Oil safety shut off solenoid valves are mounted on the back of the electrical cabinet. Both pressure atomizing and air atomizing oil systems are available for these burners. The standard offering for PHX-60 through PHX-80 is pressure atomizing based on simplex oil nozzles, however, return flow nozzles are used in some models designed for meeting New York City's Bureau of Air Resources Code.

The standard offering for PHX-100 through PHX-125 is pressure atomizing based on return flow nozzles. Air atomizing of No. 2 oil is offered on all models. Air atomizing of heavy oils is offered only in the PHX-100 and larger models.

Either Natural Gas or Propane can fuel the pilot and main flame of these burners, however, gas orifices and controls may differ between the natural gas and propane models.

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GENERAL ASSEMBLY DRAWING

PHX-60 and PHX-125 Burners
(Shown with Optional Modulating Controls)

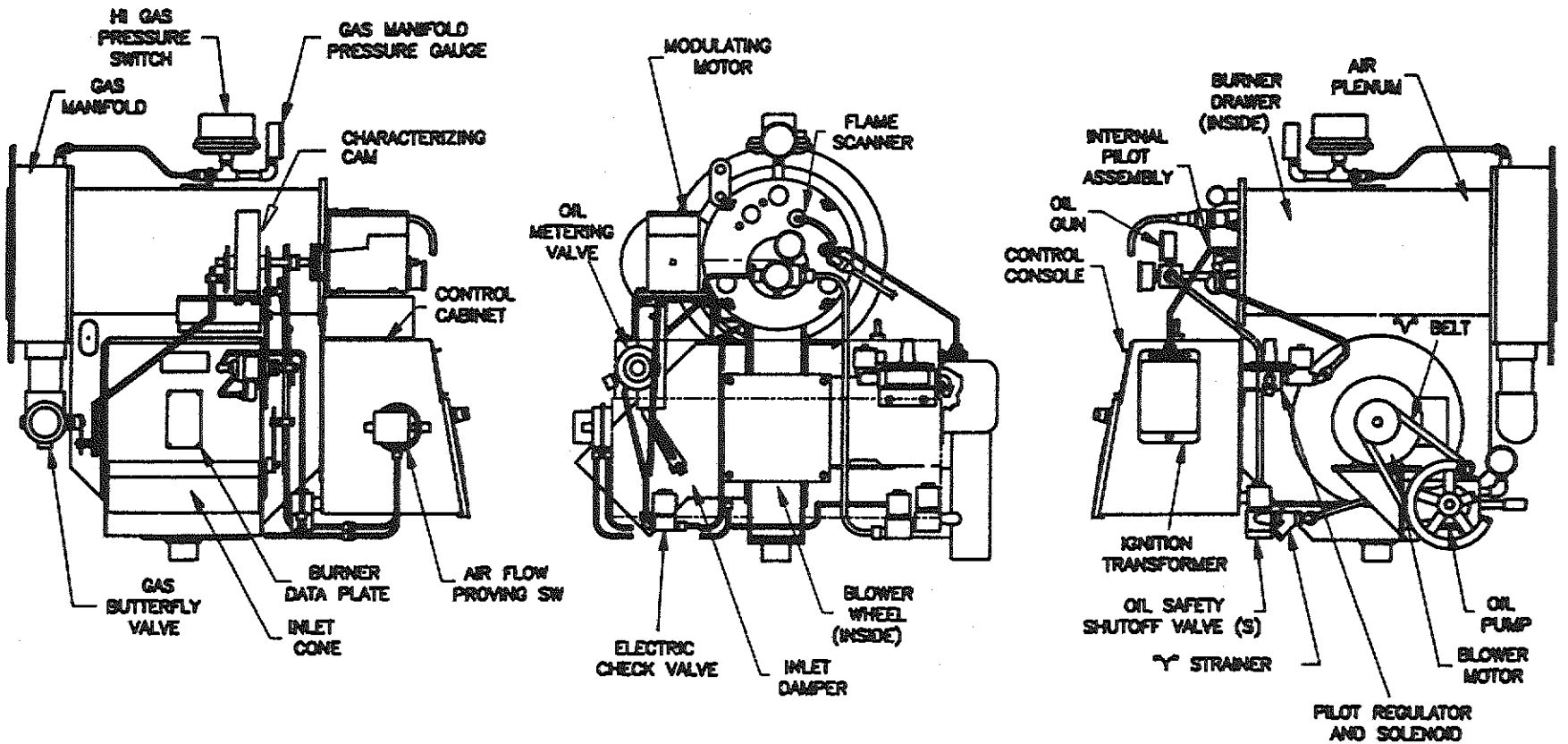

Figure 3

DATA SHEET

PHX-60 and PHX-80 Burners

	PHX-60	PHX-70	PHX-80
Nominal Air Flow CFM: (@ 20% Excess Air)	518	604	690
Blower Wheel Type	Forward Curve	Forward Curve	Forward Curve
Blower Wheel:Diameter x Width	8.25 x 1.75	8.25 x 1.75	9.12 x 2.25
Blower Wheel: Static Pressure @ CFM	7.50" WC @ 518	7.48" WC @ 604	8.50" WC @ 690
Blower Motor: HP	1-1/2 HP -	1-1/2 HP -	1-1/2 HP -
Blower Motor: RPM	3600 RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	56C	56C	56C
Air Damper: (Number of Vanes)	(2)	(2)	(2)
Flow Area H x W	9.5 x 6.56	9.5 x 6.56	9.5 x 6.56
Burner Head Throat Diameter	8.50"	8.50"	8.50"
Nominal Air Velocity Thru Diffuser	125 Ft./Sec.	125 Ft./Sec.	125 Ft./Sec.
Burner Head Attachment to Plenum	Bolted	Bolted	Bolted
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	17.3	20.2	23
Oil Nozzle Type	Simplex	Simplex	Simplex
Standard Make/Spray Pattern	Delavan B	Delavan B	Delavan B
Approved Makes/Spray Patterns	Monarch PLP/ Hago P	Monarch PLP/ Hago P	Monarch PLP/ Hago P
Oil Nozzles:(Quantity)	(3)	(3)	(3)
GPH x Spray Angle	4.0 x 80°	4.0 x 80°	5.0 x 80°
Oil Pump Capacity: GPH @ PSI	23.0 @ 300	23.0 @ 300	23.0 @ 300
Oil Pump Mounting: On Burner/Remote	On Burner	On Burner	On Burner
Oil Pressure Regulator: In Pump/Separate	In Pump	In Pump	In Pump
Regulated Oil Pressure	300 PSI	300 PSI	300 PSI

	PHX-60	PHX-70	PHX-80
Gas Firing Rate (Nat. Gas @ 80% Eff.)	2,511	2,929	3,348
Gas Orifices: Body Size	3/8 - 18 NPT	3/8 - 18 NPT	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(15) .242	(15) .261	(15) .281
Nominal Gas Velocity Thru Orifices	144.0 Ft./Sec.	144.4 Ft./Sec.	142.4 Ft./Sec.
Butterfly Valve Pipe Size	1-1/2"	1-1/2"	1-1/2"
Gas Head Pressure (@ 0.0" Furnace Pressure)	4.20" WC	4.22" WC	4.11" WC
Standard Firing Rate Control System	Hi/Low w/LFS	Hi/Low w/LFS	Hi/Low w/LFS
Optional Firing Rate Control System	Modulation	Modulation	Modulation
Standard Turndown Ratio Gas (Oil)	3 : 1 (1.73 : 1)	3 : 1 (1.73 : 1)	3 : 1 (1.73 : 1)
Standard Ignition System - Gas or Oil Firing	Gas Pilot	Gas Pilot	Gas Pilot
Standard Ignition System - Oil Firing Only	Direct Spark	Direct Spark	Direct Spark
Standard Main Power Supply	230 / 3 / 60	230 / 3 / 60	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2-#5 Oil	Nat. Gas, LP, #2-#5 Oil	Nat. Gas, LP, #2-#5 Oil
Code Constructions Available	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI

Figure 4

DATA SHEET

PHX-100 and PHX-125 Burners

	PHX-100	PHX-125
Nominal Air Flow CFM: (@ 20% Excess Air)	863	1078
Blower Wheel Type	Forward Curve	Forward Curve
Blower Wheel: Diameter x Width	9.12 x 2.25	9.87 x 3.25
Blower Wheel: Static Pressure @ CFM	8.44" WC @ 863	10.97" WC @ 1078
Blower Motor: HP	3 HP	5 HP
Blower Motor: RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	56C	182T
Air Damper: (Number of Vanes)	(2)	(2)
Flow Area H x W	11.5 x 7.716	11.5 x 7.716
Burner Head Throat Diameter	9.50"	9.50"
Nominal Air Velocity Thru Diffuser	126 Ft./Sec.	143 Ft./Sec.
Burner Head Attachment to Plenum	Bolted	Bolted
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	28.8	36
Oil Nozzle Type	Return Flow	Return Flow
Standard Make/Spray Pattern	Delavan Variflo	Delavan Variflo
Approved Makes/Spray Patterns	Monarch BPS	Monarch BPS
Oil Nozzles:(Quantity)	(3)	(3)
GPH x Spray Angle	6.0 x 80°	7.5 x 80°
Oil Pump Capacity: GPH @ PSI	50 @ 300	50 @ 300
Oil Pump Mounting: On Burner/Remote	On Burner	Remote
Oil Pressure Regulator: In Pump/Separate	In Pump	In Pump
Regulated Oil Pressure	300 PSI	300 PSI

	PHX-100	PHX-125
Gas Firing Rate (Nat. Gas @ 80% Eff.)	4,184	5,230
Gas Orifices: Body Size	3/8 - 18 NPT	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(15) .328	(15) .358
Nominal Gas Velocity Thru Orifices	130.6 Ft./Sec.	137.1 Ft./Sec.
Butterfly Valve Pipe Size	2"	2"
Gas Head Pressure (@ 0.0" Furnace Pressure)	3.45" WC	3.80" WC
Standard Firing Rate Control System	Modulation	Modulation
Standard Turndown Ratio Gas and Oil	3 : 1	3 : 1
Standard Ignition System - Gas or Oil Firing	Gas Pilot	Gas Pilot
Optional Ignition System - Oil Firing Only	Direct Spark	Direct Spark
Standard Power Supply	230 / 3 / 60	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2-#6 Oil	Nat. Gas, LP, #2-#6 Oil
Code Constructions Available	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI

Figure 5

3. PHX-150 THROUGH PHX-250 BURNERS

The general assembly drawing for PHX-150 through PHX-250 burners is shown in Figure 6, a data sheet giving the burner's specifications is in Figure 7. These burners are built only with modulation firing rate control.

The blower housing and plenum are fixture welded as a single unit. The gas manifold is built separately and mounted to the front of the plenum. The oil pump is a separate unit, remotely mounted ont he electrical cabinet. The characterizing cam and oil metering valve are mounted on brackets attached to the side of the plenum and the air inlet damper. The modulating motor drives the air damper directly from the cam drive shaft, and drives the gas butterfly valve and oil metering valve through cam controlled linkages. Oil safety shut off solenoid valves are mounted ont he back of the electrical cabinet.

Both pressure atomizing and air atomizing oil systems are available for these burners. The standard offering is pressure atomizing based on return flow oil nozzles for No. 2 oil only. Air atomization is, of course, required for heavy oils. Electric oil heaters can be mounted on the burner for Retrofit applications, but would normally be mounted ont he boiler skid for packaged boiler applications.

Either Natural Gas or Propane can fuel the pilot and main flame of theses burners, however gas orifices and controls mad differ between the natural gas and propane models.

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GENERAL ASSEMBLY DRAWING

PHX-150 through PHX-250 Burners

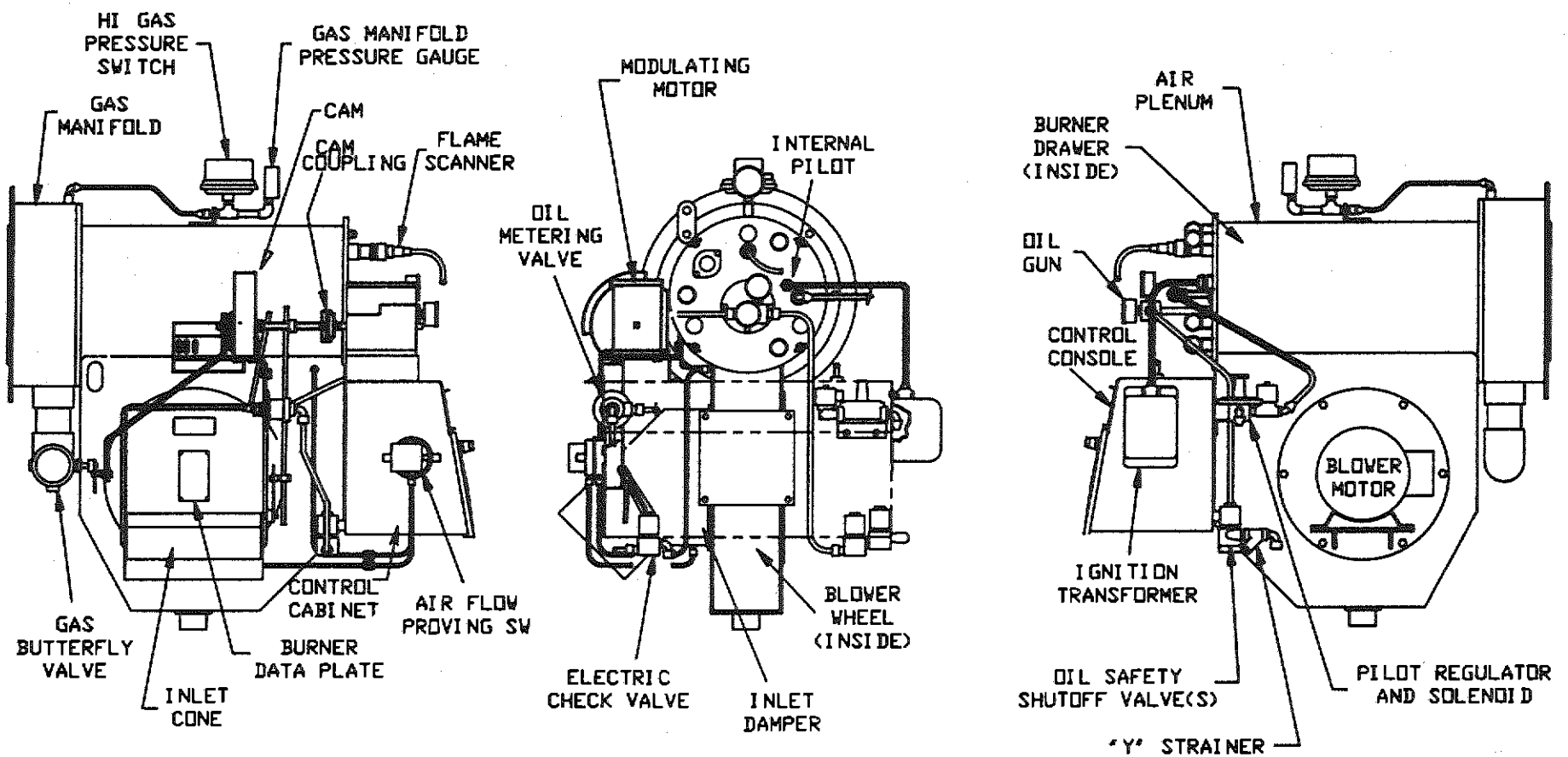

Figure 6

DATA SHEET

PHX-150 and PHX-250 Burners

	PHX-150	PHX-200	PHX-250
Nominal Air Flow CFM: (@ 20% Excess Air)	1294	1725	2156
Blower Wheel Type	Forward Curve	Forward Curve	Forward Curve
Blower Wheel:Diameter x Width	9.87 x 3.25	12.25 x 4.00	12.25 x 4.00
Blower Wheel: Static Pressure @ CFM	10.95" WC @ 1294	16.79" WC @ 1725	16.64" WC @ 2156
Blower Motor: HP	5 HP	7-1/2 HP	7-1/2 HP
Blower Motor: RPM	3600 RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	182T	184T	184T
Air Damper: (Number of Vanes)	(2)	(2)	(2)
Flow Area H x W	11.5 x 7.716	11.5 x 7.716	11.5 x 7.716
Burner Head Throat Diameter	11.50"	11.50"	11.50"
Nominal Air Velocity Thru Diffuser	154 Ft./Sec.	154 Ft./Sec.	154 Ft./Sec.
Burner Head Attachment to Plenum	Bolted	Bolted	Bolted
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	43.2	57.6	72.0
Oil Nozzle Type	Return Flow	Return Flow	Return Flow
Standard Make/Spray Pattern	Delavan Variflo	Delavan Variflo	Delavan Variflo
Approved Makes/Spray Patterns	Monarch BPS	Monarch BPS	Monarch BPS
Oil Nozzles:(Quantity)	(3)	(3)	(3)
GPH x Spray Angle	9.0 x 80°	12.0 x 80°	16.0 x 80°
Oil Pump Capacity: GPH @ PSI	50 @ 300	95 @ 300	95 @ 300
Oil Pump Mounting: On Burner/Remote	Remote	Remote	Remote
Oil Pressure Regulator: In Pump/Separate	Separate	Separate	Separate
Regulated Oil Pressure	300 PSI	300 PSI	300 PSI

	PHX-60	PHX-200	PHX-200
Gas Firing Rate (Nat. Gas @ 80% Eff.)	6,277	8,369	8,369
Gas Orifices: Body Size	3/8 - 18 NPT	3/8 - 18 NPT	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(21) .272	(15) .375	(15) .422
Nominal Gas Velocity Thru Orifices	203.5 Ft./Sec.	199.9 Ft./Sec.	197.3 Ft./Sec.
Butterfly Valve Pipe Size	2-1/2"	2-1/2"	2-1/2"
Gas Head Pressure (@ 0.0" Furnace Pressure)	8.39" WC	8.09" WC	7.88" WC
Standard Firing Rate Control System	Modulation	Modulation	Modulation
Standard Turndown Ratio Gas (Oil)	4 : 1 (3 : 1)	4 : 1 (3 : 1)	5 : 1 (3 : 1)
Standard Ignition System - Gas or Oil Firing	Gas Pilot	Gas Pilot	Gas Pilot
Standard Ignition System - Oil Firing Only	Oil Pilot	Oil Pilot	Oil Pilot
Standard Main Power Supply	230 / 3 / 60	230 / 3 / 60	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2-#6 Oil	Nat. Gas, LP, #2-#6 Oil	Nat. Gas, LP, #2-#6 Oil
Code Constructions Available	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI

Figure 7

4. PHX-300 THROUGH PHX-800 BURNERS

The general assembly drawing for PHX-300 through PHX-800 burners is shown in Figure 8, a data sheet giving the burner's specifications is in Figure 9, 10 and 11.

These burners are built only with modulation firing rate control. The blower housing and plenum are fixture welded as a single unit. The gas manifold is built separately and mounted to the front of the plenum. The oil pump is a separate unit, remotely mounted for these burners. The modulating motor, characterizing cam and oil metering valve are all mounted on a bracket attached to the side of the plenum. The modulating motor drives the air damper directly from the cam drive shaft, and drives the gas butterfly valve and oil metering valve through cam controlled linkages. Oil safety shut off solenoid valves are mounted on the back of the electrical cabinet and side of the plenum. Only air atomizing oil systems are available for these burners

The standard offerings are available for No. 2 oil and for heavy oils. Electric oil heaters are remotely mounted, normally on the boiler skid for packaged boiler applications.

Either Natural Gas or Propane can fuel the pilot and main flame of theses burners, however gas orifices and controls mad differ between the natural gas and propane models.

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GENERAL ASSEMBLY DRAWING

PHX-300 through PHX-800 Burners

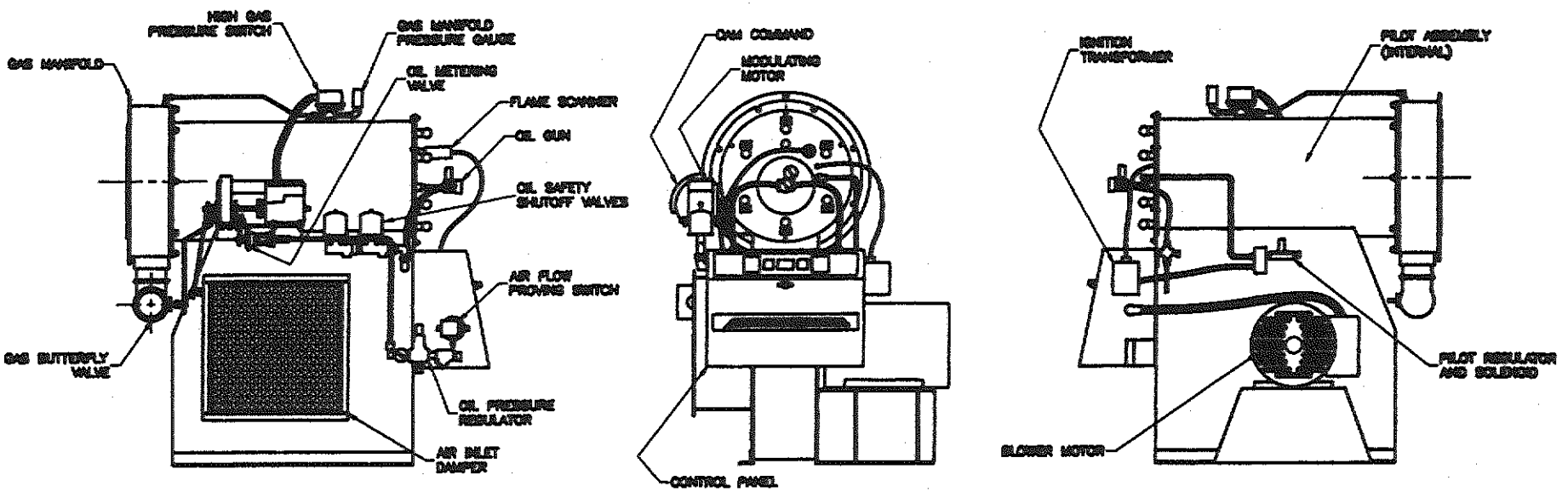


Figure 8

DATA SHEET

PHX-300 through PHX-400 Burners

	PHX-300	PHX-350	PHX-400
Nominal Air Flow CFM:			
(@ 20% Excess Air)	2588	3019	3450
Blower Wheel Type	Forward Curve	Forward Curve	Forward Curve
Blower Wheel:Diameter x Width	11.62 x 6.00	13.00 x 6.00	13.00 x 6.00
Blower Wheel: Static Pressure	14.93" WC	17.19" WC	17.56" WC
@ CFM	@ 2588	@ 3019	@ 3450
Blower Motor: HP	10 HP -	15 HP -	15 HP -
Blower Motor: RPM	3600 RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	213T	215T	215T
Air Damper: (Number of Vanes)	(4)	(4)	(4)
Flow Area H x W	13.00 x 13.00	13.00 x 13.00	13.00 x 13.00
Burner Head Throat Diameter	14.125"	14.125"	14.125"
Nominal Air Velocity Thru Diffuser	200 Ft./Sec.	200 Ft./Sec.	200 Ft./Sec.
Burner Head Attachment to Plenum	Bolted	Bolted	Bolted
Oil Firing Rate (No. 2 Oil @			
83% Eff.)	86.4	100.8	115.2
Oil Nozzle Type	Air Atomized	Air Atomized	Air Atomized
Standard Make/Spray Pattern	Monarch	Monarch	Monarch
	C-169-WA	C-169-WA	C-169-WA
Oil Nozzles:(Quantity)	(1)	(1)	(1)
GPH x Spray Angle	100 x 100°	100 x 100°	125 x 90°
Oil Pump Capacity: GPH @ PSI	174 @ 100	174 @ 100	174 @ 100
Oil Pump Mounting:			
On Burner/Remote	Remote	Remote	Remote
Oil Pressure Regulator:			
In Pump/Separate	Separate	Separate	Separate
Regulated Oil Pressure	45 PSI	45 PSI	45 PSI

	PHX-300	PHX-350	PHX-400
Atomizing Air Compressor	Atlas Copco,	Atlas Copco,	Atlas Copco,
Make, Model	LE22	LE22	LE22
Rating, SCFM @ 50 PSI	14.2	14.2	25.4
Gas Firing Rate (Nat. Gas @			
80% Eff.)	12,553	14,645	16,738
Gas Orifices: Body Size	3/8 - 18 NPT	3/8 - 18 NPT	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(18) .422	(18) .453	(18) .500
Nominal Gas Velocity Thru Orifices	197.3 Ft./Sec.	199.7 Ft./Sec.	187.4 Ft./Sec.
Butterfly Valve Pipe Size	3"	3"	3"
Gas Head Pressure (@ 0.0"			
Furnace Pressure)	7.88" WC	8.08" WC	7.11" WC
Standard Firing Rate Control System	Modulation	Modulation	Modulation
Standard Turndown Ratio	5 : 1	5 : 1	5 : 1
Standard Ignition System -			
Gas or Oil Firing	Gas Pilot	Gas Pilot	Gas Pilot
Standard Ignition System -			
Oil Firing Only	Oil Pilot	Oil Pilot	Oil Pilot
Standard Main Power Supply	230 / 3 / 60	230 / 3 / 60	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP,	Nat. Gas, LP,	Nat. Gas, LP,
	#2-#6 Oil	#2-#6 Oil	#2-#6 Oil
Code Constructions Available	UL, CSD-1,	UL, CSD-1,	UL, CSD-1,
	FM, IRI	FM, IRI	FM, IRI

Figure 9

DATA SHEET

PHX-500 Burners

	PHX-500
Nominal Air Flow CFM: (@ 20% Excess Air)	4312
Blower Wheel Type	Backward Inclined
Blower Wheel:Diameter x Width	18.25 x 7.218
Blower Wheel: Static Pressure @ CFM	15.9" WC @ 4312
Blower Motor: HP - RPM	20 HP - 3600 RPM
Blower Motor: Frame Size	254T
Air Damper: (Number of Vanes) Area H x W	(4) 16.00 x 16.00
Burner Head Throat Diameter	14.125"
Nominal Air Velocity Thru Diffuser	200 Ft./Sec.
Burner Head Attachment to Plenum	Bolted
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	144
Oil Nozzle Type	Air Atomized
Standard Make/Spray Pattern	Monarch C-169-WA
Oil Nozzles:(Quantity) GPH x Spray Angle	(1) 150.00 x 100°
Oil Pump Capacity: GPH @ PSI	174 @ 100
Oil Pump Mounting: On Burner/Remote	Remote
Oil Pressure Regulator: In Pump/Separate	Separate
Regulated Oil Pressure	50 PSI

	PHX-500
Atomizing Air Compressor Make, Model	Atlas Copco, LE40
Rating, SCFM @ 50 PSI	25.4
Gas Firing Rate (Nat. Gas @ 80% Eff.)	20,922
Gas Orifices: Body Size	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(18) .500
Nominal Gas VelocityThru Orifices	234.2 Ft./Sec.
Butterfly Valve Pipe Size	3"
Gas Head Pressure (@ 0.0" Furnace Pressure)	11.11" WC
Standard Firing Rate Control System	Modulation
Standard Turndown Ratio	5 : 1
Standard Ignition System - Gas or Oil Firing	Gas Pilot
Optional Ignition System - Oil Firing Only	Oil Pilot
Standard Power Supply	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2-#6 Oil
Code Constructions Available	UL, CSD-1, FM, IRI

Figure 10

DATA SHEET

PHX-600 through PHX-800 Burners

	PHX-600	PHX-750	PHX-800
Nominal Air Flow CFM: (@ 20% Excess Air)	5175	6469	6900
Blower Wheel Type	Backward Incline	Backward Incline	Backward Incline
Blower Wheel:Diameter x Width	20 x 6.75	22.25 x 6.31	22.25 x 6.31
Blower Wheel: Static Pressure @ CFM	18.38" WC @ 5175	22.60" WC @ 6469	22.32" WC @ 6900
Blower Motor: HP	25 HP	30 HP	40 HP
Blower Motor: RPM	3600 RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	256T	284TS	286TS
Air Damper: (Number of Vanes)	(6)	(6)	(6)
Flow Area H x W	20.12 x 20.12	20.12 x 20.12	20.12 x 20.12
Burner Head Throat Diameter	17.27"	17.27"	17.27"
Nominal Air Velocity Thru Diffuser	206 Ft./Sec.	206 Ft./Sec.	206 Ft./Sec.
Burner Head Attachment to Plenum	Bolted	Bolted	Bolted
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	172.8	216.1	230.5
Oil Nozzle Type	Air Atomized	Air Atomized	Air Atomized
Standard Make/Spray Pattern	Monarch C-169-WA	Monarch C-169-WA	Monarch C-169-WA
Oil Nozzles:(Quantity)	(1)	(1)	(1)
GPH x Spray Angle	150 x 100°	200 x 100°	200 x 100°
Oil Pump Capacity: GPH @ PSI	313 @ 100	313 @ 100	313 @ 100
Oil Pump Mounting: On Burner/Remote	Remote	Remote	Remote
Oil Pressure Regulator: In Pump/Separate	Separate	Separate	Separate
Regulated Oil Pressure	60 PSI	65 PSI	70 PSI

	PHX-600	PHX-600	PHX-600
Atomizing Air Compressor Make, Model	Atlas Copco, LE40	Atlas Copco, LE40	Atlas Copco, LE40
Rating, SCFM @ 50 PSI	25.4	25.4	25.4
Gas Firing Rate (Nat. Gas @ 80% Eff.)	25,106	31,383	33,475
Gas Orifices: Body Size	3/8 - 18 NPT	3/8 - 18 NPT	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(45) .375	(45) .422	(45) .438
Nominal Gas VelocityThru Orifices	199.9 Ft./Sec.	197.3 Ft./Sec.	195.3 Ft./Sec.
Butterfly Valve Pipe Size	4"	4"	4"
Gas Head Pressure (@ 0.0" Furnace Pressure)	8.09" WC	7.88" WC	7.73" WC
Standard Firing Rate Control System	Modulation	Modulation	Modulation
Standard Turndown Ratio	5 : 1	5 : 1	5 : 1
Standard Ignition System - Gas or Oil Firing	Gas Pilot	Gas Pilot	Gas Pilot
Standard Ignition System - Oil Firing Only	Oil Pilot	Oil Pilot	Oil Pilot
Standard Main Power Supply	230 / 3 / 60	230 / 3 / 60	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2-#6 Oil	Nat. Gas, LP, #2-#6 Oil	Nat. Gas, LP, #2-#6 Oil
Code Constructions Available	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI

Figure 11

AIR SUPPLY AND COMBUSTION AIR FAN

In the manual sections for fuel supply and metering of both gas and oil, we discuss a principle that is used for supply and metering of gases and liquids in all sorts of applications. It is the basis of our air handling system as well. The principle is that a regulated supply pressure is balanced against flow resistances to control the delivery rate.

The components in our air handling system are a blower, the burner's internal air passages and diffuser, and the air damper. Let's look at each of these to see how they fit our principle.

1. The blower, or combustion air fan, is a complete regulated supply. It serves as the motive force for air flow, so it's the supply. Its regulation comes from the principles of how blowers work. There is a delivery curve of static pressure versus flow volume for a given blower motor speed. The blower's output must obey that curve. If we know the motor speed and flow volume, we can tell just what static pressure is available.

   When we design the burner, we select the blower wheel so that the static pressure available through the burner's modulating range is just about constant.

2. The burner's internal air passages can be compared to the piping in a gas or oil supply system. When we design the burner, we have three goals for these passages: they should minimize the pressure drop of moving air from the blower to the diffuser, they should present a uniform air delivery to all parts of the diffuser, and they should be leak tight so we don't loose any of the pressurized air we paid for.

3. The diffuser performs the same type of function for the air flow that gas orifices and oil nozzles do for fuel flow. Just like gas orifices and oil nozzles distribute fuel, the diffuser distributes air.

   PhoenX burners are designed to distribute 55% of their air to the high velocity jet in the center of the diffuser. They put about 35% into the swirl vanes and about 10% between the diffuser and gas sleeve. That air distribution is designed to match the patterns of gas and oil distribution we use, so that the burner can deliver the high quality combustion you need. Also, like gas orifices and oil nozzles convert static pressure to velocity for mixing, the diffuser converts static air pressure into air flow velocity to mix the air with fuel for combustion. The total amount of flow area in the diffuser determines the air velocity. If you look through the burner head adjustment charts (see Figures 12, 13, 14, and 15) you will find that the higher the firing rate, the more open the diffuser will be adjusted.

4. The air damper is the variable restriction in the system. Just like the butterfly valve in the gas metering system and the oil metering valve in the oil system, it closes to increase its pressure drop and decrease air flow rate.

   PhoenX burners use air dampers mounted on the inlet side of the blower due to the improved stability of air flow that location provides. There is less tendency for surging at low

flow rates with inlet dampers than with outlet dampers.

PhoenX burners are designed so that, when they are applied on Kewanee boilers, their air supply systems can make full rate with 1/2" W.C. back pressure at the boiler's stack outlet.

There is a safety switch on the burner to monitor air flow. It is a differential air pressure switch, connected so that it monitors both the suction at he fan inlet and the pressure at the fan outlet.

Knowing how the parts work, let's look at how we can get in trouble with the system. Since the system is a pressure and resistance balance system, anything that upsets the balance is a problem.

5. The blower can lose capacity by being run backwards. Wire two legs of the three phase power supply in reverse and the blower motor runs in reverse. The blower will be a little noisier than usual, and it will only produce about 60% of its static pressure. Low fire is OK, but you can't get to high fire. Pay attention to motor rotation.

6. The blower can lose capacity by being fouled with dirt or trash. Again, low fire is OK and high fire doesn't have enough air. Periodically inspect the blower for dirt and trash accumulation.

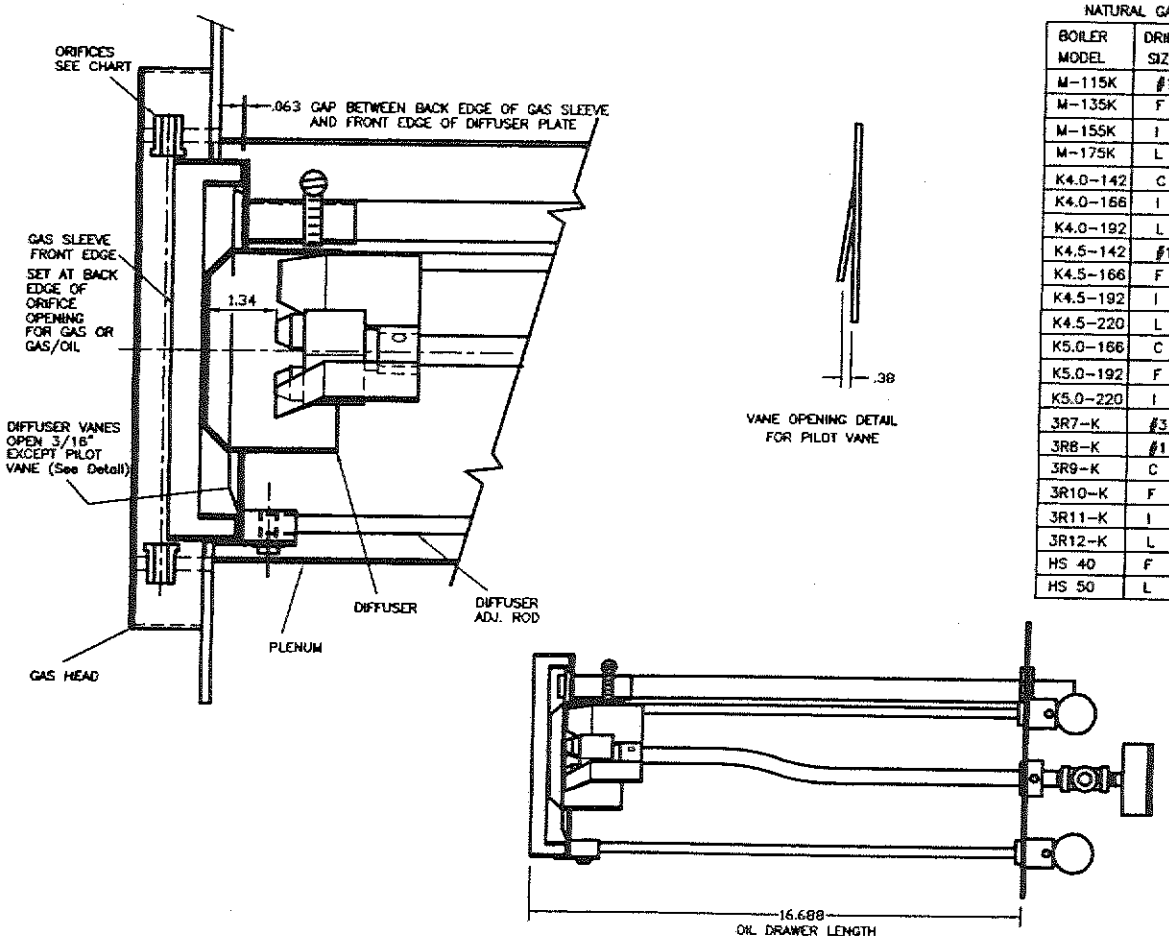
7. The blower can lose capacity due to improper clearance between the blower wheel and its inlet cone. Pressurized air from the wheel outlet recirculates through the clearance gap to the wheel inlet. Kewanee standards for the clearance gap are 1/16" at the narrowest portion of the gap for forward curve blower wheels (PHX-40 through PHX-400), and 1/8" for backward inclined wheels (PHX-500 and larger).

8. System resistance can be changed by things that aren't immediately obvious. Is there enough fresh air opening to the boiler room? If the combustion air fan has to work harder to draw in air, that's an increase in system resistance, and a decrease in air flow through the burner. Is the burner connected to a tall stack with no draft controls? As outdoor temperatures get colder the stack's draft increases, and the stack pulls on the system, increasing air flow through the burner. Know your boiler room as well as you boiler.

There are times when Kewanee will substitute a larger blower onto a burner. If a burner is to be operated on a 50Hz power supply, the blower motor will run at about 3000 RPM instead of 3600 RPM. That decrease in speed decreases blower output volume and static pressure. We substitute a larger blower, and even blower housing if necessary, to match the burner's air supply needs. If a burner is operated at high elevations (over 2000 Ft.), air density decreases and causes a drop in the blower's static pressure capacity. We can calculate the capacity loss and increase blower size to make up the difference. Sometimes there are special job site conditions for the burner to overcome, such as inlet air ducting. We can adjust blower sizes for that, too.

DIFFUSER SETTINGS AND NATURAL GAS ORIFICES

PHX-40 through PHX-50 Burners



NATURAL GAS ORIFICE USAGE CHART PHX-40 / PHX50

BOILER MODEL	DRILL SIZE	DIA	PART NUMBER	QUAN
M-115K	#1	.2280	3-190-5-901-02-05	12
M-135K	F	.2570	3-190-5-901-02-09	12
M-155K	I	.2720	3-190-5-901-02-11	12
M-175K	L	.2900	3-190-5-901-02-13	12
K4.0-142	C	.2420	3-190-5-901-02-07	12
K4.0-166	I	.2720	3-190-5-901-02-11	12
K4.0-192	L	.2900	3-190-5-901-02-13	12
K4.5-142	#1	.2280	3-190-5-901-02-05	12
K4.5-166	F	.2570	3-190-5-901-02-09	12
K4.5-192	I	.2720	3-190-5-901-02-11	12
K4.5-220	L	.2900	3-190-5-901-02-13	12
K5.0-166	C	.2420	3-190-5-901-02-07	12
K5.0-192	F	.2570	3-190-5-901-02-09	12
K5.0-220	I	.2720	3-190-5-901-02-11	12
3R7-K	#3	.2130	3-190-5-901-02-04	12
3R8-K	#1	.2280	3-190-5-901-02-05	12
3R9-K	C	.2420	3-190-5-901-02-07	12
3R10-K	F	.2570	3-190-5-901-02-09	12
3R11-K	I	.2720	3-190-5-901-02-11	12
3R12-K	L	.2900	3-190-5-901-02-13	12
HS 40	F	.2570	3-190-5-901-02-09	12
HS 50	L	.2900	3-190-5-901-02-13	12

Figure 12

INITIAL ADJUSTMENTS GAS SLEEVE AND DIFFUSER

PHX-60 through PHX-80 Burners

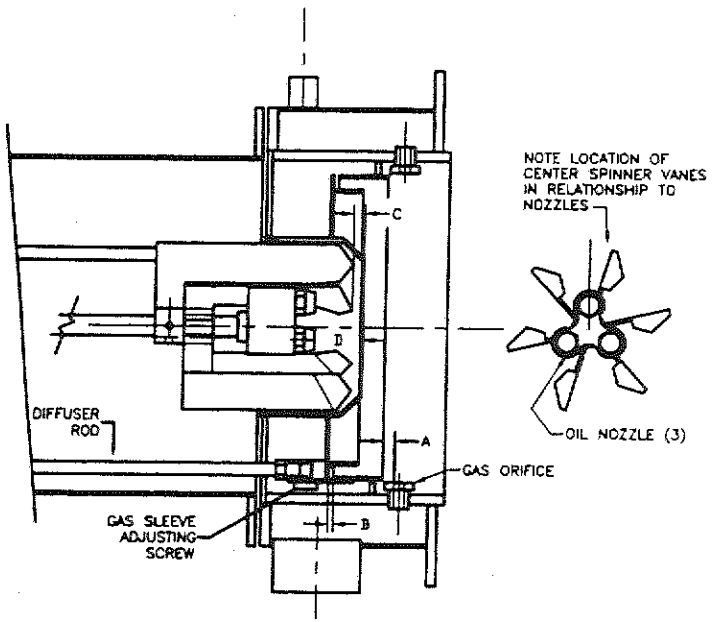
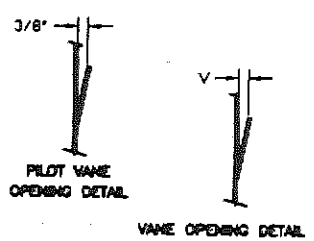


TABLE OF ADJUSTMENT ON SIZE 3

BOILER	BHP	ORIFICE	OIL NOZZLE	A	B	C	D	V	>	BLOWER
K4.0-220	59.7	C	3 Del. 4.0 GPH 80°B	1/2	0	7/8	1 1/16	1/8	40°	RS25-175
K5.0-253	55	A	3 Del. 3.5 GPH 80°B	1/2	0	27/32	1	1/8	40°	RS25-175
L35W, L3W L3S, H3S	50	C	3 Del. 4.0 GPH 80°B	1/2	0	29/32	1 1/16	1/8	40°	RS25-175
K4.5-253, M205K K5.0-284	61.1	C	3 Del. 4.0 GPH 80°B	1/2	0	29/32	1 3/32	1/8	40°	RS25-175
K5.0-315	61.8	C	3 Del. 4.0 GPH 80°B	1/2	0	15/16	1 3/32	1/8	40°	RS25-175
K4.0-253	68.6	G	3 Del. 4.5 GPH 80°B	1/2	0	1	1 9/32	1/8	40°	RS25-175
K4.5-284	68.7	G	3 Del. 4.5 GPH 80°B	1/2	0	1	1 9/32	1/8	40°	RS25-175
M235K L35W, L3W L3S, H3S	70	G	3 Del. 4.5 GPH 80°B	1/2	0	1	1 11/32	3/16	30°	RS25-175
K4.5-315	76.2	I	3 Del. 5.0 GPH 80°B	1/2	1/32	1 1/16	1 1/2	3/16	30°	R912-225
K4.0-284	77.2	I	3 Del. 5.0 GPH 80°B	1/2	1/32	1 1/16	1 1/2	3/16	30°	R912-225
7L280-K	79	I	3 Del. 5.0 GPH 80°B	1/2	1/32	1 3/32	1 9/16	3/16	30°	R912-225
M 285-K L35W, L3W L3S,H3S	80	9/32	3 Del. 5.0 GPH 80°B	1/2	1/32	1 3/32	1 19/32	3/16	30°	R912-225
K4.0-315	85.7	9/32	3 Del. 5.5 GPH 80°B	1/2	3/32	1 7/32	1 3/16	3/16	30°	R912-225

A=GAS SLEEVE POSITION--FOR GAS OR GAS/OIL
B=GAS SLEEVE GAP
C=CENTER SPINNER POSITION
D=NOZZLE POSITION
V=DIFFUSER VANE GAP
>=CENTER SPINNER ANGLE



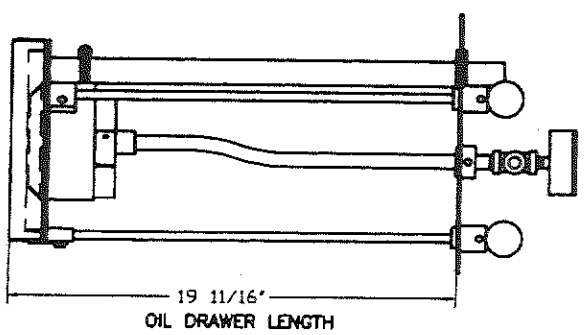


Figure 13

INITIAL ADJUSTMENTS GAS SLEEVE AND DIFFUSER

PHX-100 through PHX-125 Burners

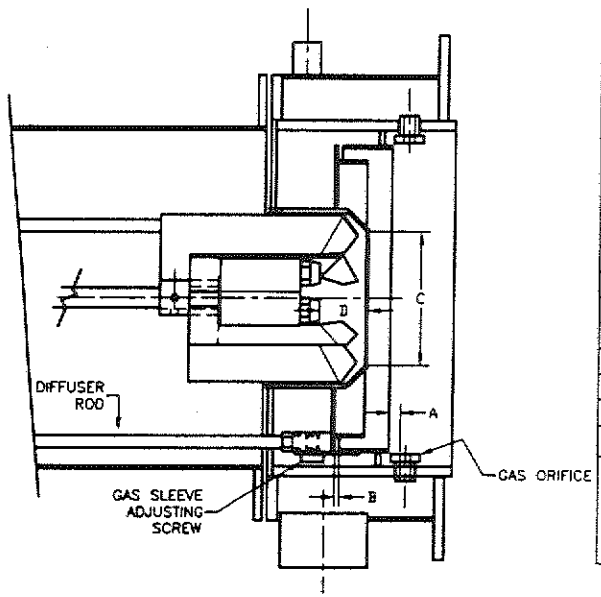
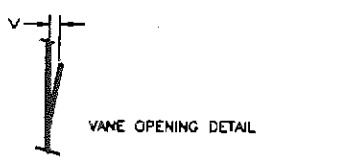


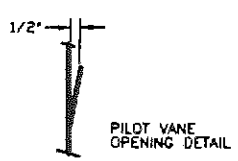
TABLE OF ADJUSTMENT ON SIZE 4

BOILER	BHP	ORIFICE	OIL NOZZLE	A	B	C	D	V	>	BLOWER
K5.0-418	90	N (.3020)	3 Del. 5.5 GPH 80°B	1/2	1/32	3.78	1 11/16	1/8	40°	R912x225
M-335K K4.5-418 CLASSIC III	100	21/64 (.3281)	3 Del. 6.0 GPH 80°B	1/2	1/32	3.78	1 11/16	3/16	40°	R912x225
K5.0-521	112.4	Q (.3320)	3 Del. 6.5 GPH 80°B	1/2	1/32	3.78	1 11/16	3/16	40°	R912x225
K4.0-418	112.5	Q (.3320)	3 Del. 6.5 GPH 80°B	1/2	1/32	3.78	1 11/16	3/16	40°	R912x225
7L282K	113	Q (.3320)	3 Del. 7.0 GPH 80°B	1/2	1/32	3.78	1 11/16	3/16	40°	R912x225
K4.5-521	124.9	T (.3580)	3 Del. 7.5 GPH 80°B	1/2	1/16	3.78	1 11/16	1/4	40°	R987x325
CLASSIC III	125	T (.3580)	3 Del. 7.5 GPH 80°B	1/2	1/32	3.78	1 11/16	1/4	40°	R987x325
M425K	126.9	T (.3580)	3 Del. 7.5 GPH 80°B	1/2	1/32	4.09	2 1/4	1/4	40°	R987x325
7L283K	132	T (.3580)	3 Del. 8.0 GPH 80°B	1/2	1/32	4.09	2 1/4	1/4	40°	R987x325
K5.0-619	135	U (.3680)	3 Del. 8.0 GPH 80°B	1/2	1/32	4.09	2 1/4	5/16	40°	R987x325
K4.0-521	140.5	V (.3770)	3 Del. 8.0 GPH 80°B	1/2	1/32	4.09	2 1/4	5/16	40°	R987x325

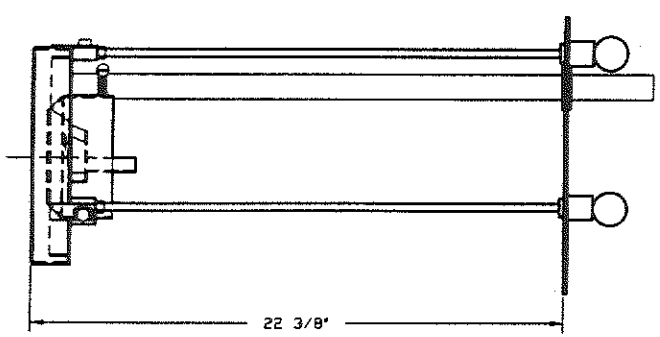
A=GAS SLEEVE POSITION FOR GAS OR GAS/OIL
B=GAS SLEEVE GAP
C=EXIT DIA. OF CENTER CONE
D=NOZZLE POSITION
V=DIFFUSER VANE GAP
>=CENTER SPINNER ANGLE



VANE OPENING DETAIL



PILOT VANE
OPENING DETAIL

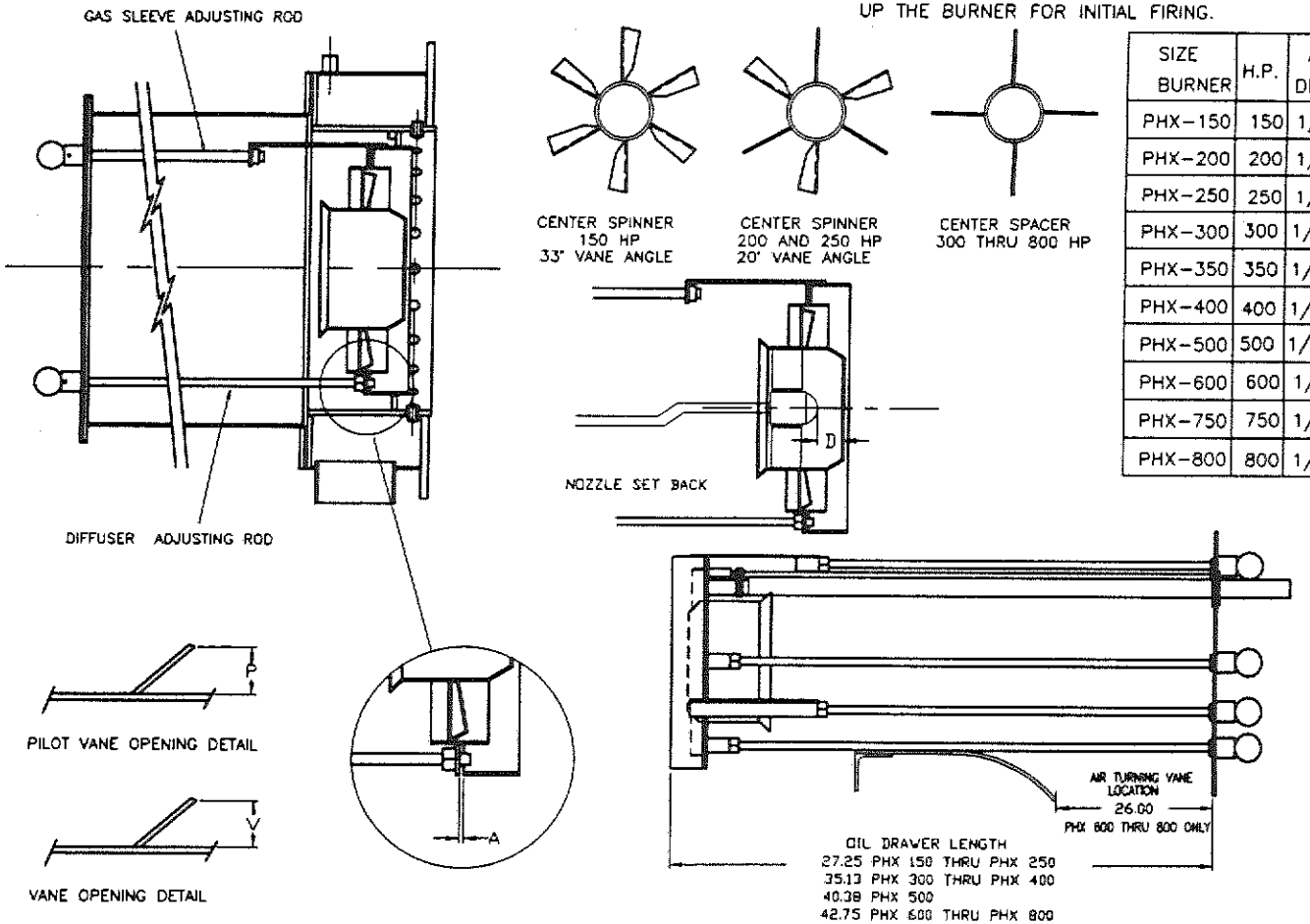


OIL DRAWER LENGTH

Figure 14

INITIAL ADJUSTMENTS GAS SLEEVE AND DIFFUSER

PHX-150 through PHX-800 Burners



THESE ARE THE SETTINGS THAT SHOULD BE USED WHEN SETTING UP THE BURNER FOR INITIAL FIRING.

SIZE BURNER	H.P.	A DIM	V DIM	P DIM	D DIM
PHX-150	150	1/8	.188	.375	1.00
PHX-200	200	1/8	.250	.375	1.00
PHX-250	250	1/8	.375	.375	1.00
PHX-300	300	1/8	.625	.625	1.50
PHX-350	350	1/8	.625	.625	1.50
PHX-400	400	1/8	.750	.625	1.50
PHX-500	500	1/8	.750	.625	1.50
PHX-600	600	1/8	.750	.750	1.50
PHX-750	750	1/4	.875	.750	1.50
PHX-800	800	1/4	.875	.750	1.50

Figure 15

FUEL SUPPLY AND METERING - GAS

1. PRINCIPLE OF OPERATION

Control of the flow rate of gas is based ont he principle that the pressure drop across a flow resistance in the gas piping (such as a valve or gas orifice) is proportional to the square of the flow rate through that resistance. We apply that principle by providing a regulated gas pressure supply, adjusted so that its set pressure is equal to the total of all the flow resistances in the gas train, burner head, and boiler furnace when the burner is operating at high fire. Let's look at each of the items that we need to balance:

A. The gas pressure regulator is our first component in the system. It is one of your main adjustments in the system, and should be the first item you adjust when setting rate and O2 on a new burner.

B. The gas train's main components are its piping, safety shutoff valves, vent valve, pressure switches and test cocks. For flow balancing purposes, we only consider their flow resistances as important. The gas pressure specified on the burner's order allowed us to select a gas train with a flow resistance to match the supply pressure available.

C. The gas butterfly valve is the variable resistance in the system. We adjust it so that it is almost fully open at high fire. This adjustment produces a flow versus valve opening characteristics and gives best metering control through the modulating range. We measure gas flow and set the gas pressure regulator to provide full firing rate with the butterfly valve in that "nearly open" position. As the butterfly valve closes, its resistance to flow increases, so flow rate drops. We adjust the butterfly valve's low fire position to produce the flow rate of the burner's specified turndown ratio.

NOTE: When you're starting up a new burner, it's best not to change any butterfly valve adjustments until you have set the gas pressure regulator to match your observed pressures to the ones on the fire test record.

D. The gas orifices in the burner head are the main resistance to flow at high fire. We select them to give the best mixing velocity of the firing rate that the burner was ordered for. (See the burner head adjustment charts for orifice sizes.)

E. The boiler furnace pressure varies with firing rate, breeching and stack design. It will be at its highest when the burner is operating at high fire. We must consider furnace pressure in our gas pressure calculations since the gas pressure to the gas orifices still has to overcome the furnace pressure, too.

2. DESIGN CONSIDERATIONS

Gas trains are designed to meet the code requirements specified when the burner is ordered. Our standard gas trains meet the requirements of the underwriters Laboratories and the ASME's Controls and Safety Devices Code, CSD-1. We can also meet many other code requirements, such as those of Factory Mutual (FM), Industrial Risk Insurers (IRI), and Brooklyn Union Gas (BUG) when they are specified on the order.

We size the gas trains to limit the regulated gas pressure to 25" water column of less. This limitation helps match butterfly valve flow characteristics to air damper flow characteristics, to give best fuel / air ratio control through the modulating range. The schematics in Figures, 16 17, and 18 show how we put the gas train components together.

We can provide gas trains for propane as well as natural gas. The propane gas trains are slightly smaller in size for lower for the richer gas. We can also provide dual gas trains to allow firing propane as a back-up fuel for natural gas. A typical example of how we pipe them is shown in Figure 19.

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GAS TRAIN

Modulation
UL and FM - (0 to 2,500,000 BTU)
10 to 50 HP

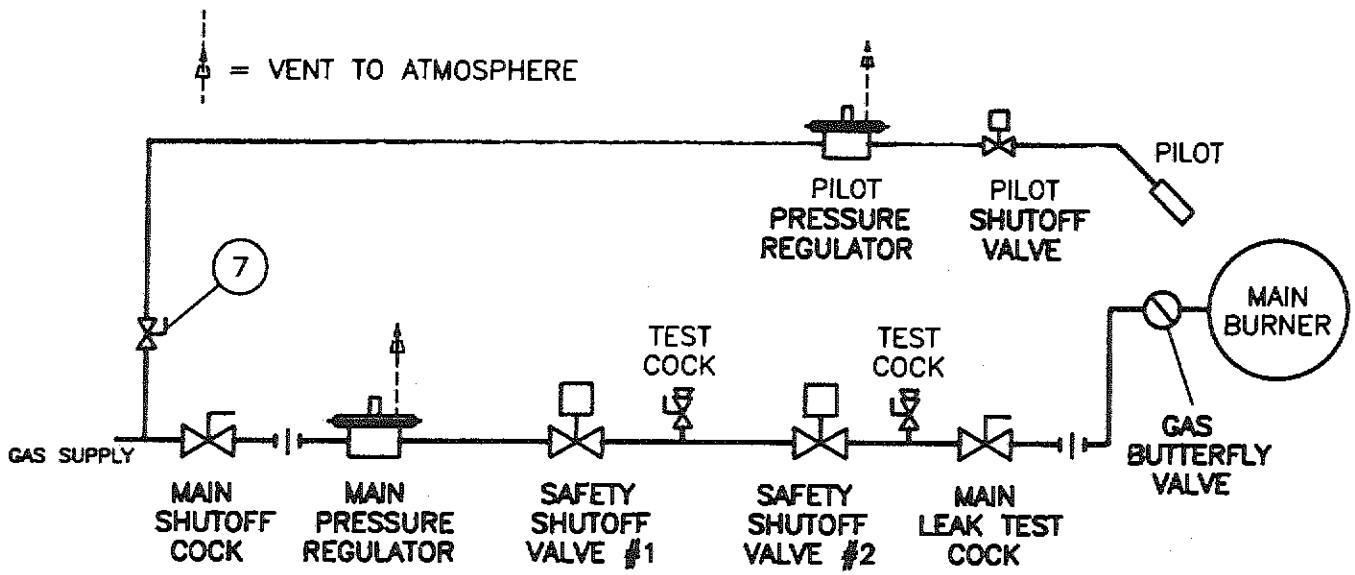

Figure 16

GAS TRAIN

UL and FM - (2,500,000 to 12,000,000 BTU)
60 to 250 HP

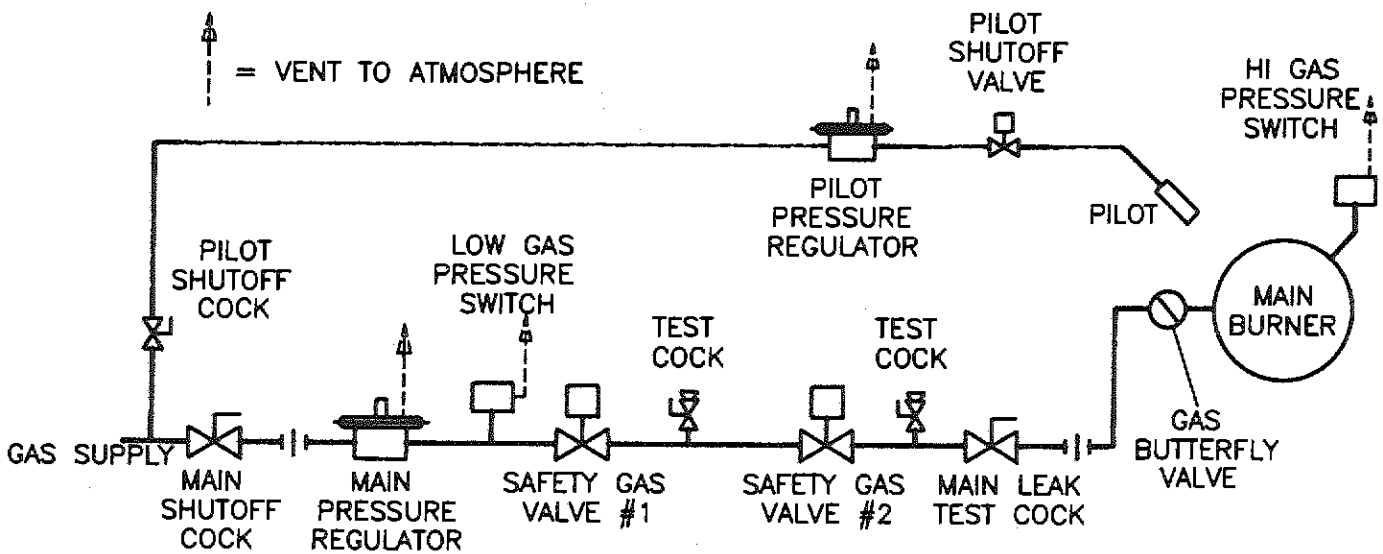

Figure 17

GAS TRAIN

IRI - (0 to 12,000,000 BTU)
10 to 250 HP

UL, FM and IRI - (12,000,000 and Over BTU)
300 HP and Over

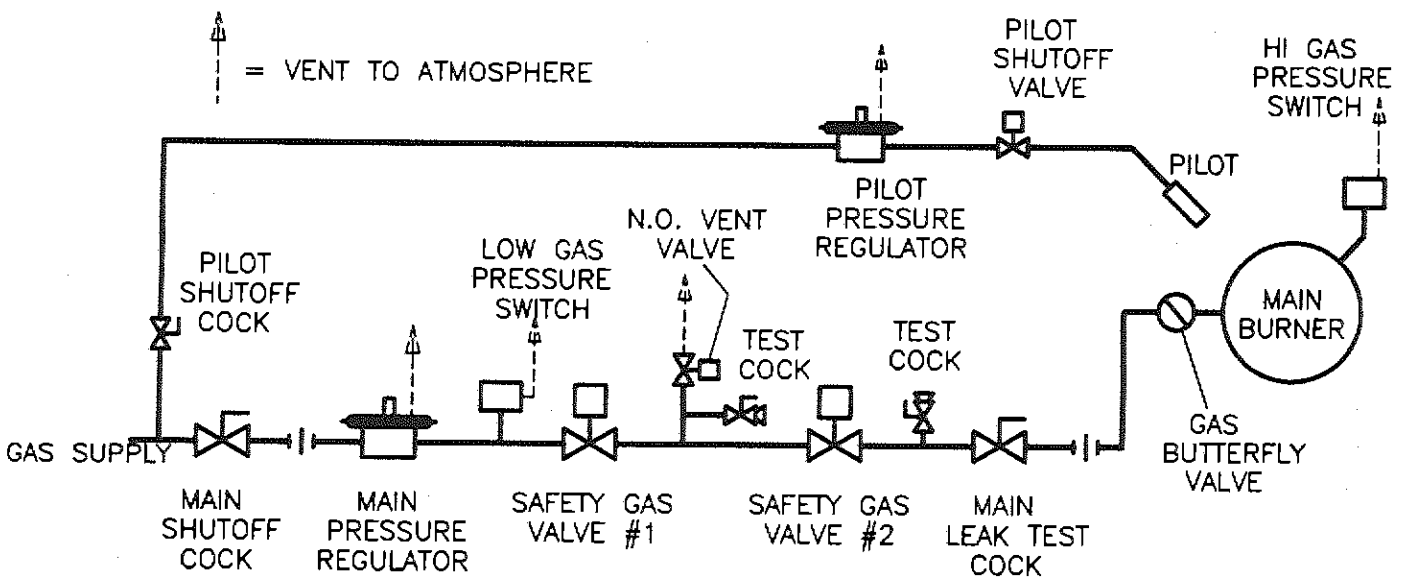

Figure 18

DUAL GAS TRAIN

UL, FM and IRI - (12,000,000 and Over BTU)
150 HP and Over

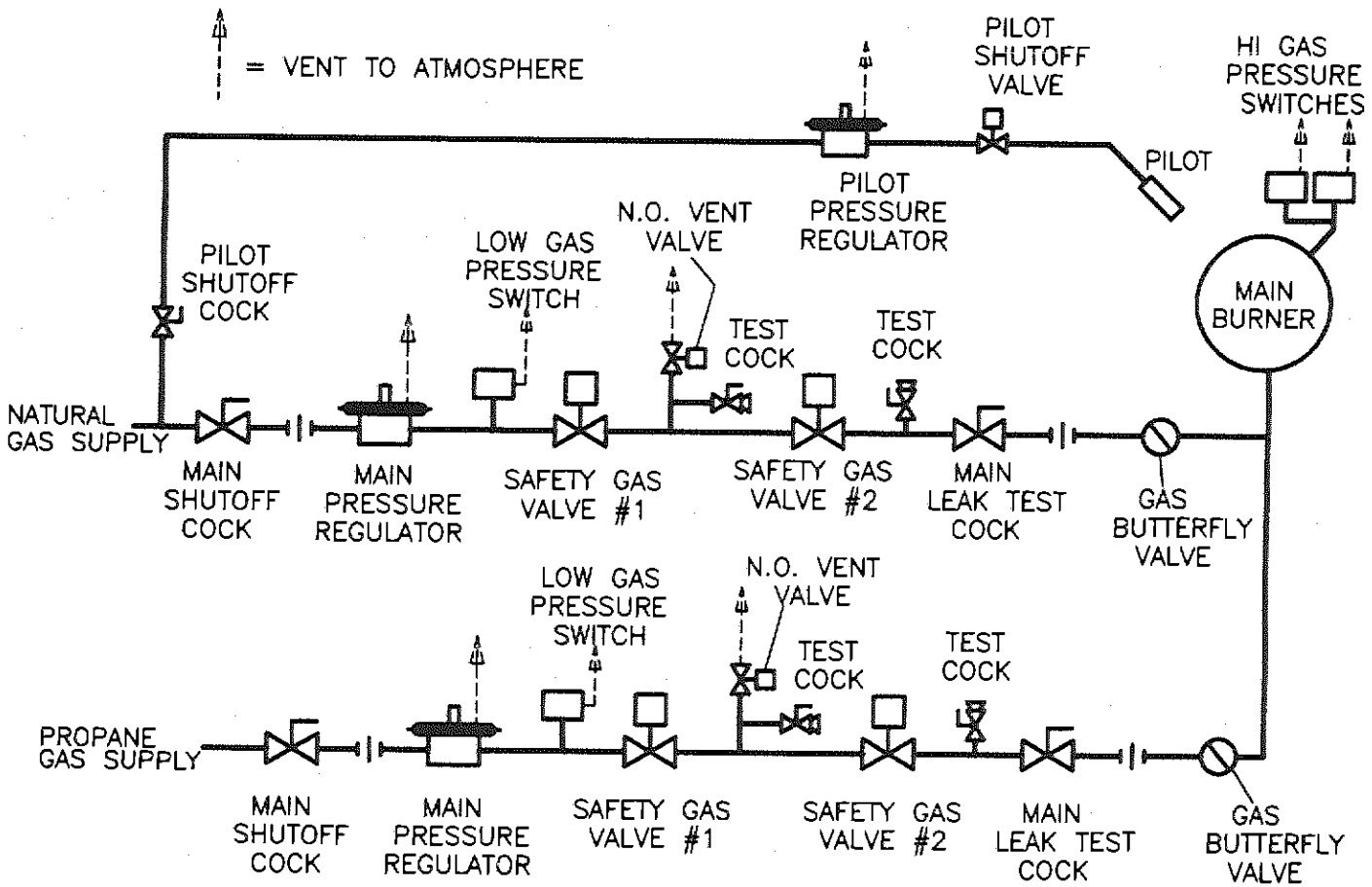

Figure 19

OIL NOZZLE TYPES

The first principle of combustion is that there are three elements required to support combustion: fuel, oxygen, and heat to sustain the chemical reaction between the fuel and oxygen. That's enough to know for candles and campfires, but our business is to get some work out of the fires we make. To get the kind of work from fire that is expected of us, we have to be able to fire at much higher rates than candles and campfires. To get our firing rates, we must be able to mix fuel and oxygen quickly. For oil fires that means turning the stream of liquid oil into a vapor that can be mixed with air. That is called vaporization. But there is a first step to vaporization at the rates we need, too. We must break the stream of oil into a tremendous number of tiny droplets. That is called atomization, and that is the job of the oil nozzle. The atomized spray has a tremendous amount of surface area, and picks up heat from the flame. The heat from the flame quickly converts all of those droplets into vapor that can mix with the air.

There are different types of oil nozzles, designed to meet the needs of atomizing different types of oil at different firing rates. The different types of nozzles require different types of oil supply and metering systems. We'll look at nozzle types first, and then at the metering systems required to support them.

The standard nozzles on PHX-40 through PHX-80 burners are simplex nozzles. The PHX-100 through PHX-250 burners use return flow nozzles as their standard, and PHX-300 and larger burners come standard with air atomizing nozzles.

There are exceptions to our standard offerings. Air atomization is optionally available for burners as small as the PHX-60. Return flow nozzles are optionally available for burners as small as the PHX-40, but are not offered on any burners larger than the PHX-250. Simplex nozzles are not offered on burners larger than the PHX-80.

1. Simplex Nozzles

Simplex nozzles are pressure atomizing nozzles. Their only source of energy for atomizing the oil comes from the pressure at which the oil is supplied to the nozzle. They are called "simplex" because their pressure versus flow rate relationship matches that of a simple orifice. The square root of the pressure ratio between two firing rates is linearly proportional to the firing rate ratio between those rates. That relationship makes estimation of firing rates easy. These nozzles are typically rated at 100 PSI, and their rates are stamped on the body of the nozzle. By using an oil pressure gauge which measures the oil pressure delivered to the nozzle, and some simple math, you can usually calculate firing rates accurate within 5%. Kewanee PhoenX burners apply these nozzles at high fire rates near 300 PSI (see the burner head adjustment charts for nozzle selections and high fire pressures).

For 300 PSI operation, the actual high fire rate at which the nozzle will operate is equal to the rated capacity multiplied by the square root of three. When these nozzles are used in low fire start, low-high-low or modulating systems, their low fire rates are usually based on 100 PSI operation, so their turndown ratio is the square root of three (or 1.73) to one. They are seldom used at pressures below 100 PSI, since

atomization suffers at lower pressures.

Figure 20 shows the details of simplex nozzle construction. These nozzles include strainers or filters to protect them from contamination, and tangentially machined swirl porting to control fuel delivery distribution. They are available in calibrated sizes matched to standardized delivery rates and spray cone angles. They feature a variety of spray patterns which can distribute their fuel droplets evenly across the spray cone, or in patterns which can be hollow, uniformly distributed, or heavy in the center. PhoenX burners use the Delevan B nozzles in sets of three in a triple nozzle adapter as their standard. They have a uniform spray distribution pattern that matches the PhoenX burner head's air distribution pattern and gives good combustion performance. Compatibility of a specific nozzle with a given burner head is ultimately decided by test, so it is important to follow the Kewanee's recommendations for nozzle usage. Simplex nozzles are used only for light, distillate oils, and only at rates up to the PHX-80 due to their limited turndown.

2. Return Flow Nozzles

Pressure atomizing systems require fewer expensive components than air atomizing systems, so there is economic advantage to using them. However, pressure atomizing at higher rates than simplex nozzles allow requires a means of obtaining greater turn down ratios than simplex nozzles provide. That problem was solved by a nozzle design referred to as a "return flow" nozzle. Figure 21 shows a cut away view of a return flow nozzle.

Return flow nozzles take the pressure energy of the oil and convert some of it to velocity energy by injecting the oil tangentially into a swirl chamber in the nozzle. The oil swirls at a high speed against the walls of the swirl chamber. The swirl chamber has two exits. The one at the tip of the nozzle uses the speed of the oil to spray it from the nozzle tip. The incoming oil pressure is nearly constant across the modulating range of the nozzle, so the oil speed in the chamber remains high through the range. That high speed maintains good atomization of the oil at higher turndown ratios than simplex nozzles allow. Swirl cone and nozzle tip geometry establish the spray angle and spray pattern of the nozzle. The second exit from the swirl chamber, at the opposite end from the tip, allows the "return flow" of oil from the nozzle back to the burner's oil piping system. This exit is located on the centerline of swirl rotation of the swirl chamber. The oil at the center of the swirl chamber has very little speed. Oil exiting there removes the smallest amount of velocity energy from the system, leaving most of that energy in the swirling oil. Return flow nozzles are rated by their manufacturers for turndown ratios of 4 or 5 to one. Kewanee PhoenX burners use them only for No. 2 oil firing.

Delivery rates for return flow nozzles vary with the thickness of the film of oil exiting the nozzle tip. Higher viscosity oils than those for which a nozzle is rated will produce slightly greater delivery flow rates than those rated for the nozzle.

3. Air Atomizing Nozzles

The third type of oil nozzle to consider is the air atomizing nozzle. This type of nozzle uses a flow of pressurized air to supply energy to atomize its oil. The very earliest designs of this nozzle type used a simple orifice to direct a stream of oil vertically upward. A second simple orifice directed a high pressure, high velocity flow of steam horizontally to intersect the oil flow. The steam broke the oil flow into a mist of fine droplets which were sprayed forward into the fire. The most typical design techniques of today's nozzles retain that basic principle, but perform their functions inside the nozzle body. Figure 22 shows a cut away of a Monarch air atomizing nozzle often used on PhoenX burners. Only the oil mist, carried by an air flow, exits the nozzle. The air provides the required energy for atomizing the oil flow, so turndown ratios are larger than for pressure atomizing nozzles. Even though nozzle manufacturers only rate these nozzles for 3 or 4 to one turndown ratios, they are typically used at 5 to one turndown, and provide good service there. They can be used for light or heavy oils, however heavy oils must be heated to reduce their viscosity to about 100 SSU for good atomization. The Monarch nozzle pin settings shown in Figure 23 are greater than Monarch's standards. Kewanee development tests have shown that these wider openings provide better flame concentricity and less tendency to light and heavy spots in the spray pattern than Monarch's standards.

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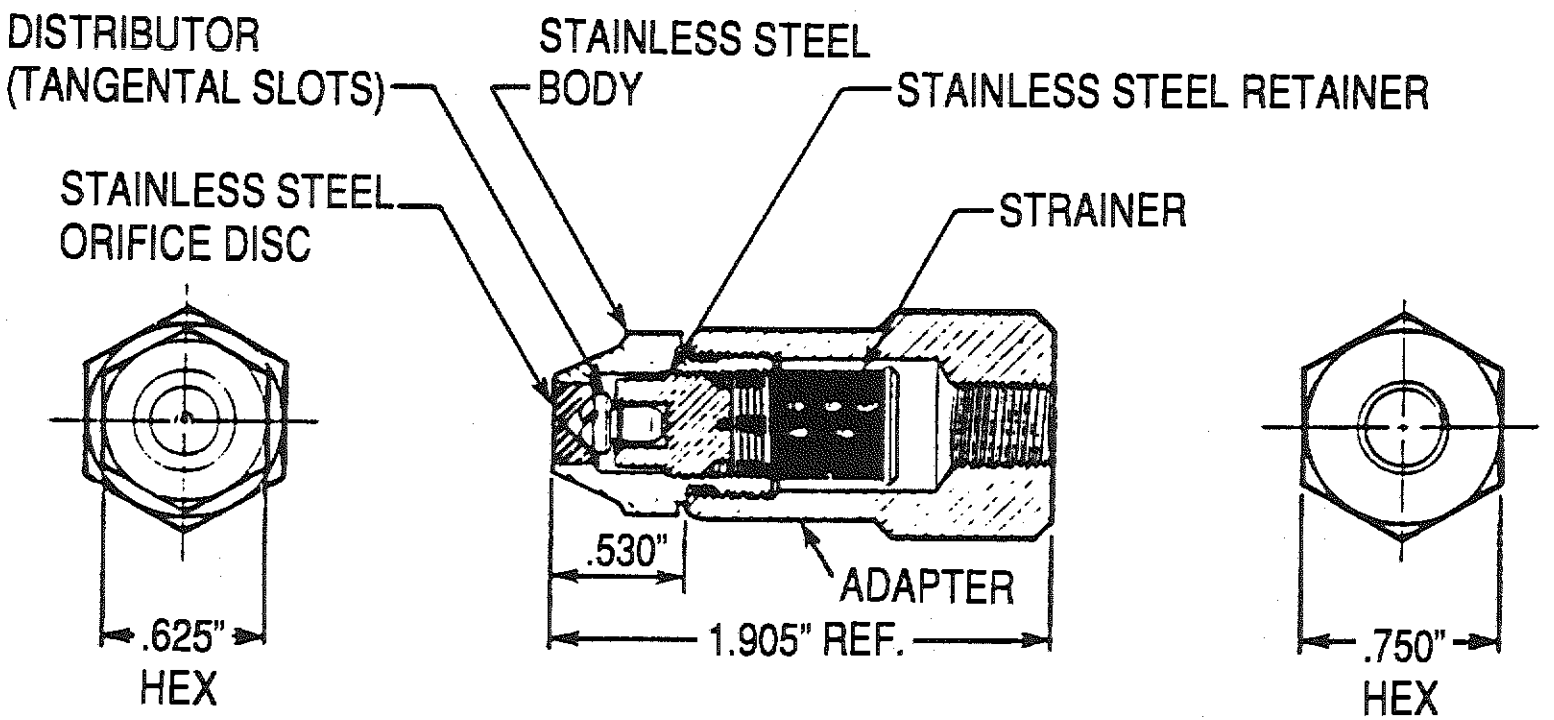
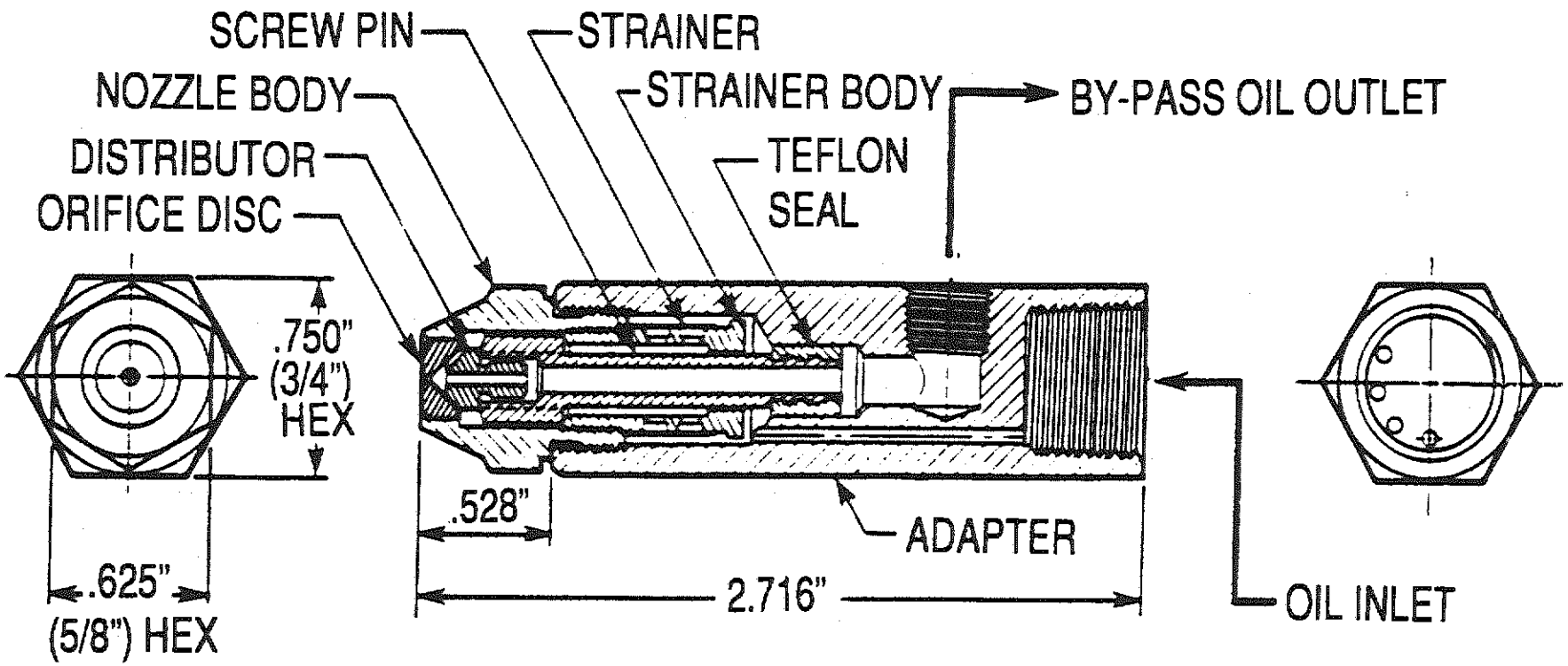
SIMPLEX NOZZLE ASSEMBLY



1. Nozzle rating and spray angle stamped on nozzle body. Rating based on 100 PSI test pressure.
2. Application will vary with burner size and firing sequence.

Figure 20

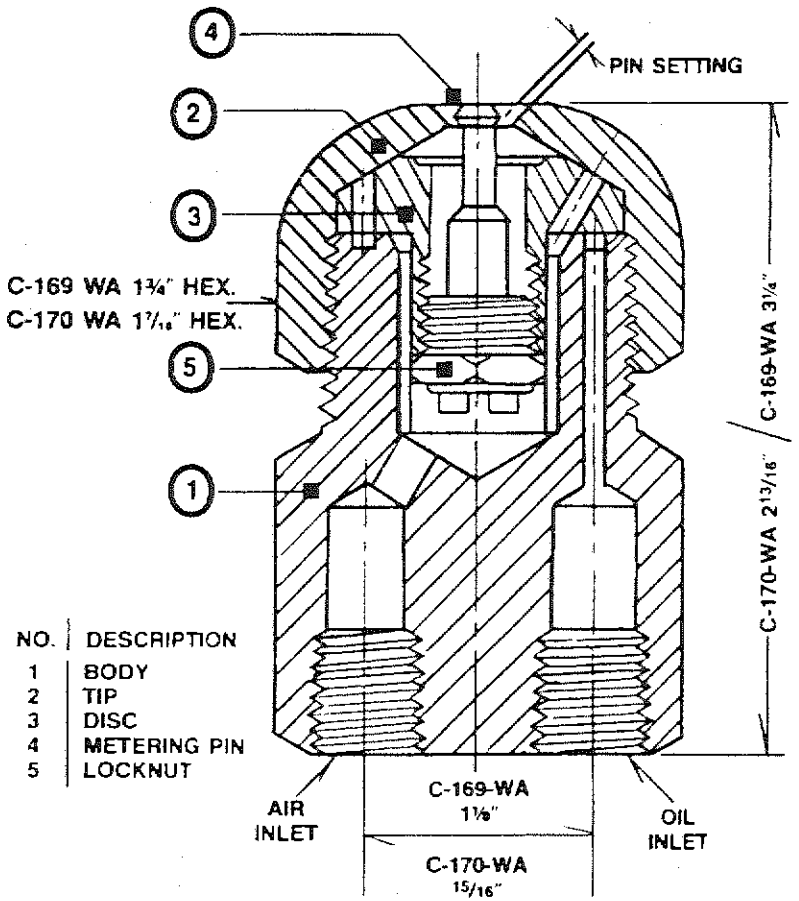
BY-PASS OR RETURN NOZZLE ASSEMBLY

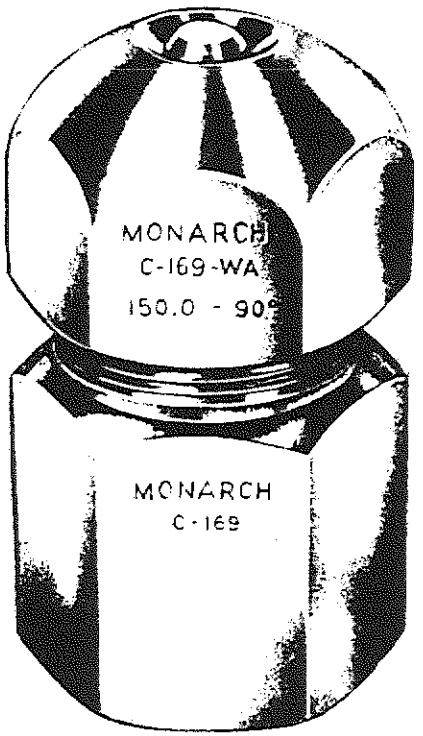


1. Nozzle rating and spray angle stamped on nozzle body. Rating based on 100 PSI test pressure.
2. Application will vary with burner size and firing sequence.

Figure 21

MONARCH AIR ATOMIZED NOZZLE ASSEMBLY





NOTE: Application will vary with burner configuration and firing rate

Figure 22

MONARCH NOZZLE PIN SETTINGS

Figure Number	Rated GPH*	NPT Connections		Pin Setting
		Air	Oil	
C-169-WA	30	1/4"	1/4"	.062"
	40	1/4"	1/4"	.062"
	50	1/4"	1/4"	.062"
	60	1/4"	1/4"	.062"
	80	1/4"	1/4"	.062"
	100	1/4"	1/4"	.062"
	125	3/8"	1/4"	.062"
	150	3/8"	1/4"	.062"
	200	3/8"	3/8"	.062"
	250	3/8"	3/8"	.062"

* With air at 15 PSI and No. 2 oil at 26 PSI **OR** with air at 21 PSI and No. 2 oil at 31 PSI

Figure 23

FUEL SUPPLY AND METERING - SIMPLEX OIL NOZZLES

Oil supply and metering is so dependent upon the type of oil nozzle being used that this section of the manual will be organized by nozzle type. Please verify the type of nozzle applicable to your burner. Simplex nozzles have only a single oil pipe going through the plenum cover, to the nozzle adapter. Return flow nozzles have two oil pipes through the plenum cover, a supply and a return. Air atomizing nozzles have one oil pipe and one air pipe going through the plenum cover.

1. SIMPLEX NOZZLE OIL METERING

Control of the flow rate of oil in simplex nozzle systems is based on the same principles applicable to gas flow control in gas firing burners. The pressure drop across a flow resistance in the oil piping (such as a valve or oil nozzle) is proportional to the flow rate through that resistance. We apply that principle by providing a regulated oil pressure supply, adjusted so that its set pressure is equal to the total of all the flow resistances in the oil train, from the oil pressure regulator through the nozzle, when the burner is operating at high fire. Those principles apply regardless of the type of rate control system being used. Simplex nozzles are used in three different types of firing rate control systems; Low Fire

Start, High Low, and Modulation. Figures 24 and 25 present schematics of how we arrange the parts that make up those simplex nozzle piping systems. The Firing Rate Control Systems section explains how each of these systems works. For now, let's just look at each of the piping components as they relate to rate control:

A. The oil pressure regulator is usually built into the oil pump of simplex nozzle systems, but it may be mounted on the side of the burner depending on system or code requirements. It is one of your main adjustments in this system, and should be the first item you verify when checking rate or O2 on a new burner.

B. The oil train's main components are its piping, safety shutoff valves, and pressure switches. For flow balancing purposes, these components have been sized to provide minimal pressure losses.

C. The oil metering valve (on modulating systems only, see Figure 25) is the variable resistance that provides firing rate change in the system.

   In this system the valve opens to divert flow from the nozzle line to the return line to reduce oil flow to the nozzle and decrease firing rate. It's best adjustment will produce a flow versus valve opening characteristic that closely matches the air damper's characteristics to give best metering control.

   At fire test, we measure oil flow and set the oil pressure

regulator to provide full firing rate (abut 300 PSI) with the oil metering valve in its high fire position (closed). As the metering valve opens, its resistance to flow decreases, so flow rate to the return line increases, and flow rate to the oil nozzle drops. We adjust the metering valve's low fire position to produce 100 PSI at the oil nozzle. This gives the proper flow rate for the burner's specified turndown ratio.

When you're starting up a new boiler and adjusting O2 levels, it's best to first verify that the oil pressures you observe match the ones on the fire test record.

D. The low fire oil pressure regulator (on low fire start or high low systems, see Figure 24) provides a second regulated pressure to be available for nozzle operation.

When the low fire solenoid valve is opened, oil flows through the low fire oil pressure regulator, and reduces system pressure to its setting. This regulator is typically set to 100 PSI, which is the lowest recommended pressure for operation of simplex nozzles. When the solenoid valve is closed, the oil pump's pressure regulator controls system pressure to about 300 PSI, providing high fire operation.

E. The oil nozzle is the main resistance to flow at high fire. We select nozzle sizes to match the firing rate that the burner was ordered for. (See the burner head adjustment charts for nozzle selections.)

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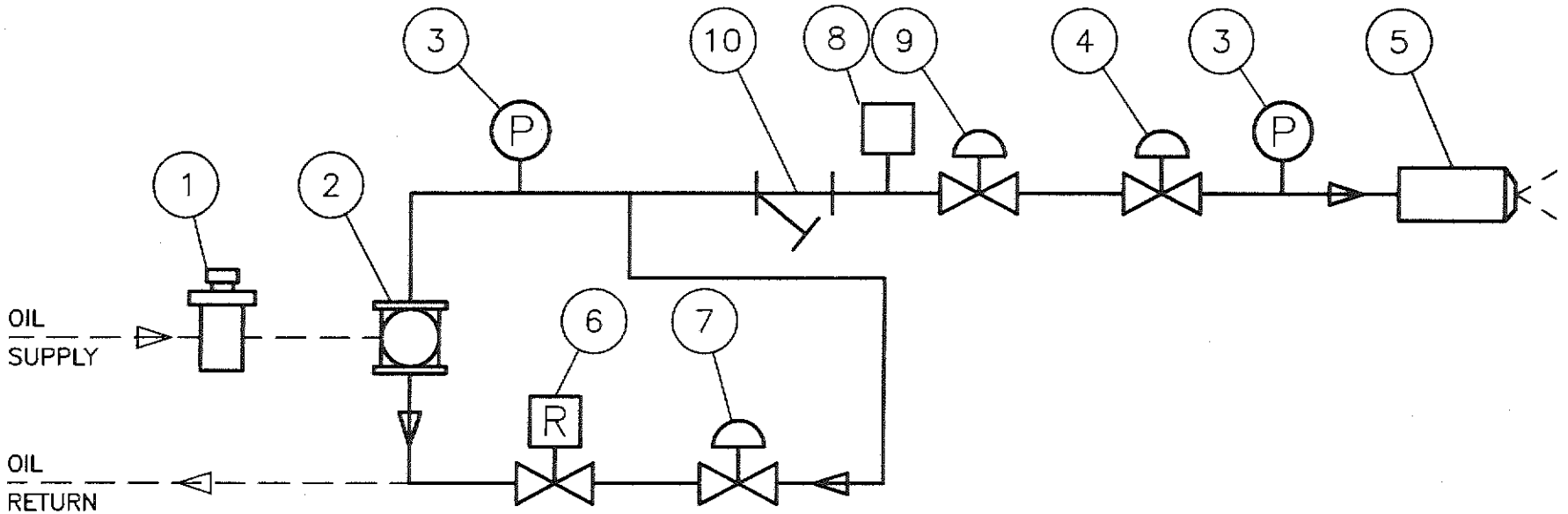
SIMPLEX NOZZLE SYSTEM

High-Low or On-Off with Low Fire Start
Pressure Atomized No. 2 Oil



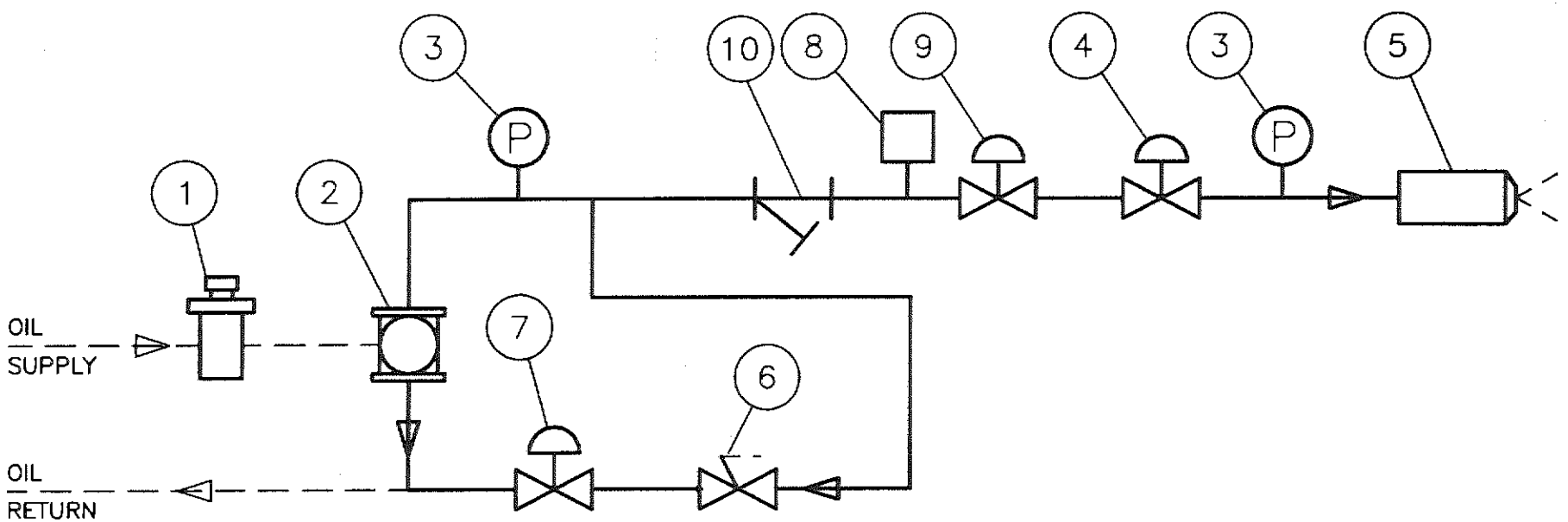
*NOTE: Pump discharge line is piped from pump's gauge port to avoid hydraulic interference between low fire regulator (6) and pump's internal low pressure cut-off.

1. Oil Filter (s)
2. Oil Pump
3. Pressure Gauge(s)
4. Main Oil Valve
5. Oil Nozzle(s)
6. Pressure Regulator
7. By-Pass Oil Valve
8. Low Oil Pressure Interlock
9. Safety Oil Valve
10. Strainer

Figure 24

SIMPLEX NOZZLE SYSTEM

Modulation
Pressure Atomized No. 2 Oil



1. Oil Filter (s)
2. Oil Pump
3. Pressure Gauge(s)
4. Main Oil Valve
5. Oil Nozzle(s)
6. Oil Metering Valve
7. By-Pass Oil Valve
8. Low Oil Pressure Interlock
9. Safety Oil Valve
10. Strainer

Figure 25

FUEL SUPPLY AND METERING - RETURN FLOW OIL NOZZLES

1. RETURN FLOW NOZZLE OIL METERING

Control of the flow rate of oil in return flow nozzle systems is based on a different principle than either simplex or air atomizing nozzle systems. Figure 26 shows a schematic of a return flow piping system. Notice that the oil metering valve is in a return line from the nozzle. The metering valve closes as the burner modulates to high fire. When the metering valve is fully closed, oil flow in the return line is completely stopped. At that time, and only at that time, the piping system behaves just as a simplex system would. The pressure drop across the flow resistances in the oil piping system is proportional to the flow rate through those resistances. The regulated oil pressure supply is adjusted so that its set pressure is equal to the total of all the flow resistances in the oil train, from the oil pressure regulator through the nozzle.

A. The oil pressure regulator is usually built into the oil pump of return flow nozzle systems, but it may be mounted on the side of the burner depending on system or code requirements. It is one of your main adjustments in this system, and should be the first item you verify when checking rate or O2 on a new burner.

B. The oil train's main components are its piping, safety shutoff valves, and pressure switches. For flow balancing purposes, these components have been sized to provide minimal pressure losses.

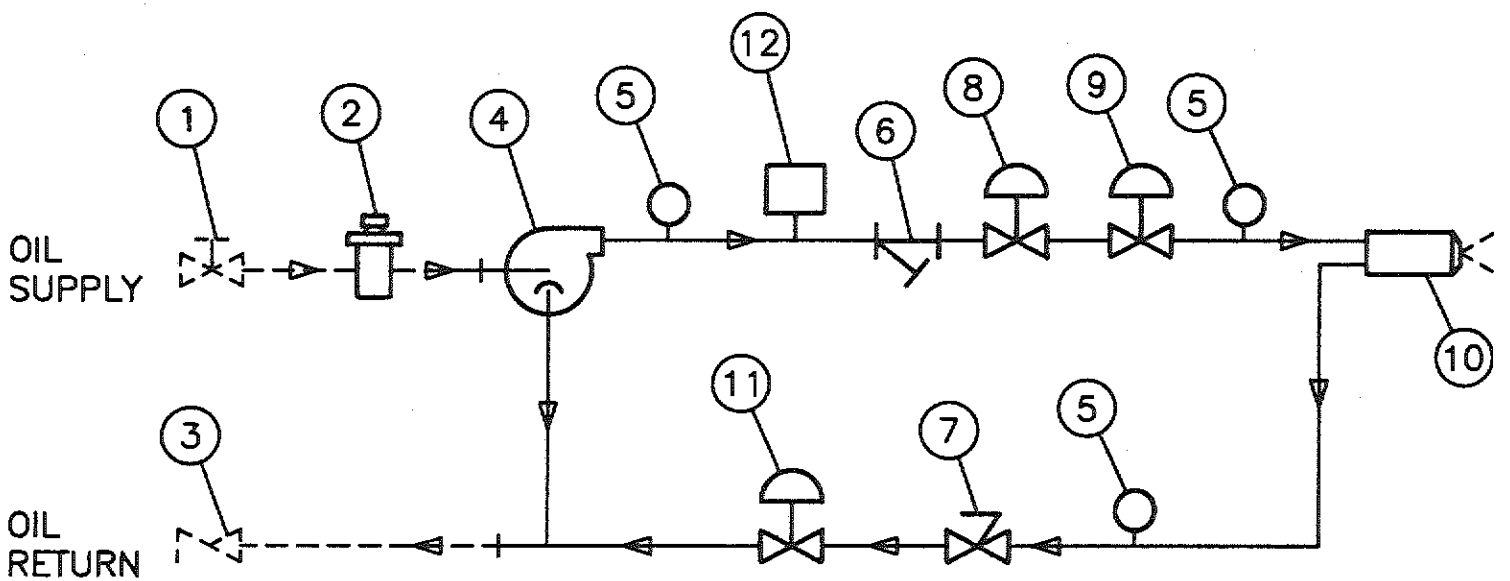
C. The oil metering valve is the variable resistance allowing return line oil flow in this system. It should be fully closed at high fire. We measure oil flow and set the oil pressure regulator to provide full firing rate with the oil metering valve in its high fire position (closed). As the metering valve opens, nozzle return line flow increases, so firing flow rate drops. We adjust the metering valve's low fire position to produce the rated low fire fuel flow. This should give a turndown ratio of about 3 to 1. When you're starting up a new boiler and adjusting O2 levels, it's best to first verify that the oil pressures you observe match the ones on the fire test record.

D. The oil nozzle is the main resistance to flow at high fire. We select nozzle sizes to match the firing rate that the burner was ordered for. (See the burner head adjustment charts for nozzle selections.)

We also provide return flow nozzles in a High Low system designed to meet New York City's Bureau of Air Resources requirements. That system functions much like the High-Low system using simplex nozzles with the exception being that with the return flow nozzles, the low fire pressure regulator controls return line pressure.

RETURN FLOW NOZZLE SYSTEM

Modulation
Pressure Atomized No. 2 Oil



1. Oil Supply Gate Valve
2. Oil Strainer
3. Oil Return Check Valve
4. Oil Pump Assembly
5. Oil Pressure Gauge
6. Secondary Oil Strainer
7. Oil Metering Valve
8. Main Oil Valve, N.C.
9. Safety Oil Valve, N.C.
10. Pressure Atomizing Oil Nozzle
11. Oil check Valve
12. Low Oil Pressure Switch

Figure 26

FUEL SUPPLY AND METERING - AIR ATOMIZING OIL NOZZLES

1. AIR ATOMIZING NOZZLE OIL METERING SYSTEMS

Control of the flow rate of oil in our air atomizing nozzle system is opposite to that of our modulating simplex nozzle system, in that the action of the metering valve is direct (opening the valve increases flow, closing it decreases flow). There are also more variables to control in air atomizing systems. We'll start with the No. 2 air atomizing system, which has the fewest added variables.

2. Number 2 Oil Systems

Figure 27 shows a schematic of a typical No. 2 oil air atomizing piping arrangement. Lets look first at the oil supply to the nozzle. Other than a few added safeties, it has the same components as a simplex nozzle oil system, and we deal with them in the same manner. The pressure drops across the flow resistances in the oil piping are proportional to the flow rate through those resistances. We provide a regulated oil pressure supply, adjusted so that its set pressure is equal to the total of all the flow resistances in the oil train, from the oil pressure regulator through the nozzle, when the burner is operating at high fire.

A. The oil pressure regulator in air atomizing nozzle systems is a separate component, not part of the oil pump, and is mounted on the side of the burner. It is still one of your main adjustments in this system, and should be the first item you verify when checking rate or O2 on a new burner.

B. The oil train's main components are its piping, safety shutoff valves, and pressure switches. For flow balancing purposes, these components have been sized to provide minimal pressure losses.

C. The oil metering valve is the variable resistance in the system. We adjust it to about 50% open at high fire. This adjustment produces a flow versus valve opening characteristic that closely matches the air damper's characteristics, and gives best metering control. We measure oil flow and set the oil pressure regulator to provide full firing rate with the oil metering valve in its high fire position (open). As the metering valve closes, its resistance to flow increases, so flow rate drops. We adjust the metering valve's low fire position to produce the proper flow rate for the burner's specified turndown ratio. When you're starting up a new boiler and adjusting O2 levels, it's best to <u>first</u> verify that the oil pressures you observe match the ones on the fire test record.

D. The oil nozzle is the main resistance to flow at high fire. We select nozzle sizes to match the firing rate that the burner was ordered for. (See the burner head adjustment charts for nozzle selections.)

The atomizing air supply creates an additional variable in the system, so let's look there now. The air piping system consists only of the following components:

1. The atomizing air compressor supplies air for the nozzle. It is sized to provide the CFM flow requirements of the nozzle at the pressure required by the nozzle for proper firing rate.

2. A dampening tank smoothes out the pressure pulsations coming from the air compressor's discharge. It is necessary to smooth out those pulsations in order to obtain the best performance from the air atomizing nozzle.

3. An air bleed needle valve allows trimming the compressor's flow rate to meet the nozzle's needs. We select compressors fairly close to the nozzle's actual needs, so generally this valve will be nearly closed in a properly adjusted burner.

4. An atomizing air pressure gauge allows you to monitor air supply to the nozzle.

5. An atomizing air pressure switch allows the flame safeguard control to monitor air supply to the nozzle, and to shut the burner off if the supply of atomizing air is interrupted.

The atomizing air flow affects oil metering because air atomizing nozzles respond to the flow of both air and oil going through them. Increasing air pressure to the nozzle increases air flow rates, and creates a corresponding increase in oil pressure requirements. When you are adjusting nozzle pressures in air atomizing systems, both the oil pressure and the air pressure must be matched to fire test record data to obtain the same rate that was obtained at fire test.

3. Number 4, 5, or 6 Oil Systems

Heavy oils have a higher viscosity (viscosity means "resistance to flow") than No. 2 oil. At normal temperatures, No. 2 oil has a viscosity between 30 and 40 SSU. Even when properly heated for atomizing, the heavy oils are brought only to about 100 SSU. This higher viscosity makes the heavy oils more difficult to atomize, so there are added components in their metering systems to deal with that. The principles of metering are exactly the same as were just described for No. 2 oil systems. Instead of reviewing the principles of metering, we'll look at the components added to the system to allow it to handle heavy oils.

Figures 28, 29 and 30 show typical heavy oil system schematics. The dash line boxes on the right side of the schematic indicate which components are mounted on the burner, and which are a part of the air compressor assembly. Most of the components specific to heavy oil firing are not in either of those boxes, they are mounted on the boiler skid for packaged boilers. Lets look outside the boxes first, at the oil heating equipment.

4. Oil Heaters

Item 8 in Figure 29 is a steam oil heater. It is supported by a steam supply system that includes a thermostatic control valve, a steam pressure regulator, and a steam trap. This is the heater that does most of the work of heating the oil supply. It gets its heat from the steam being produced by the boiler being fired by the oil it is heating. That helps save money for the end user of this equipment, since his cost is lower for the heat produced by the boiler than for heat from the electricity powering an electric heater. In a boiler room where costs are watched closely, the steam heater will be set to a temperature very near the atomizing temperature for the oil. For hot water boilers as shown in Figure 30, this heater would get its heat from hot water instead of steam. Just downstream of the steam heater is an electric heater. It has two functions in the system. First, at startup it can support the oil heating requirements to maintain low fire. That allows you to develop the steam pressure or water temperature necessary to operate the steam heater. Second, the electric heater is a convenient trim heater to easily dial in the last few degrees you need in adjusting the system.

The steam heater is not supplied with burners designed for firing No. 4 or 5 oil as shown in Figure 28. They don't have as much heating load as the No. 6 oil systems, so there isn't as much economic justification. They do have to support the full high fire rate of the burner, plus an extra 25% for recirculation, so they are slightly larger than the trim heaters on No. 6 oil systems.

The heaters for Kewanee PhoenX burners are sized to take their oil from pumping temperature (which has the oil at about 3000 SSU) to atomizing temperature (where the oil is at about 100 SSU), so heater capacities vary with firing rate and oil type.

5. Nozzle Line Purge System

The equipment that is specifically for heavy oil firing that is mounted on the burner generally falls into two categories, safety switches and indicators related to heating the oil for atomization, and the nozzle line purge system. The switches and indicators are self explanatory, so we'll look at the nozzle line purge system.

Heavy oils are continuously circulated by the pumping system in order to keep the fuel and its piping components hot and ready to be fired by the burner. The point on the burner at which that circulation turns to go back to the tank is at the safety shutoff valves. Everything up to them is heated by oil circulation, everything past them is not heated by oil circulation. When the burner is off line, the piping past the safety shutoff valves cools to the ambient temperature. If heavy oil was allowed to lie in those lines, it too would cool

to ambient. Starting the burner would then become difficult. The heavy oil would be difficult to force through the nozzle, and it wouldn't atomize well. The burner might not light on the first attempt, and it would throw oil on the diffuser, refractory, and in the furnace. The nozzle line purge system solves that problem. Air from the atomizing air compressor is used to push the oil out of the nozzle line during the first few seconds of the burner's post purge interval. The system is adjusted so that the nozzle oil pressure is maintained constant from when the burner was firing, so the flame continues until all the oil in the nozzle line has been burned. The nozzle line is then empty, and ready for the burner to light off on demand.

This nozzle line purge system is standard on all PhoenX heavy oil burners and is available as an option on air atomized No. 2 oil burners.

6. Export #5, #6 and Bunker C Oil Systems

Fuel oils produced in many countries do not conform to the United States' ASTM D396 specifications. The residual is often reduced in viscosity by the addition of crude oil, which contains light volatile elements. When the mixture is heated to atomizing temperature, those volatiles boil, turning the oil into a foam. If that foam reaches the nozzle, the flame will sputter, and may be extinguished. If oil temperature is reduced to avoid sputtering, smoky flames and carbon deposits result. Kewanee's solution to that problem is to install a vapor separation tower (item 13 in Figures 31, 32, & 33). Vapor rises to the top of the tower, and is vented back to the tank through a needle valve (item 12). Liquid falls to the bottom of the tower, and proceeds through the remainder of the oil train as it would in our other systems.

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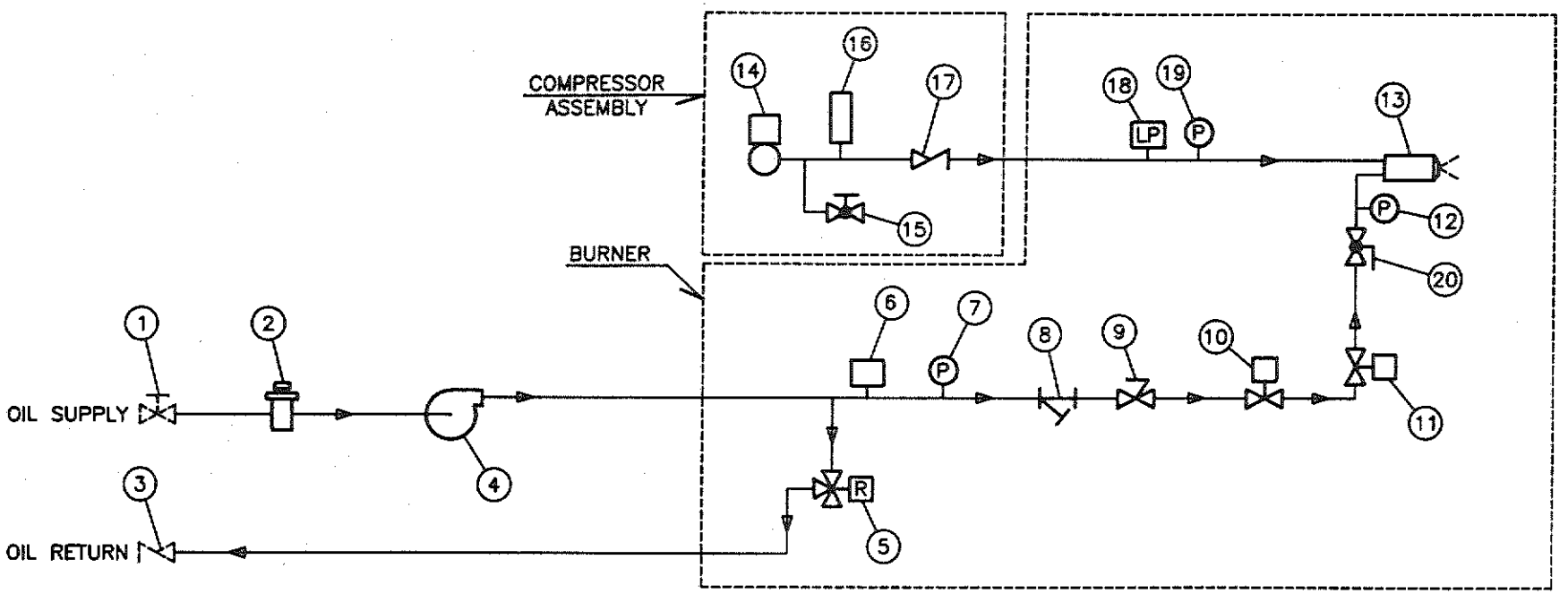
AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 2 Oil

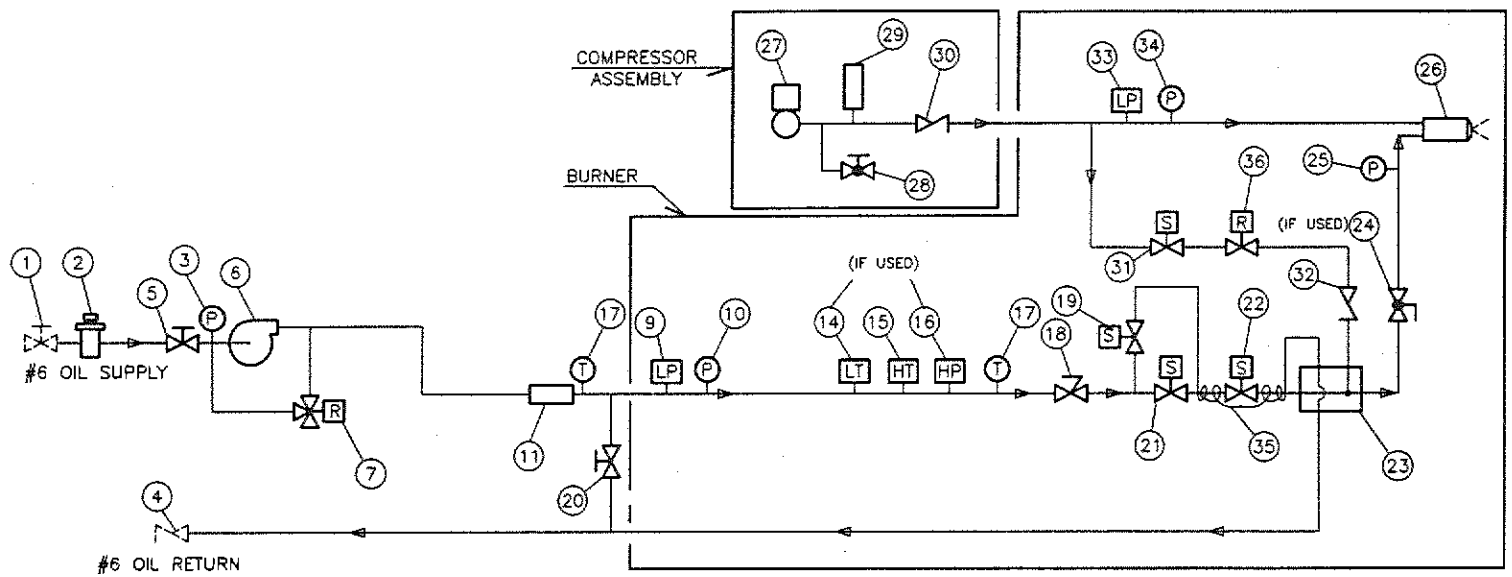


1. Oil Supply Gate Valve (By Others)
2. Oil Strainer
3. Oil Return Check Valve (By Others)
4. Oil Pump
5. Oil Pressure Regulating Valve
6. Low Oil Pressure Switch
7. Oil Pressure Gauge
8. Secondary Oil Strainer
9. Oil Metering Valve
10. Main Oil Valve, N.C.
11. Safety Oil Valve, N.C.
12. Nozzle Oil Pressure Gauge
13. Air Atomizing Oil Nozzle
14. Air Compressor
15. Air Bleed Needle Valve (If Used)
16. Compressor Dampening Tank
17. Air Check Valve
18. Low Atomizing Air Switch
19. Nozzle Air Pressure Gauge
20. Oil Shut off Valve (If Used)

Figure 27

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 4 and No. 5 Oil

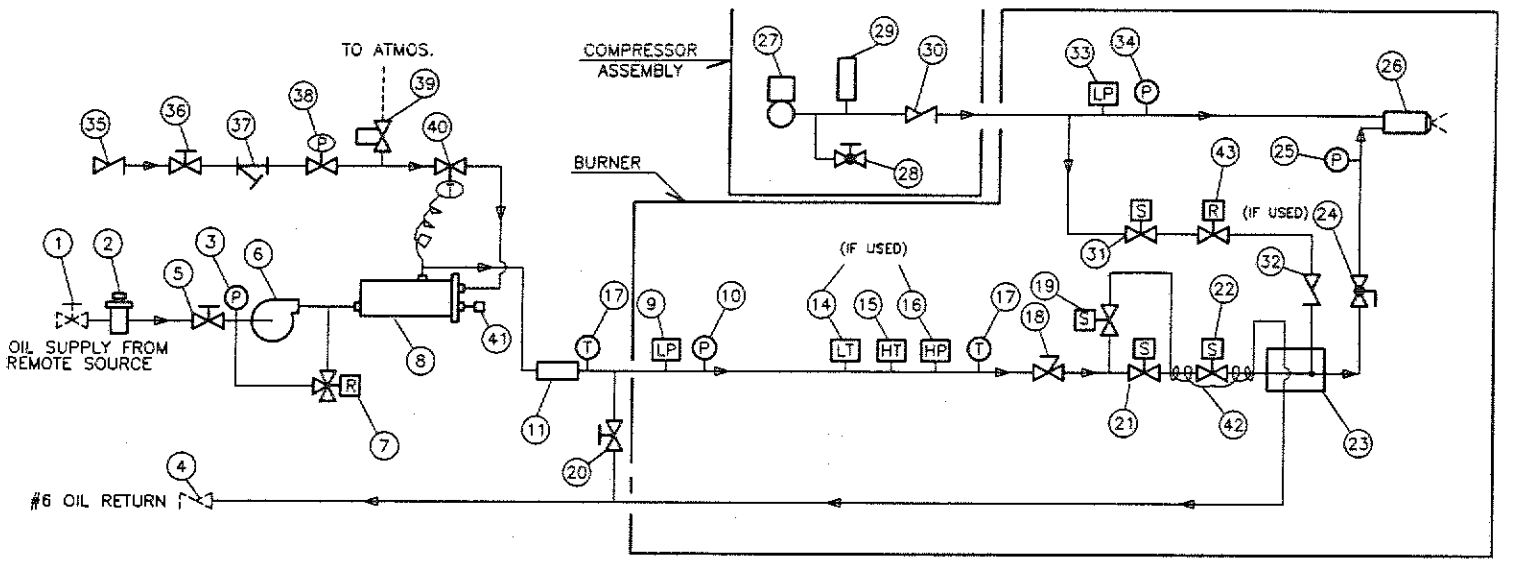


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Valve
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. 1/4" Heat Tracing Line
36. Air Purge Pressure Regulator

Figure 28

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 6 Oil - Steam Application

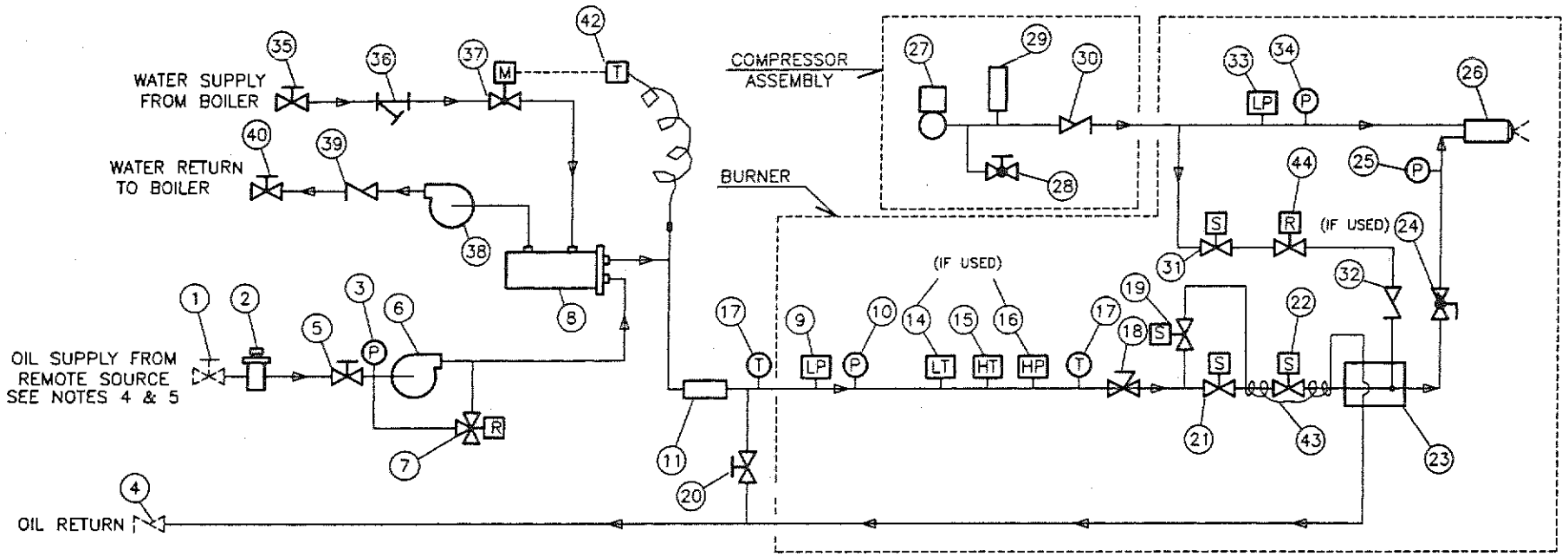


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Valve
8. Steam Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Steam Supply Check Valve
36. Steam Supply Gate Valve
37. Steam Strainer
38. Steam Press. Regulator (High Press. Boilers Only)
39. Steam Safety Relief Valve (High Press. Boilers Only)
40. Temp. Regulating Valve
41. Steam Trap
42. 1/4" Heat Tracing Line
43. Air Purge Pressure Regulator

Figure 29

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 6 Oil - Water Application

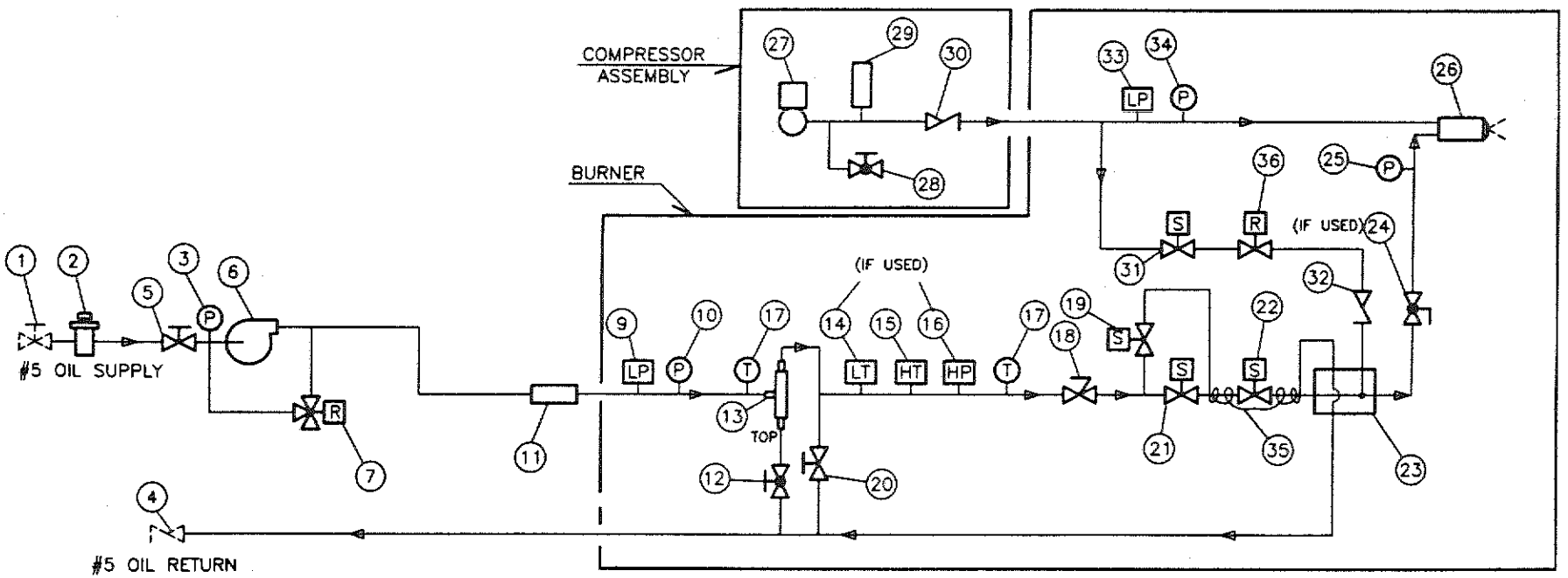


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Valve
8. Water Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Water Supply Gate Valve
36. Water Strainer
37. Temp. Regulating Valve
38. Water Circulating Pump
39. Water Return Check Valve
40. Water Return Gate Valve
41 Remote Oil Pump Set (Not Shown)
42. Temperature Controller
43. 1/4" Heat Tracing Line
44. Air Purge Pressure Regulator

Figure 30

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 5 Oil Export

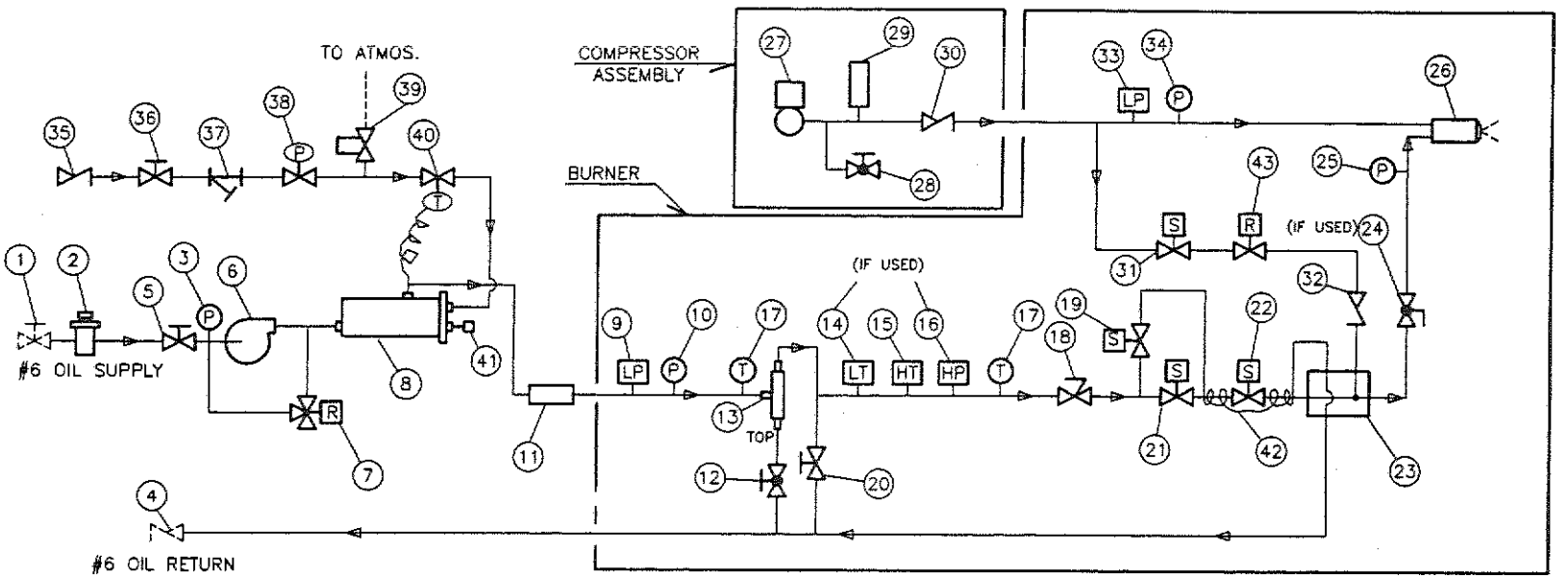


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Valve
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
12. Needle Valve
13. Vapor Separator
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. 1/4" Heat Tracing Line
36. Air Purge Pressure Regulator

Figure 31

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 6 Oil Export - Steam Application

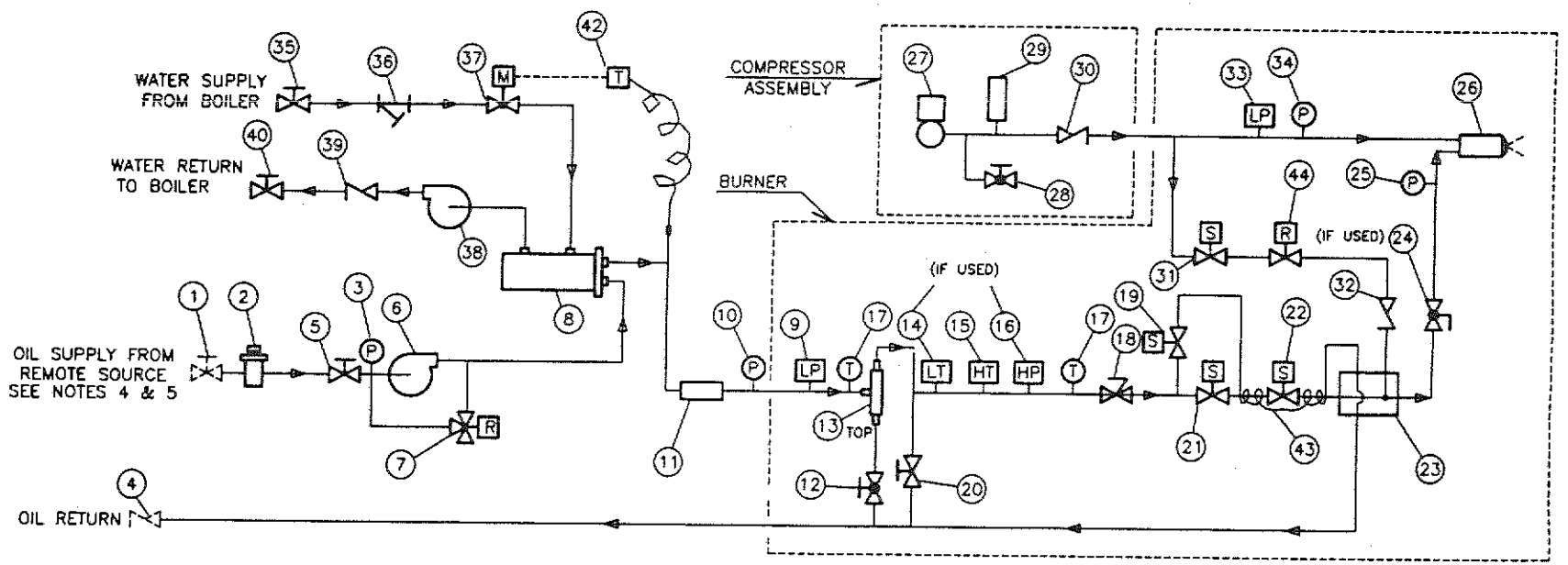


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
8. Steam Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Steam Supply Check Valve
36. Steam Supply Gate Valve
37. Steam Strainer
38 Steam Press. Regulator (High Press. Boilers Only)
39. Steam Safety Relief Valve (High Press. Boilers Only)
40. Temp. Regulating Valve
41. Steam Trap
42. 1/4" Heat Tracing Line
43. Air Purge Pressure Regulator

Figure 32

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 6 Oil Export - Water Application



1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Valve
8. Water Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Water Supply Gate Valve
36. Water Strainer
37. Temp. Regulating Valve
38. Water Circulating Pump
39. Water Return Check Valve
40. Water Return Gate Valve
41 Remote Oil Pump Set (Not Shown)
42. Temperature Controller
43. 1/4" Heat Tracing Line
44. Air Purge Pressure Regulator

Figure 33

FIRING RATE CONTROL SYSTEMS

Firing rate control systems address the need for fuel efficiency, rate control, and system cost in various ways to meet the needs of both large and small burners. The following varieties of oil system operation are offered on Kewanee PhoenX burners:

1. On-Off Firing
2. On-off with low fire start
3. High-Low with low fire start
4. Full Modulation

1. ON - OFF FIRING

This is the simplest and least expensive type of firing rate control. The burner lights off at its designed firing rate and fires continuously at that rate until the operating control turns it off. This system is used only on gas firing PHX-40 and PHX-50 burners. Its gas piping schematic is shown in Figure 34 and contains just the gas train and burner head. It has no butterfly valve.

2. ON - OFF WITH LOW FIRE START

When the main flame of a burner is ignited, the hot products of combustion expand rapidly and create a pressure pulse inside the boiler furnace. As firing rates increase with burner sizes, so does the energy released at light off. Direct spark oil ignition systems often used on small burners aggravate this problem. Their flame starts from a single spark point, and more oil is added before ignition is complete. High light off energy release rates can cause a rapid pressure rise in the furnace chamber. The pressure rise, in turn can lead to pulsations in furnace pressure which can cause a flameout. The low fire start system is designed to minimize pulsations by reducing the firing rate at light off. At light-off, rate control is taken over by a logic system that automatically reduces oil pressure to the burner nozzle and decreases the firing rate. After 10 or 15 seconds (depending on fuel type and rate) for the main flame to be ignited and stabilized, the burner goes to high fire until it is turned off. The logic system involved is simple, inexpensive and reliable. It only requires adding a pressure regulator and solenoid valve to the burner's piping schematic. They are shown in the oil piping schematic in Figure 35. Kewanee PhoenX burners only offer this system with oil fired burners using simplex pressure atomizing oil nozzles. Their 1.7 to1 turndown ratios for pressure regulating systems set the light-off fire rate. The inlet air damper remains at a setting fixed for the high fire rate of the burner. Combination gas / oil burners which use this system for their oil system have on - off gas firing systems.

3. HIGH-LOW

Fixed rate systems such as On-Off or On-Off with Low Fire Start satisfy the boiler's load demand at their high fire rates. Therefore, stand-by time for the burner, the time when it is not firing, is at its maximum, and stand-by losses are at their greatest. While these losses are not large losses, they can be minimized by decreasing the stand-by time. That means the same thing as maximizing the run time of the burner, which can be done by reducing the firing rate of the burner for part

of the time it is firing. The High-Low system does this by reducing firing rate in response to a second steam pressure or water temperature control mounted on the boiler. The burner fires at high fire until it has satisfied enough of the boiler's load demand to trip the added control. That control switches the burner to low fire. If steam pressure or water temperature continues to rise, the operating control will switch the burner off. On the other hand, if steam pressure or water temperature falls, the added control will return the burner to high fire. This system is simple, well known in the industry, and well suited for low firing rates. The pressure regulating valves used to establish its high and low fire rates are reliable and durable. Its oil piping schematic is the same as the low fire start system in Figure 35. Unlike the low fire start system, the air damper on High-Low firing systems is controlled by a two position motor that sets the air flow rate for either low fire or for high fire.

4. MODULATION

This system provides the greatest flexibility in firing rate control, but it is also more complex than the others described here. A modulating control mounted on the boiler provides an electrical control signal to a modulating motor. The mechanical controls consist of the modulating motor on the burner, Kewanee's exclusive CAMCommand to maintain fuel air ratio control, a fuel metering valve, and the linkage that ties them all together. The oil piping (see Figure 36) includes a pair of safety shutoff valves, the metering valve, and the nozzle. As with all the other systems, an operating control on the boiler signals light-off of the burner. After the main flame establishing period, a proportional modulating control sensing boiler steam pressure or water temperature signals the modulating motor to drive the burner to high fire. As the steam pressure or water temperature rises, the modulating control reduces the burner's firing rate in response to steam pressure. If steam pressure or water temperature falls, the burner's firing rate increases. If steam pressure or water temperature rises to the operating control's set point, the burner is turned off. It is our standard firing rate control system for PHX-100 and larger burners, both for control purposes and fuel economy purposes. Under 100 Horsepower the fuel economy argument begins to lose strength, and control actually becomes more reliable from pressure regulating valves (such as in the high low system) than from modulating metering valves. This system is used with all nozzle types, and all types of oil.

5. KEWANEE PHOENX CAMCOMMAND

Early modulating burners used jackshaft linkages to match the opening of the air damper to the opening of the oil metering valve and gas butterfly valve. The problem with that was that it was difficult to adjust the linkage to keep an acceptable fuel air ratio through out the modulating range. As burner designs progressed, and customers demanded better and better performance from them, characterizing cams were designed to allow trimming fuel delivery to match air flow at several points in the modulating range. CAMCommand is Kewanee's answer to that need.

Figure 37 shows the operating mechanism of CAMCommand, and describes step by step how it works.

There are two important points to remember about how CAMCommand works.

A. When all the adjusting screws are set to the same height from the frame, the output of the cam is just the same as if you were using jackshaft linkage control. That is your best starting point if you are repairing a system that has been completely taken out of adjustment. Get the jackshaft linkages working at their best, and CAMCommand makes the rest easy. Figures 38, 39, 40, 41, 42, and 43 show the nominal setting you'll need as a starting point.

B. The follower wheel in CAMCommand needs to follow a smooth curve in the flexible strip. Adjusting the trim screws so that there is a step between adjacent screws creates a problem that you don't want, and can even lock CAMCommand so that it can't turn.

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GAS TRAIN

On-Off
UL and FM - (0 to 2,500,000 BTU)
10 to 50 HP

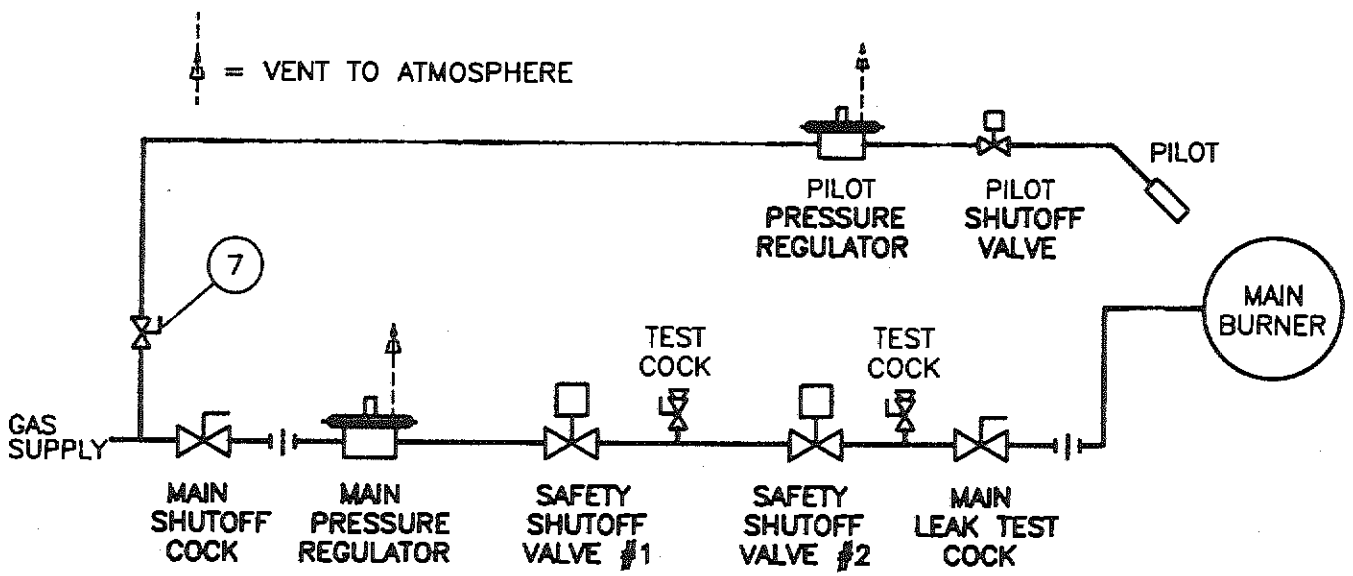
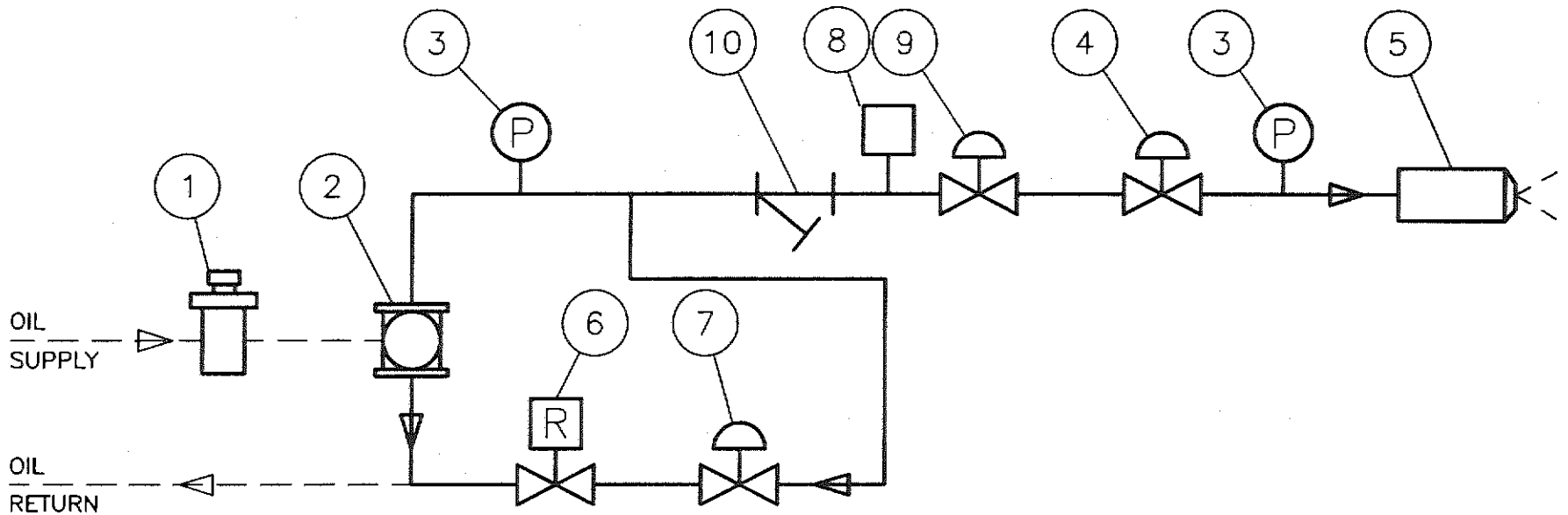


Figure 34

SIMPLEX NOZZLE SYSTEM

High-Low or On-Off with Low Fire Start
Pressure Atomized No. 2 Oil



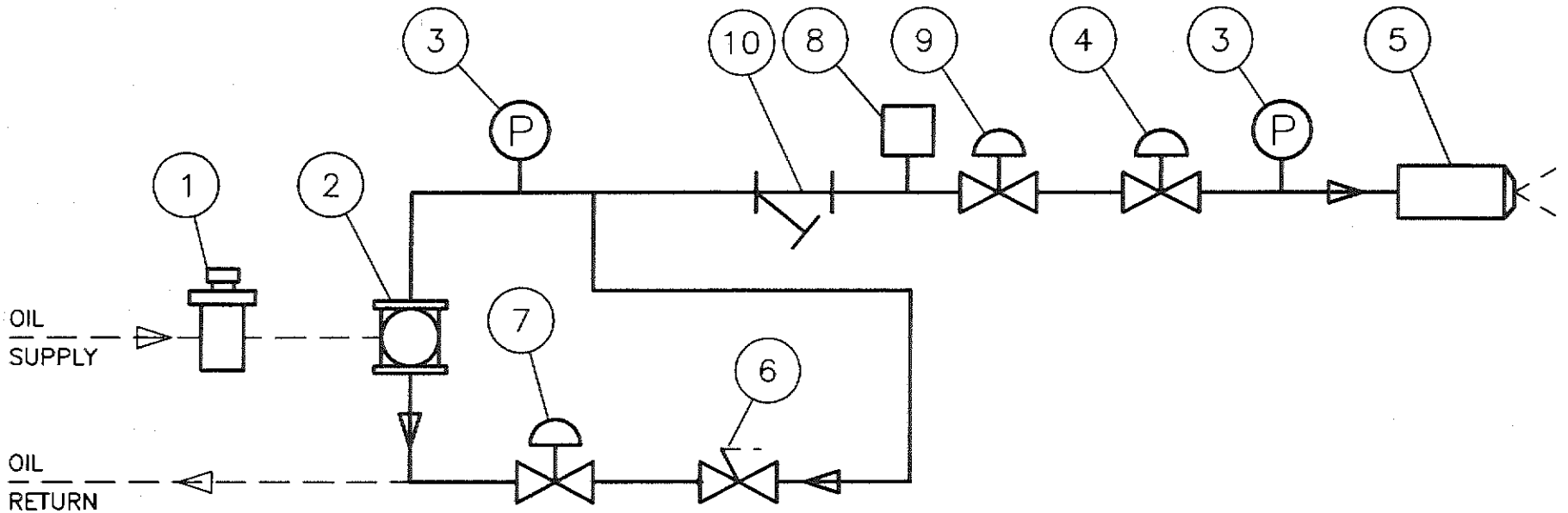
*NOTE: Pump discharge line is piped from pump's gauge port to avoid hydraulic interference between low fire regulator (6) and pump's internal low pressure cut-off.

1. Oil Filter (s)
2. Oil Pump
3. Pressure Gauge(s)
4. Main Oil Valve
5. Oil Nozzle(s)
6. Pressure Regulator
7. By-Pass Oil Valve
8. Low Oil Pressure Interlock
9. Safety Oil Valve
10. Strainer

Figure 35

SIMPLEX NOZZLE SYSTEM

Modulation
Pressure Atomized No. 2 Oil



1. Oil Filter (s)
2. Oil Pump
3. Pressure Gauge(s)
4. Main Oil Valve
5. Oil Nozzle(s)
6. Pressure Regulator
7. By-Pass Oil Valve
8. Low Oil Pressure Interlock
9. Safety Oil Valve
10. Strainer

Figure 36

KEWANEE CAMCOMMAND

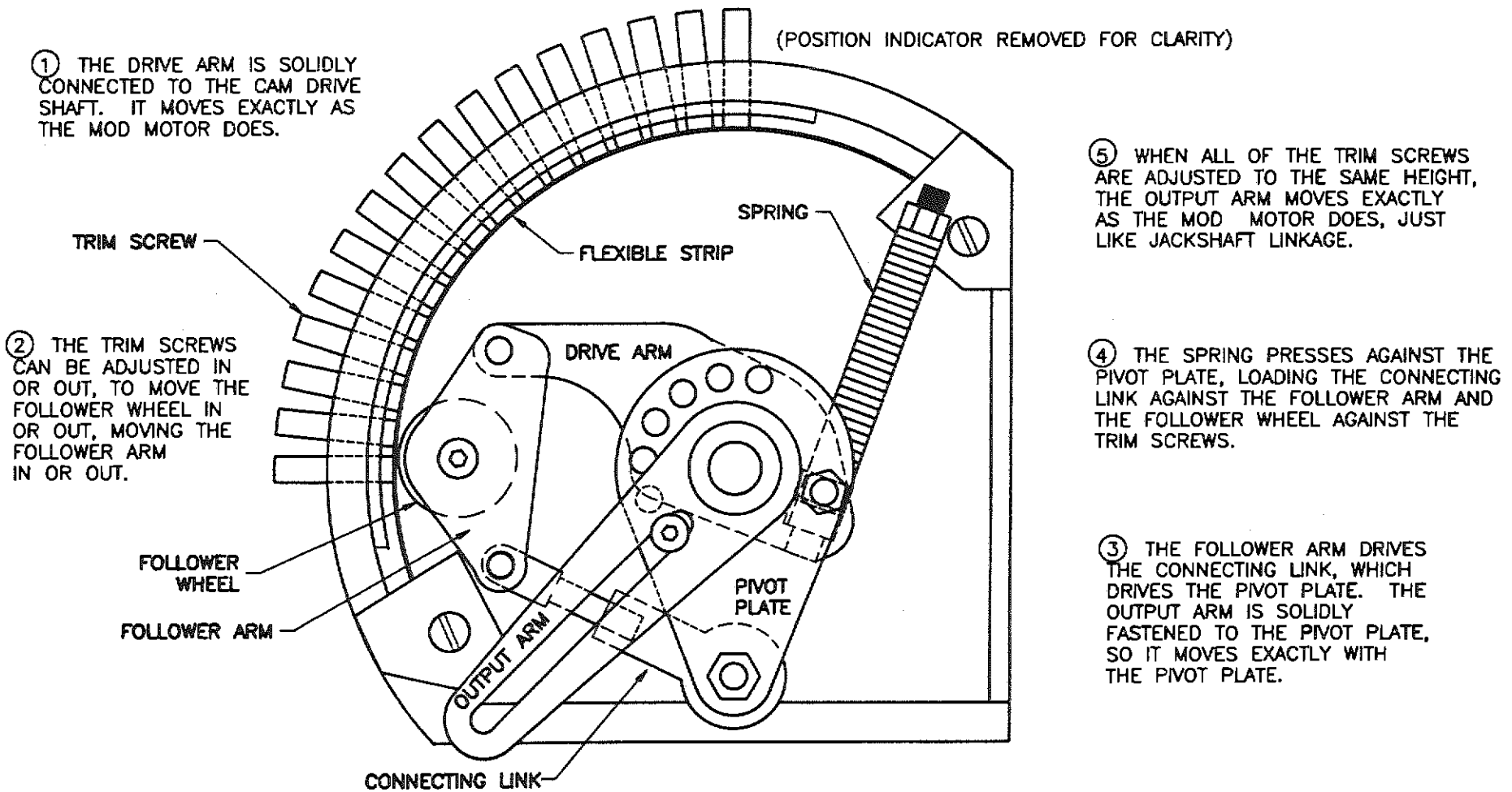
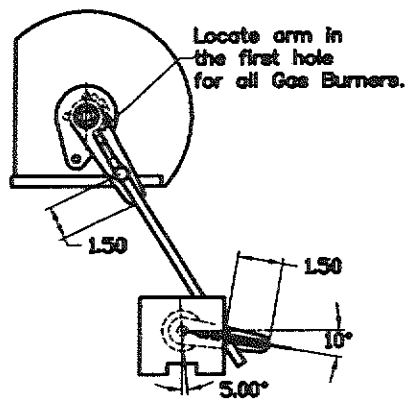


Figure 37

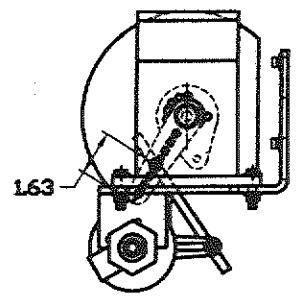
KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-40 and PHX-50 Burners

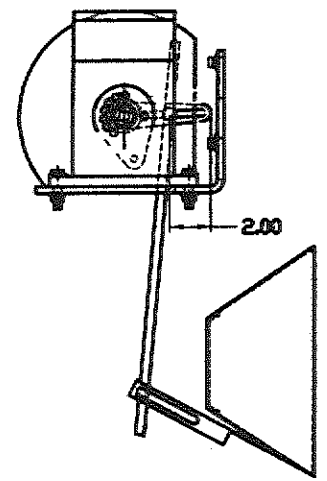
GAS
MODULATION



PRESSURE ATOMIZED OIL
MODULATION



AIR
MODULATION



AIR
ON-OFF

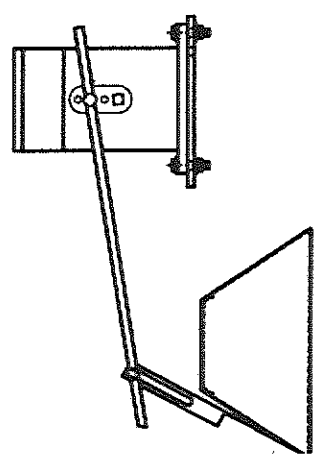
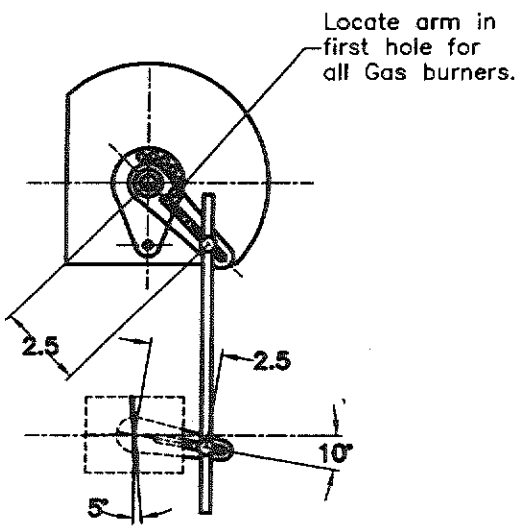


Figure 38

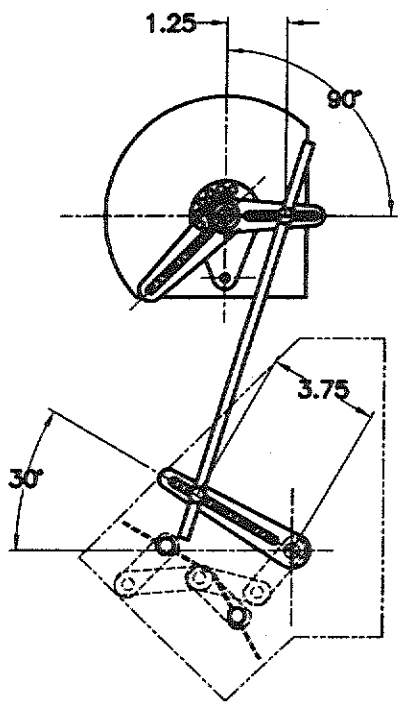
KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-60 and PHX-80 Burners

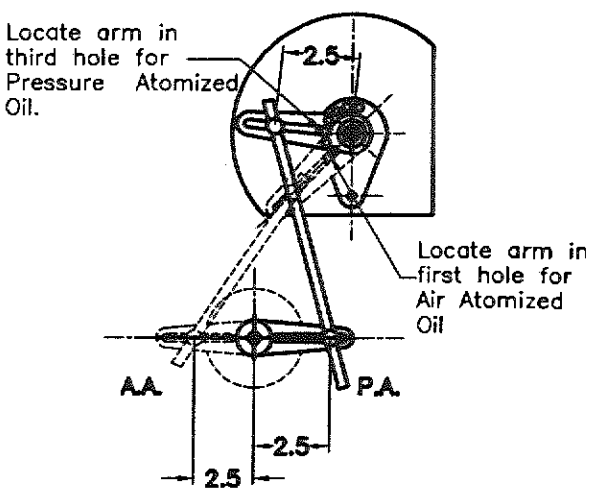
GAS



AIR



OIL

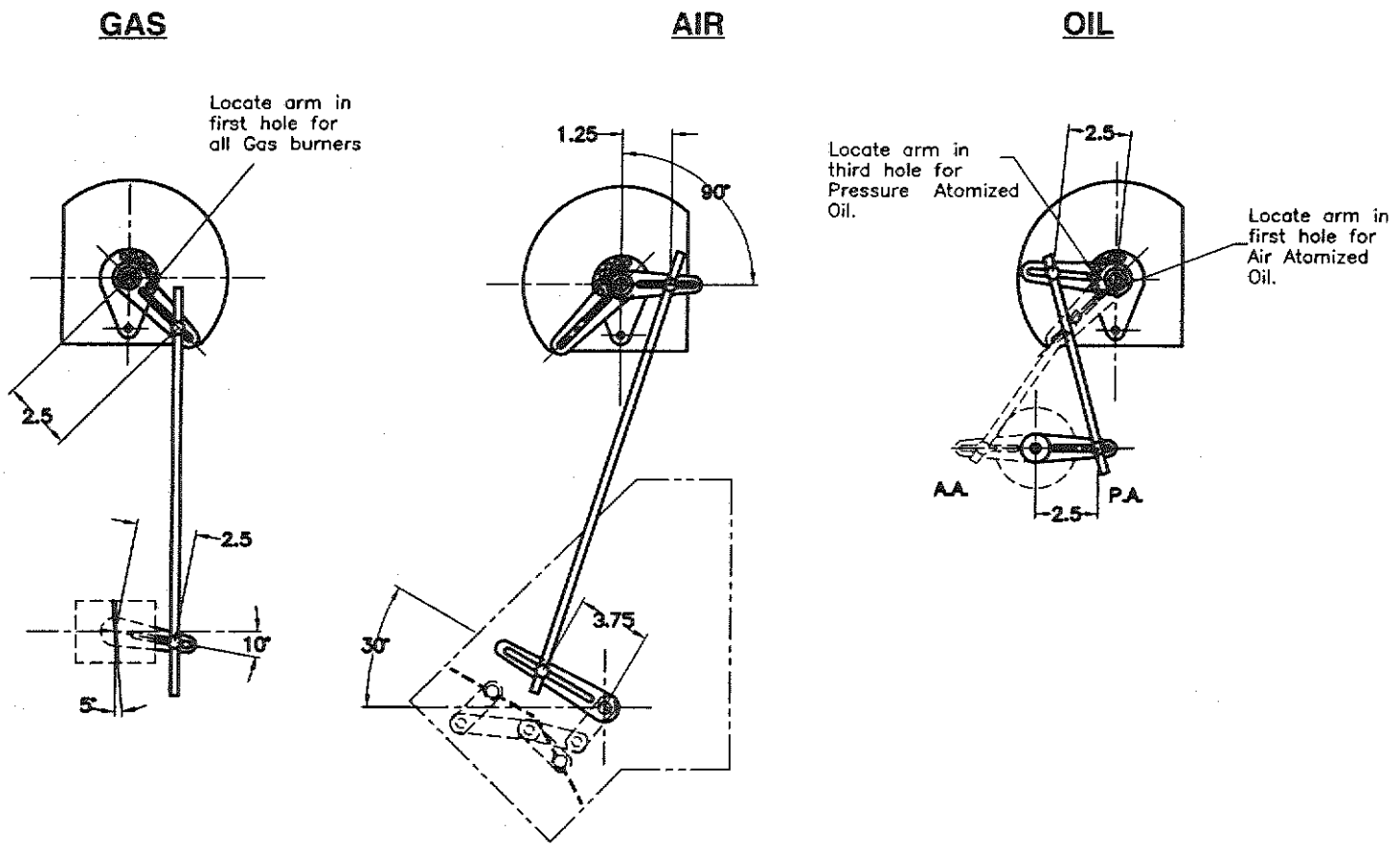


NOTE: on "Oil" drawing above, A.A. represents Air Atomized and P.A. represents Pressure Atomized

Figure 39

KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-100 and PHX-125 Burners

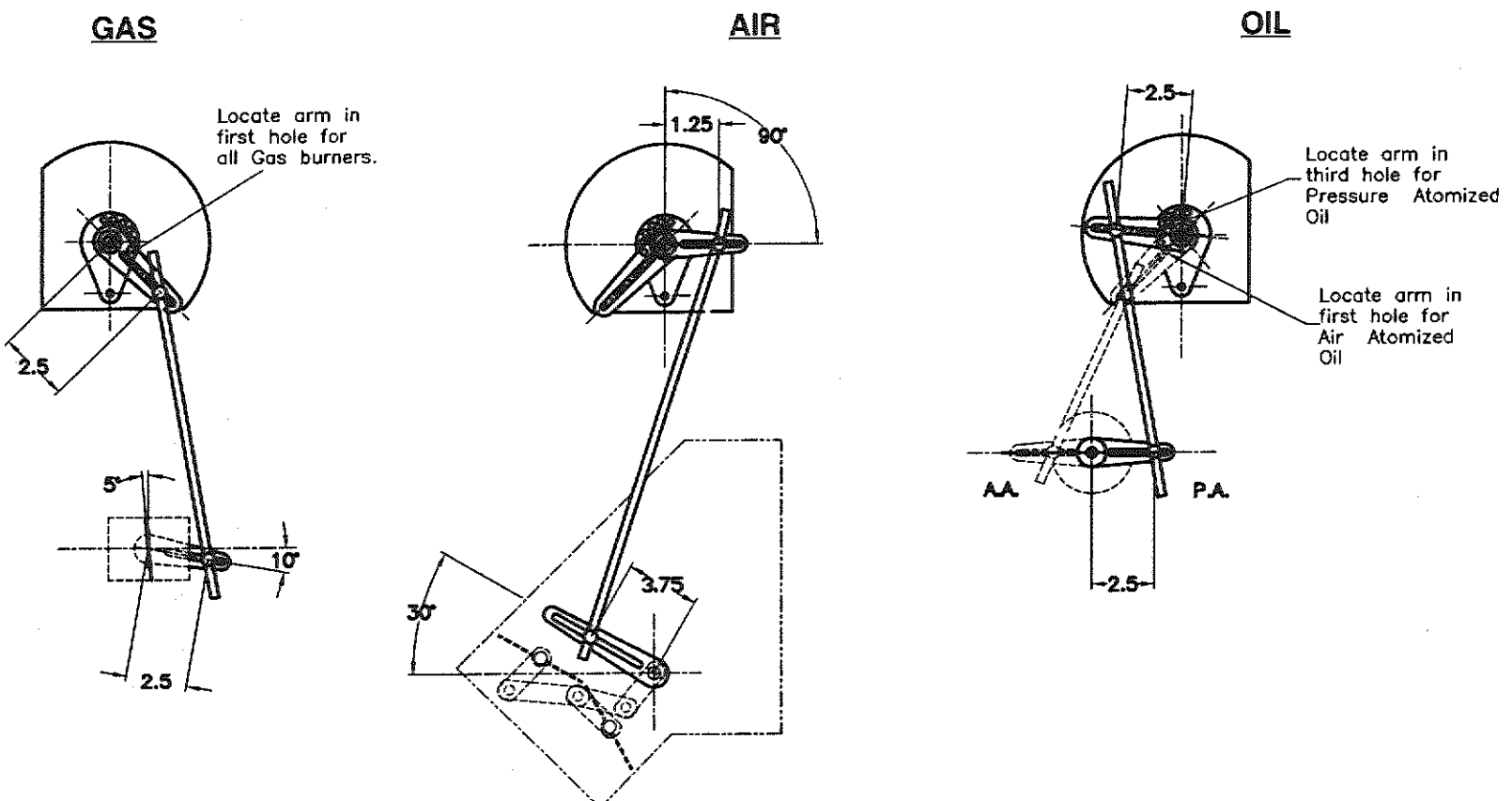


NOTE: on "Oil" drawing above, A.A. represents Air Atomized and P.A. represents Pressure Atomized

Figure 40

KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-150 and PHX-250 Burners



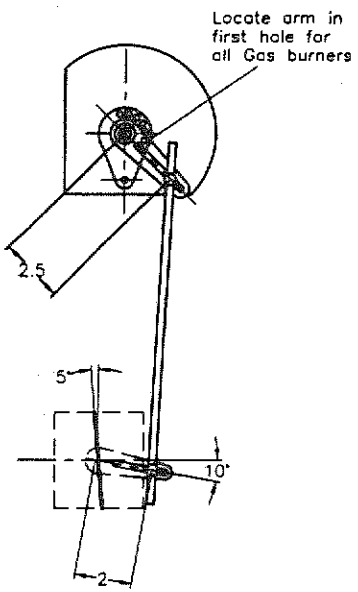
NOTE: on "Oil" drawing above, A.A. represents Air Atomized and P.A. represents Pressure Atomized

Figure 41

KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-300 and PHX-500 Burners

GAS



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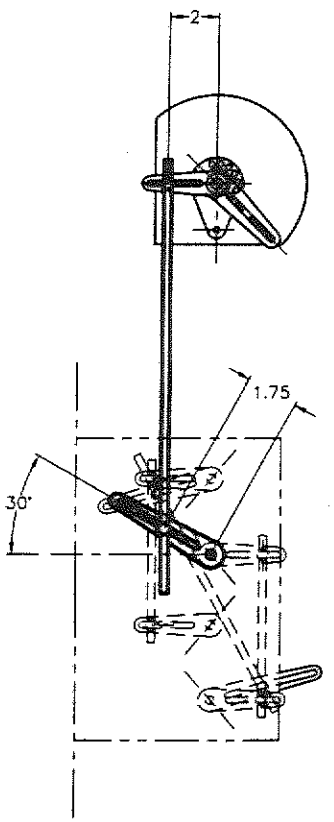
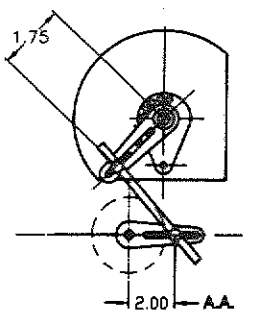


OIL



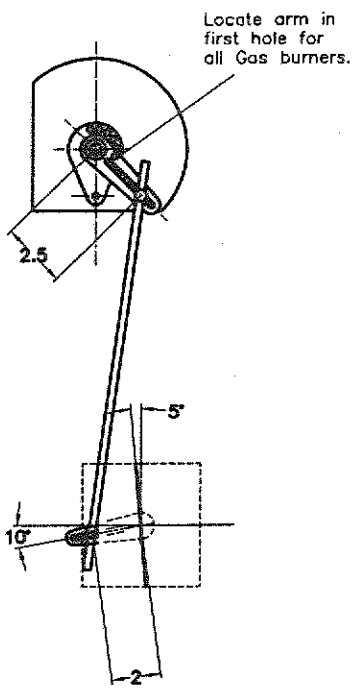
NOTE: on "Oil" drawing above, A.A. represents Air Atomized

Figure 42

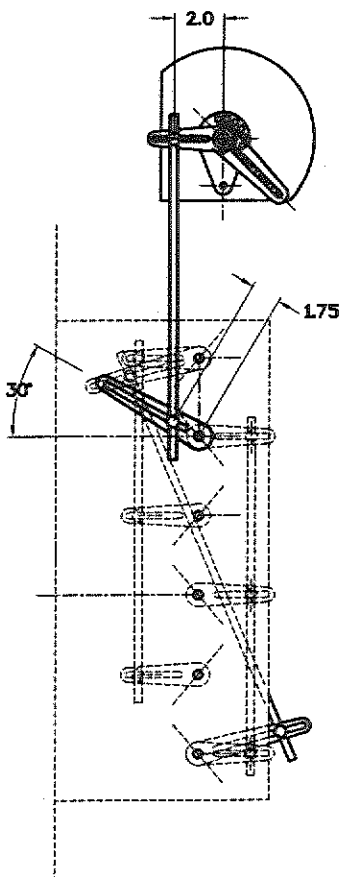
KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-600 and PHX-800 Burners

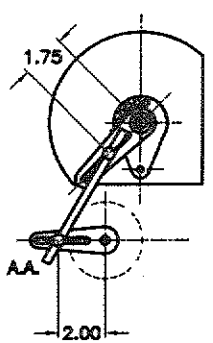
GAS



AIR



OIL



NOTE: on "Oil" drawing above, A.A. represents Air Atomized

Figure 43

IGNITION SYSTEMS - GAS PILOTS

All sizes of the PhoenX burners use the same gas pilot assembly. Its construction details are shown in Figure 44. The pilot is of the two stage design. That means that there are actually two combustion zones created by this pilot. The first is inside the body of the pilot. Gas from the orifice inside the pilot mixes with air and is ignited by a spark generated by the electrode. The fuel air mixture at the electrode is a normal mixture, rich enough for reliable ignition, but lean enough to avoid carbon filament formation. At the open end of the pilot there is a second gas orifice. It injects additional gas into the flame, creating a second flame stage which is very rich. This rich mixture is required to create a pilot flame that can survive in the very turbulent air flow just downstream of the diffuser.

It is not necessary to frequently clean this pilot. If it is removed for inspection, we recommend that the pilot be removed as a unit from the diffuser, leaving the electrode installed in the pilot. Installation of the electrodes in the pilot body requires a light touch. A man with too strong a hand can easily break the electrode by over tightening the gland assembly.

There are only three adjustments for this pilot:

1. The Electrode Gap should always be set to the indicated 1/8". Use of a feeler gauge or the smooth end of a drill bit is recommended for setting the gap.

2. The Air Intake Opening should be set as required for the burner size. Larger burners with greater turndown ratios have less air pressure drop across their diffusers at low fire. It is this pressure drop which provides air through the pilot. Consequently we use larger air intake openings on the bigger burners.

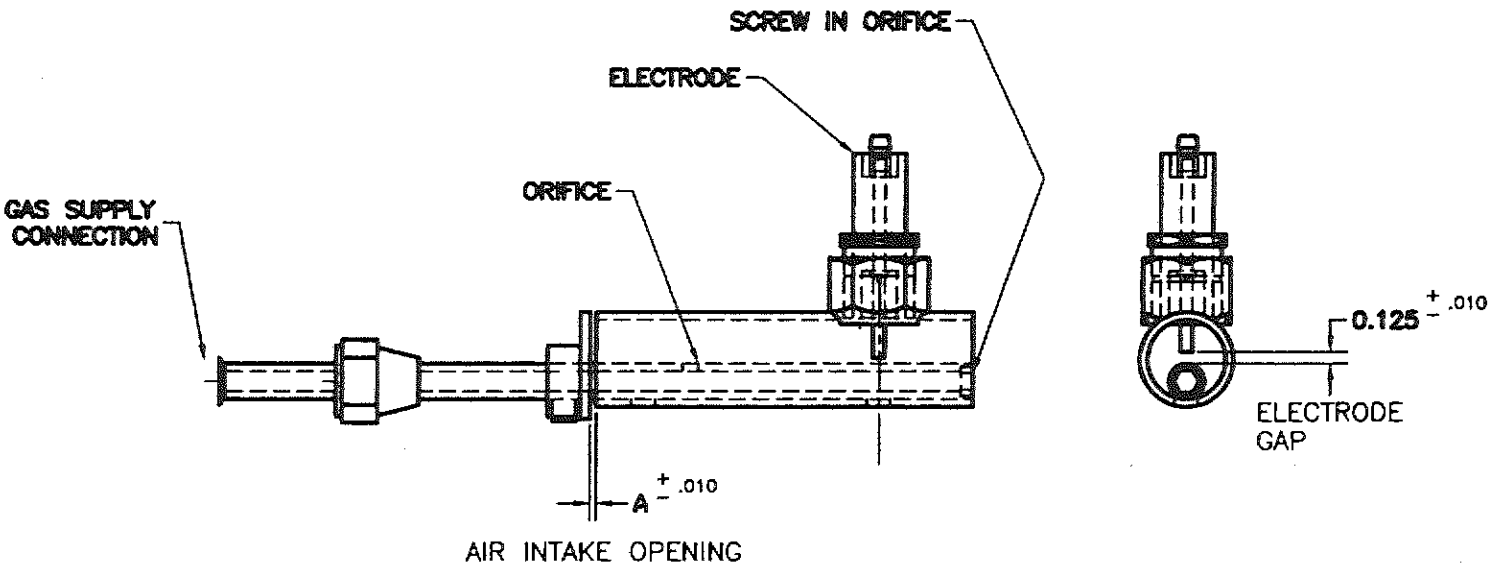
3. Gas Supply Pressure to the pilot should be set to provide appropriate fuel air ratios.

The pilot box on the diffuser allows only the flow through the pilot to go through the vane to which it is attached. This design creates a protected zone for the pilot flame, making it more reliable in service.

The electrical controls of the burner sequence the pilot on only to provide ignition to light the main flame, and then turn it off again. This sequencing is known as "Interrupted Ignition", and is the only pilot sequencing scheme used by Kewanee. Interrupted Ignition provides a higher level of flame sensing security than "Intermittent Ignition" or "Continuous Ignition" systems since the pilot is turned off during the main flame firing interval and thus can not provide a flame signal that would be interpreted as being the main flame signal.

Burners equipped with gas pilots should periodically be tested for ignition spark signal rejection and pilot turndown. Consult the flame safeguard manual provided with your burner's controls for details on how to conduct these tests.

GAS PILOT SETTINGS



DIMENSION A	BURNER SIZE
.063	PHX–40 Through PHX–400
.093	PHX–500 Through PHX–800

Figure 44

IGNITION SYSTEMS - DIRECT SPARK

Direct spark ignition is available only for No. 2 oil firing on PHX-40 through PHX-125 burners. Figures 45, 46, and 47 provide the details of this design. A 10,000 Volt ignition transformer provides spark to the electrodes. The electrodes are mounted to the center spinner of the oil gun assembly. Adjustment dimensions are provided on the referenced figures. Those dimensions should be maintained within about 1/32".

When adjusting the electrodes, care must be taken to avoid bending them outside of the specified settings. In particular, the exposed surface of the electrode wires must not be allowed to be within ¼" of grounded metal parts other than the oil nozzles.

You can see from the referenced figures that properly adjusted electrodes keep their tips outside of the spray pattern of the oil nozzles. This prevents oil accumulation on the electrodes. Air flow through the burner's diffuser carries the spark away from the electrodes creating a "horse shoe" shaped spark pattern. Since the air flow is directed into the oil spray pattern, it carries the spark there.

You can also see in the referenced figures that the tips of the electrodes are designed to drain any oil that might get on them away from their insulators. For some of the electrodes that means that the tips slope downward to their point. For others it means that there is a drip loop behind the point of the electrode. Maintain Kewanee's standard placement of the electrodes as shown in the referenced figures so that these design rules are not violated.

Direct spark can be used in conjunction with gas pilots. Some customers require that the oil fire not rely on gas for its ignition source, so direct spark must be provided for oil firing. Direct spark ignition of gas fires, although legal if properly proven, is so risky that we do not offer it, so gas pilots are required for gas firing. Fortunately, direct spark ignition and gas pilots do not conflict with each other for diffuser mounting space. Control system logic selects the appropriate ignition system for the fuel being fired.

Direct spark ignition systems used in conjunction with ultraviolet flame sensing should periodically be tested for ignition spark signal rejection. Consult the flame safeguard manual provided with the burner's controls for details on how to conduct this test.

DIRECT SPARK IGNITION SETTINGS

PHX-40 and PHX-50 Burners

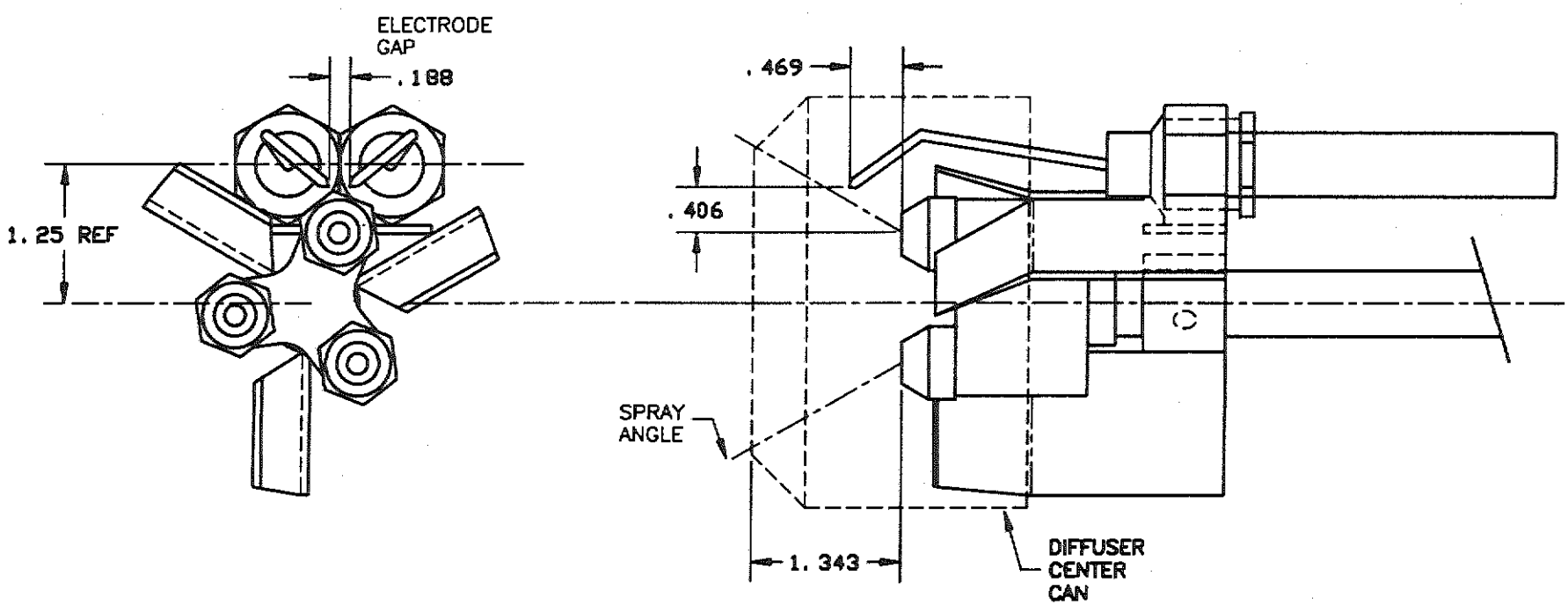


Figure 45

DIRECT SPARK IGNITION SETTINGS

PHX-60 and PHX-80 Burners

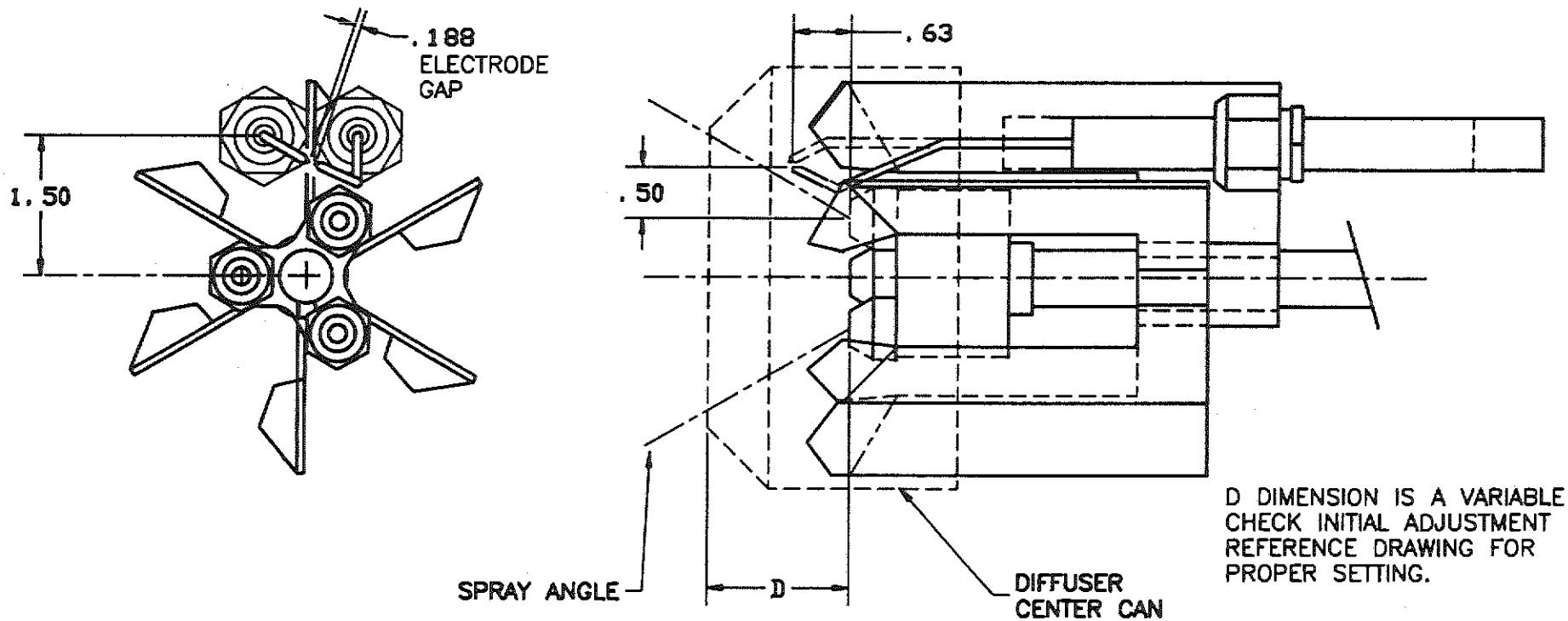


Figure 46

DIRECT SPARK IGNITION SETTINGS

PHX-100 and PHX-125 Burners

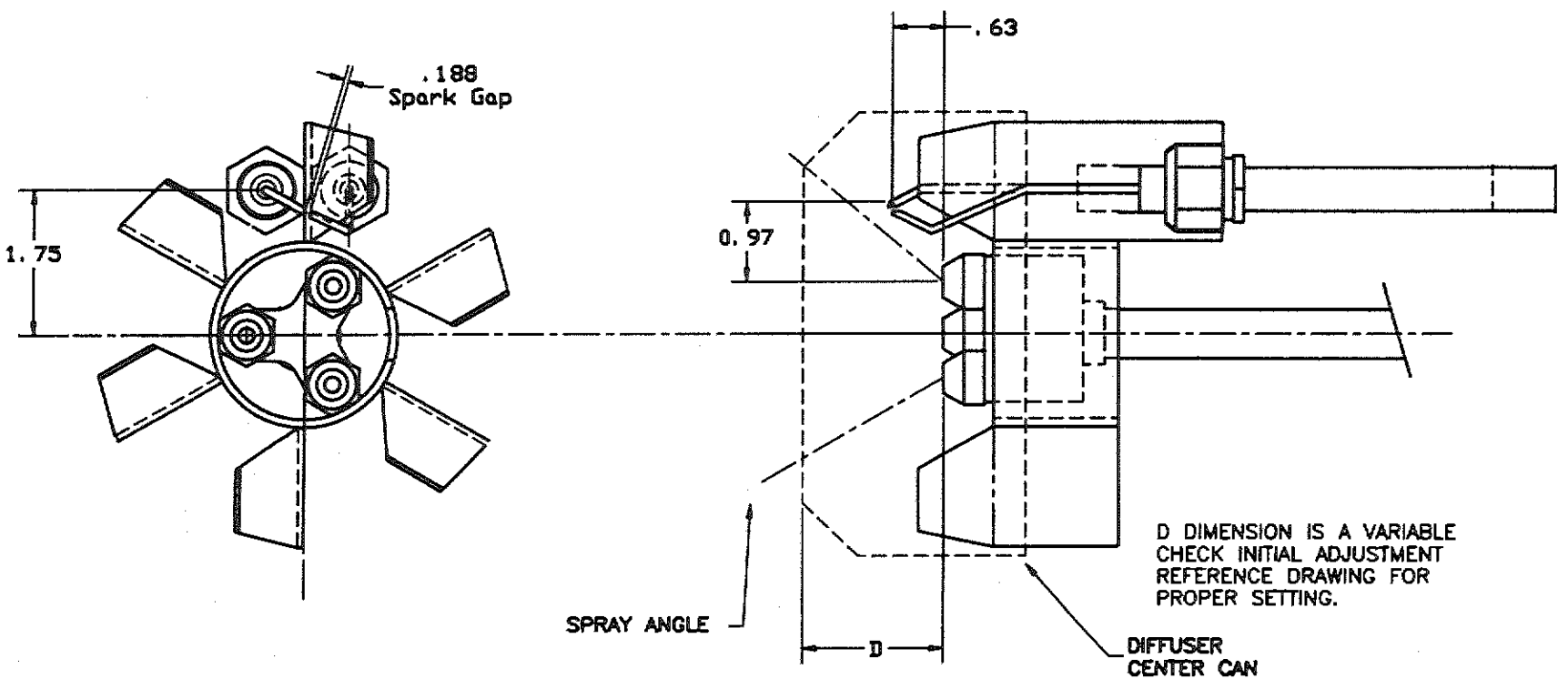


Figure 47

IGNITION SYSTEMS - OIL PILOTS

The PHX-150 through PHX-800 burners fire at rates high enough to require proven pilot ignition. Burners in this range designed for firing only oil fuels can use an oil pilot for their ignition source. Figures 48 and 49 show the design details for the oil pilots offered for PHX-150 through PHX-250 and PHX-300 through PHX-800 burners respectively. Although the oil pilot construction details vary between the two groups of burners, operating principles and requirements are the same.

1. Only No. 2 fuel oil may be used as the fuel for oil pilots. Heavier oils are not acceptable for the pilot, so if a heavier oil is being fired in the main flame, a separate fuel supply is required for the pilot.

2. A minimum oil pressure to the pilot nozzle of 100 PSI is required for reliable performance. This means that if an air atomizing No. 2 oil burner requires an oil pilot, an auxiliary oil pump must be provided if the main pump operates at less than 100 PSI.

Figures 48 and 49 show the adjustment details for oil pilots. These pilots work much the same as the main flames of small burners.

The principles explained in this manual's sections on direct spark ignition apply to the ignition of these pilots, and the principles on simplex nozzles explain their nozzle operation.

Oil pilots use the same mounting location on the diffuser as do gas pilots. Consequently either a gas pilot or an oil pilot must be selected for a burner. We can not offer the two in combination.

Oil pilots must pass the same listing tests for ignition spark signal rejection and pilot turndown as do gas pilots. Those tests are appropriate as periodic installation inspection tests. . Consult the flame safeguard manual provided with your burner's controls for details on how to conduct these tests.

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OIL PILOT SETTINGS

PHX-150 and PHX-250 Burners

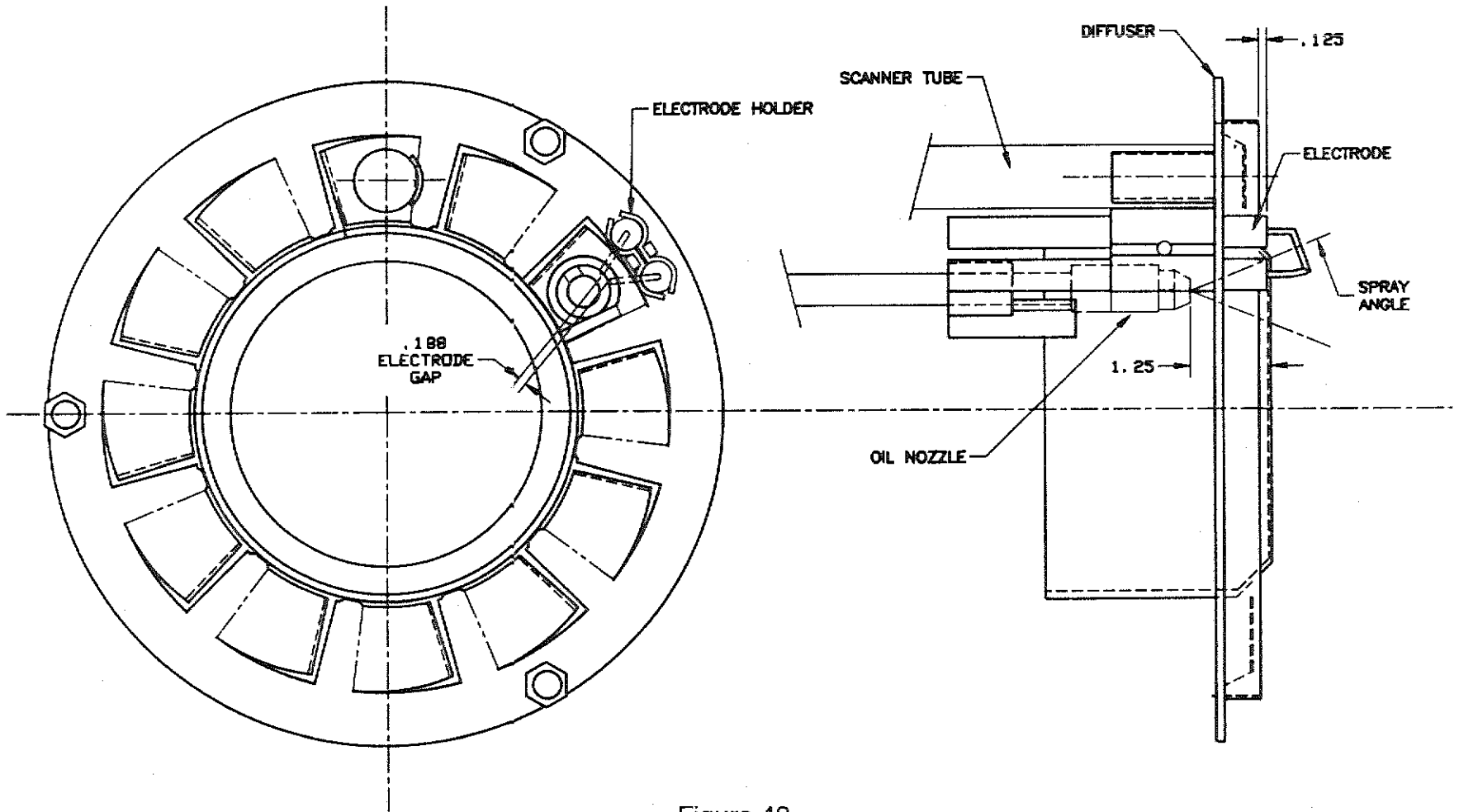

Figure 48

OIL PILOT SETTINGS

PHX-300 and PHX-800 Burners

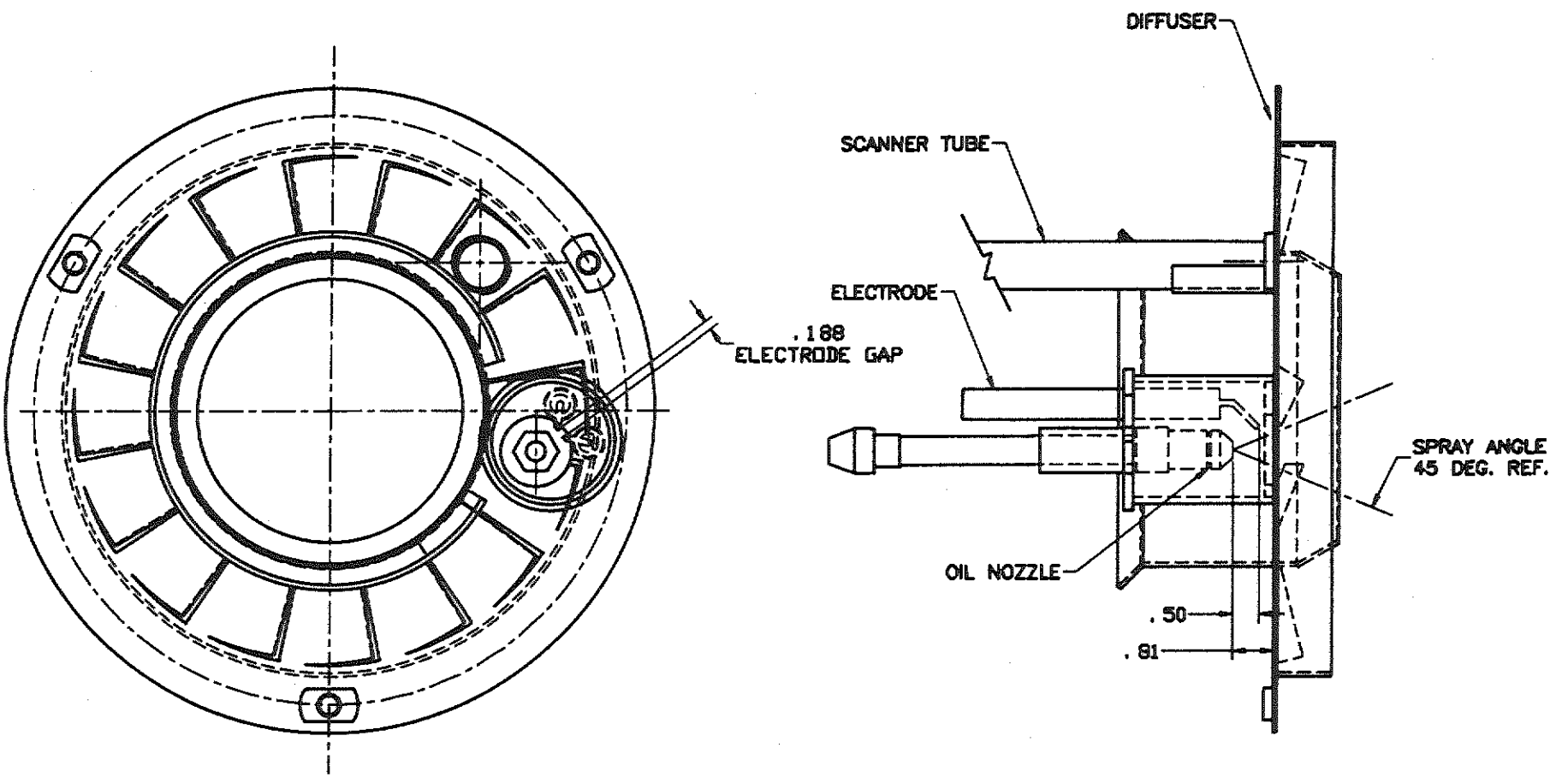

Figure 49

BURNER MOUNTING REFRACTORIES

1. GAS AND LIGHT OIL APPLICATIONS

PhoenX burners use their refractories for more than just an adapter to the boiler's furnace. Figure 50 shows a typical gas and light oil refractory design. The burner head is fastened to the refractory with clamps held in place by studs welded to the refractory's mounting plate. One or two Cerafelt insulating gaskets (depending on burner model) protect the burner head from the heat of the refractory. For some models, the head is centered on the refractory by two steel centering blocks welded to the refractory mounting plate. The refractory is mounted to the boiler's furnace by mounting studs on the furnace, and the joint is sealed by a Fiberglas rope gasket.

PhoenX burners have been designed to use the refractory as a part of their combustion systems. Heat radiated into the base of the flame from the refractory helps retain and stabilize the flame. The inner surface of the refractory is cone shaped, providing for the expansion of the flame as it enters the furnace. Only refractories conforming to Kewanee's standards should be used for mounting PhoenX burners.

2. HEAVY OIL APPLICATIONS

Figure 51 shows a typical refractory mounting for PhoenX burners designed to fire No.'s 4, 5 or 6 oil. The refractory adapter itself is identical to the gas and light oil refractories,

but extension tiles have been added. These extension tiles provide increased amounts of heat radiation into the base of the flame to improve vaporization of the heavy oils. They are mandatory for heavy oil firing PhoenX burners. Design details vary from one application of these tiles to another. Some are mortared together taking advantage of the keystone shape of each tile for retention in the furnace. Others have tongue and groove joints interlocking the tiles together, with or without mortar. All designs use brackets welded to the inner surface of the furnace to prevent migration of the tiles into the furnace due to heating and cooling expansion and contraction.

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BURNER MOUNTING REFRACTORY

Gas and Light Oil

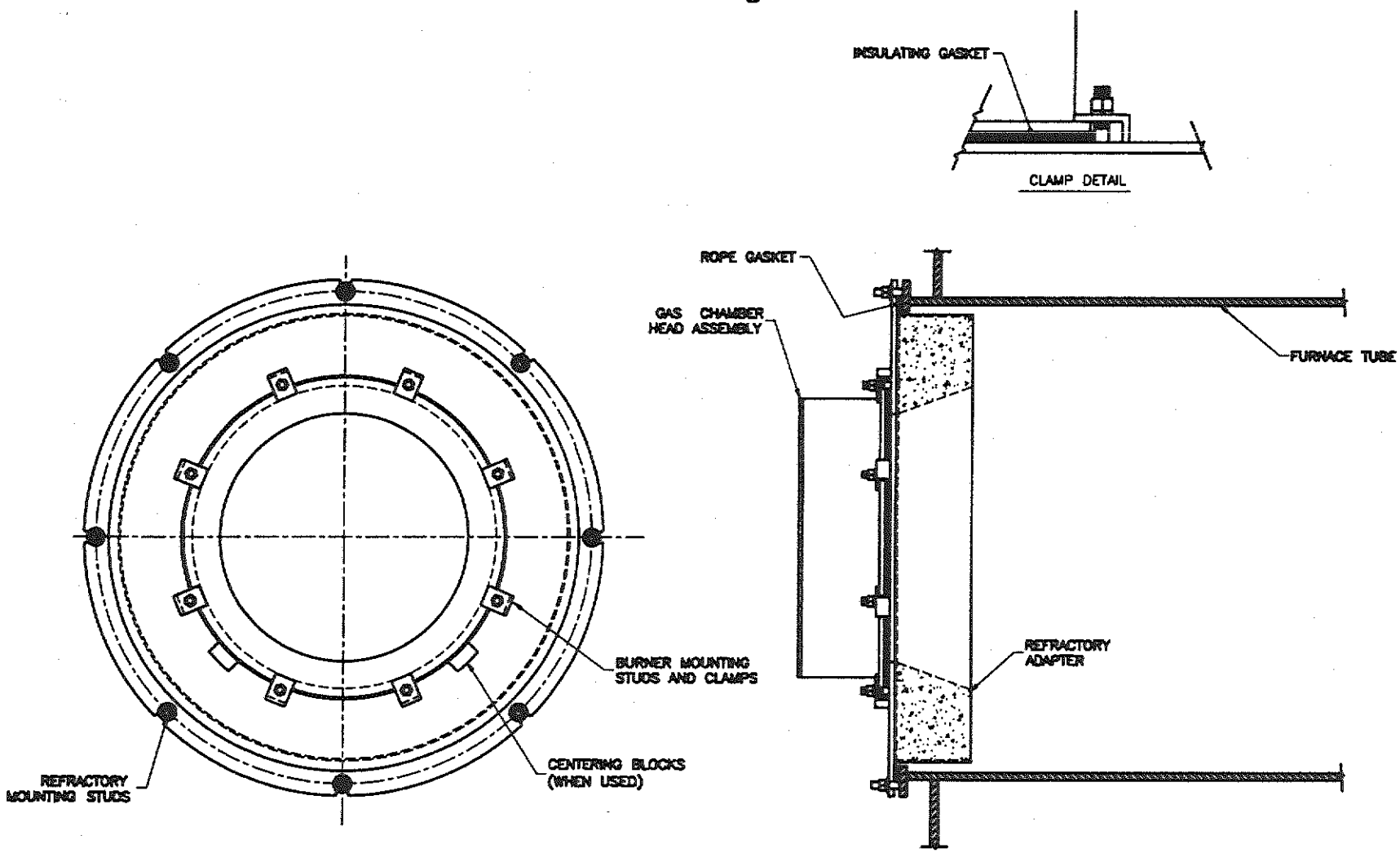

Figure 50

BURNER MOUNTING REFRACTORY

Heavy Oil Extension Blocks

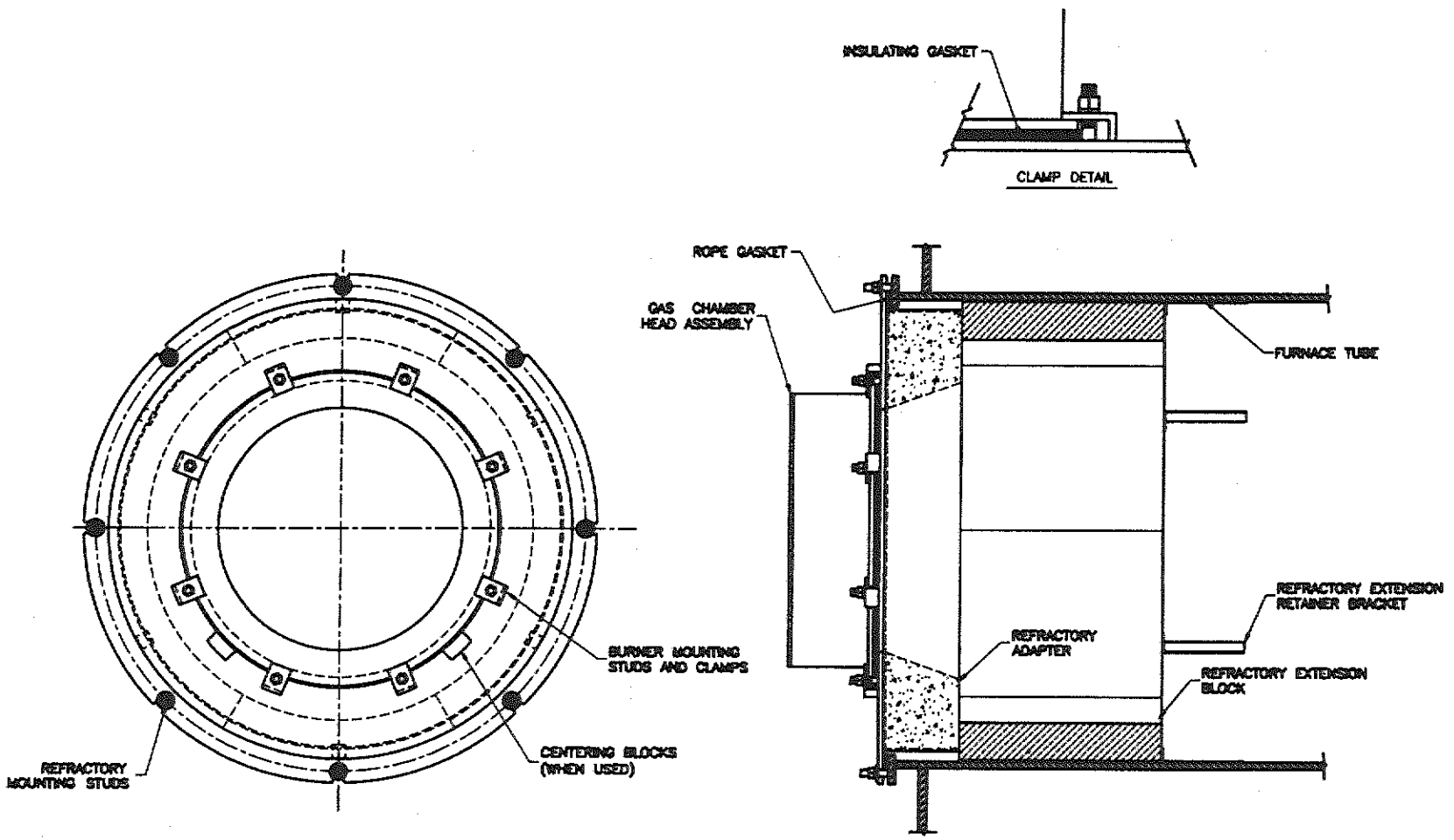

Figure 51

Section 3

INSTALLATION PROCEDURES

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

1. UNPACKING UNIT

The burner is a self-contained unit, but its gas train, refractory and air atomizing oil package, where used, are crated separately for ease of handling when shipped as a retrofit burner. When the unit is received, shipping cartons should be examined for external damage. Care should be taken while uncrating the packages to avoid damaginggauges and control valves. On package units, removal of protective covers is necessary to inspect units.

2. INSPECTING UNIT

When the unit is uncrated, check the burner control cabinet, controls, gauges and any instruments that may be damaged in transit. Check the shipment against packing list and acknowledgment of original order. Any claims for damages or shortages should be filed immediately with the carrier by the installer.

3. BURNER MOUNTING DETAILS

A. Refractory Extension Tiles (Used on all No. 4, 5 and 6 Oil Burners) - Heavy oil burners for No. 4, 5 and 6 oils require extension tiles lining the first portion of the furnace beyond the burner mounting refractory (See Figure 52). These tiles reflect the flame's heat into the atomized oil spray to improve vaporization of the oil. Steel tabs are welded to the boiler's furnace wall to secure the tiles against migration into the furnace (ASME Code welding is required). Refractory mortar is required between the tiles, and between the tiles and burner mounting refractory. Consult the burner mounting detail drawing supplied with the refractory for specific installation details.

B. Burner Mounting Refractory All PhoenX burners require the use of a burner mounting refractory meeting Kewanee's design specifications. Before mounting this refractory on the boiler, attach the fiberglass rope gasket around the burner mounting refractory's outer band. Mount the refractory in place on the boiler being careful to maintain the fiberglass rope in position, and firmly tighten the nuts of the mounting studs to achieve a rigid installation.

C. Burner Attach the Cerafelt gasket(s) to the face of the burner (two may be required depending on burner model). Mount the burner to the burner mounting refractory using the threaded studs on the face of the refractory. If alignment blocks are provided on the refractory mounting adapter, the burner's gas ring flange should set down onto both blocks. If alignment

blocks are not provided, remove the burner's drawer assembly and examine the alignment of the burner head to the burner mounting refractory. Proper alignment will provide a small concentric step all the way around the head. Level the burner using the top of the burner's electrical cabinet as your reference surface. Tighten the clamping nuts firmly to achieve a rigid installation. Support the larger burners to the boiler room floor or housekeeping pad by use of a pipe attached to the threaded coupling on the bottom of the blower housing (PHX-60 through PHX-250) or braces attached to the bottom flanges of the blower housing (PHX-300 through PHX-800).

D. Gas Train Attach the gas train to the burner connection union, supporting it as necessary from the floor or boiler skid. Connect it to the gas supply. For general information regarding gas train configurations see Section 13. For specifics about your particular gas train consult the submittal drawings provided for your order.

E. Piping for Propane Pilots Propane pilots are often used for oil fired burners where a gas pilot is desired and natural gas is unavailable, or for burners firing a low BTU gas which would not support a reliable pilot. The conventional propane supply for these pilots is provided by a remote supply tank fitted with a regulator set for 11" W.C. Aluminum tubing of 3/8" O.D. is adequate for supply piping to the burner if the distance involved does not exceed 20 Ft. For longer distances Kewanee recommends 1/2" iron pipe.

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BURNER MOUNTING REFRACTORY

Heavy Oil Extension Blocks

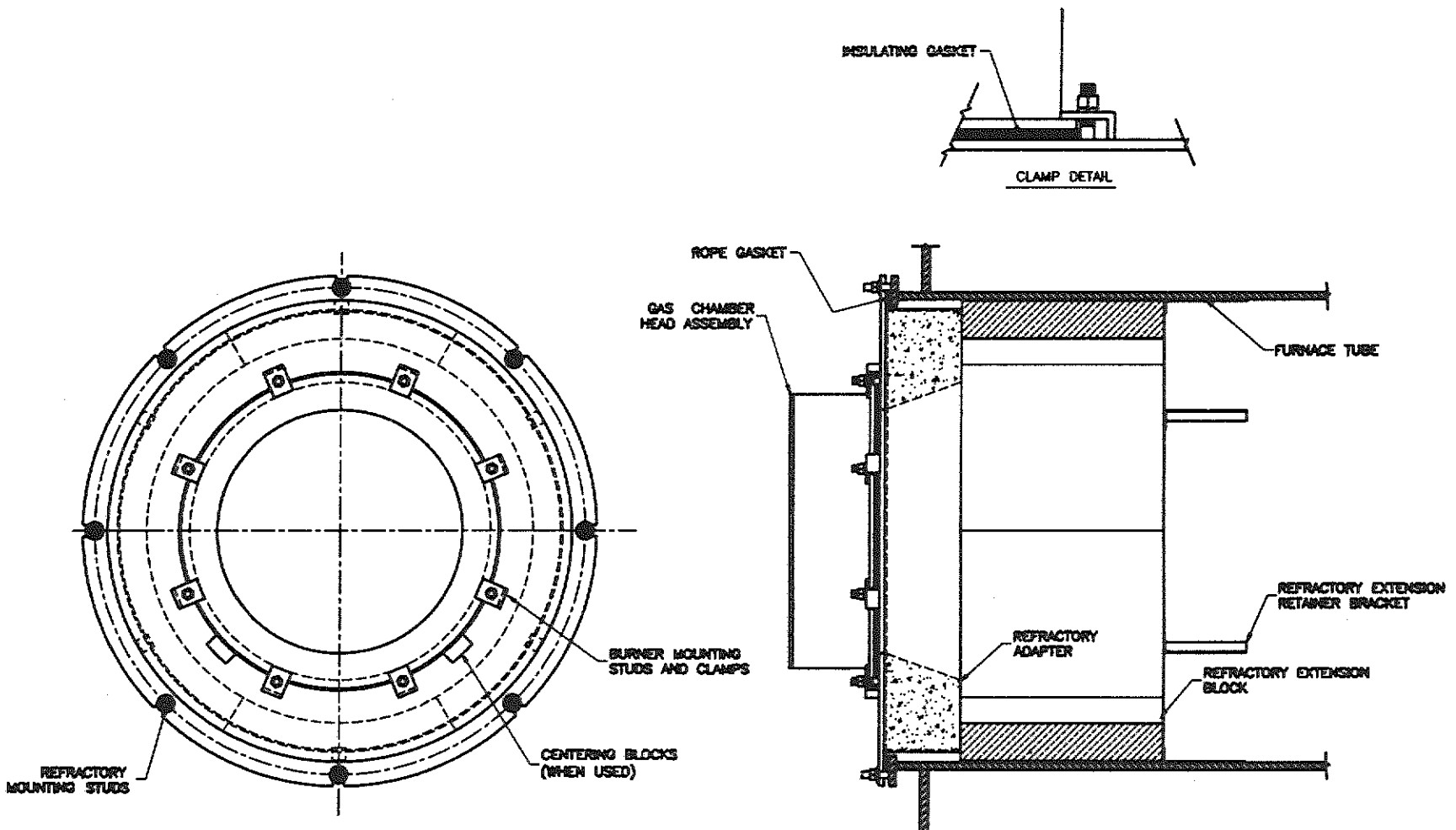

Figure 52

Pressure drop for various flows through several pipe sizes to allow correct piping selection is provided in Figure 53.

PRESSURE DROPS

Natural Gas in Schedule 40 Iron Pipe

Gas Flow CFH	4815	5231	6278	8370	10463	12554
Pipe Diameter (inches)	Pressure Drop - in W.C. for 10 Feet					
3/4	67.6	105.65	---	---	---	---
1	19.32	30.19	43.49	77.30	20.79	---
1-1/4	4.75	7.42	10.68	18.98	29.67	42.71
1-1/2	2.04	3.19	4.60	8.17	12.77	18.38
2	0.56	0.88	1.27	2.25	3.51	5.06
2-1/2	0.23	0.35	0.51	0.91	1.42	2.04
3	0.07	0.11	0.16	0.29	0.45	0.65
4	0.02	0.02	0.04	0.07	0.11	0.15

NOTE: For longer lengths, pressure drop is proportionately greater. Example: A 2" drop for 10' will be 4" for 20' etc.

Figure 53

Equivalent feet of various fittings is provided in Figure 54 for aiding pressure drop determination

PRESSURE DROPS

Equivalent Length in Feed of Pipe for Various Valves and Fittings

(To be used in conjunction with Figure 53)

Description of Item	1/2"	3/4"	1"	1-1/2"	2"	2-1/2"	3"	4"
Conventional Swing Check (fully open)	5.60	8.40	11.25	16.80	22.50	28.10	33.75	45.00
Clearway Swing Check (fully open)	2.10	3.10	4.20	6.25	8.40	10.40	12.60	16.80
Globe Lift or Stock Check (fully open)	14.20	21.25	28.30	42.50	56.60	70.80	84.90	113.00
Angle Lift or Stop Check (fully open)	6.00	9.10	12.10	18.10	24.20	30.20	36.30	48.30
In-line Ball Check (fully open)	6.25	9.40	12.50	18.75	25.00	31.25	37.50	50.00
90° Standard Elbow	1.50	2.20	2.70	4.50	5.20	6.50	8.00	11.00
45° Standard Elbow	0.70	1.00	1.30	2.00	2.60	3.50	3.90	5.30
90o Street Elbow	2.10	3.10	4.20	6.25	8.40	10.40	12.60	16.70
45o Street Elbow	1.10	1.60	2.20	3.20	4.40	5.50	6.60	8.70
Standard Tee (with flow through run)	1.00	1.30	1.70	2.80	3.50	4.30	5.20	7.00
Standard Tee (with flow through branch)	3.20	4.50	5.70	9.00	12.00	14.00	16.00	22.00

Figure 54

Gas piping should be installed in accordance with NFPA-54: National Fuel Gas code published by the National Fire Protection Association and, if applicable, NFPA-58: Storage and Handling of Liquefied Petroleum Gases. Any local codes that may apply should be strictly adhered to. 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 shut-off valve should include a full size dirt pocket or trap.

CAUTION: When testing gas piping, make sure the gas cock upstream of the gas pressure regulator is closed to prevent damage to the regulator.

CAUTION: Vent valves, relief valves and vent tappings from all pressure regulators and pressure switches shall be piped to outside atmosphere by the installing contractor.

E. Oil Burning Equipment - National Fire Protection Association (NFPA-31): Installation of oil burning equipment establishes the general criteria for dealing with these equipments and associated components. Insurance and local jurisdictional codes will apply also.

F. Air Atomizing Module - Place the air compressor and oil pump assemblies in a convenient location near the burner. On heavy-oil units, keep the interconnecting lines as short as possible. Attach air and oil feed lines to the burner and the oil supply and return lines to the tank. See typical piping schematics in Section 14.

CAUTION: Check all oil system piping for internal cleanliness prior to installation.

G. Typical Piping Arrangement - Typical oil supply piping arrangements are shown in Figures 55 and 56.

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TYPICAL OIL PIPING

No. 2 Oil

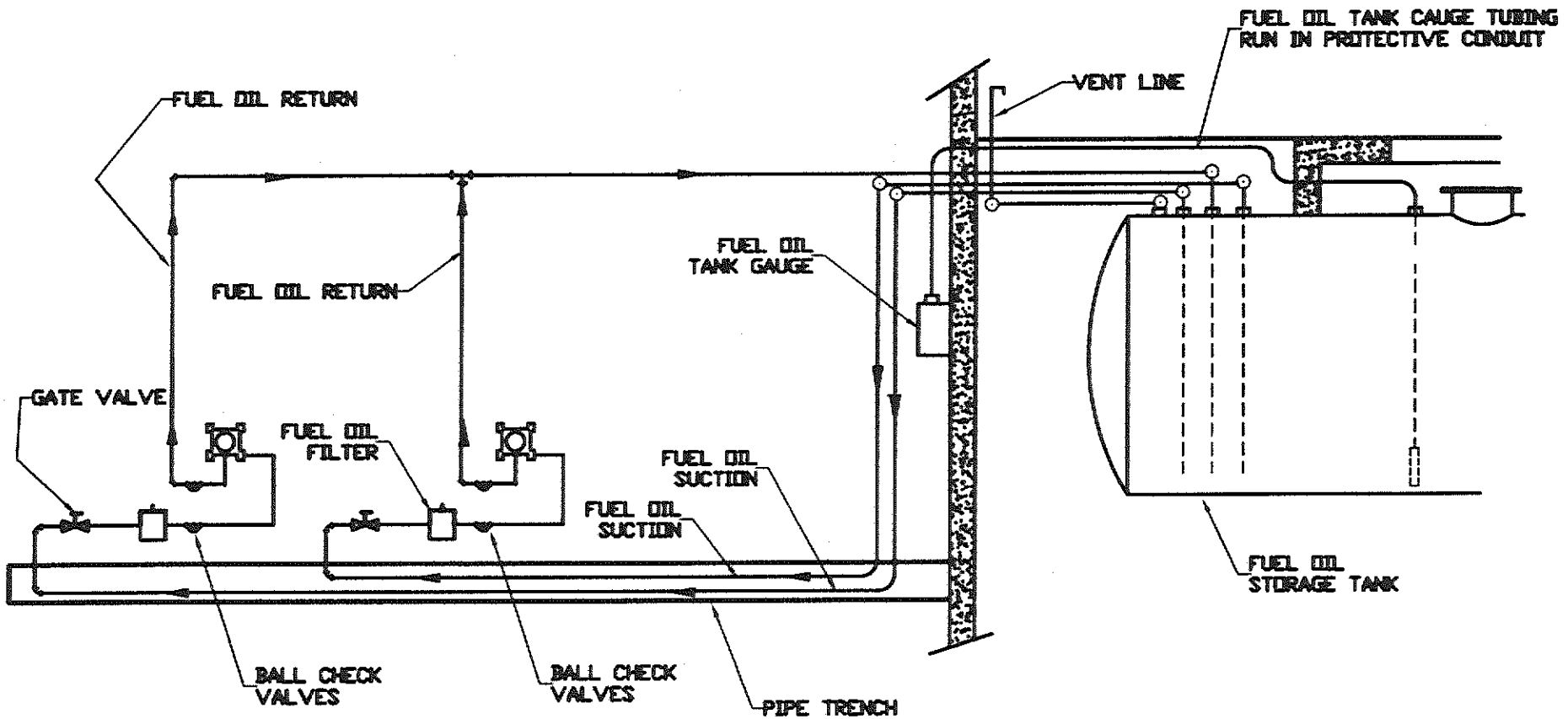


Figure 55

TYPICAL HEAVY OIL CIRCULATING LOOP

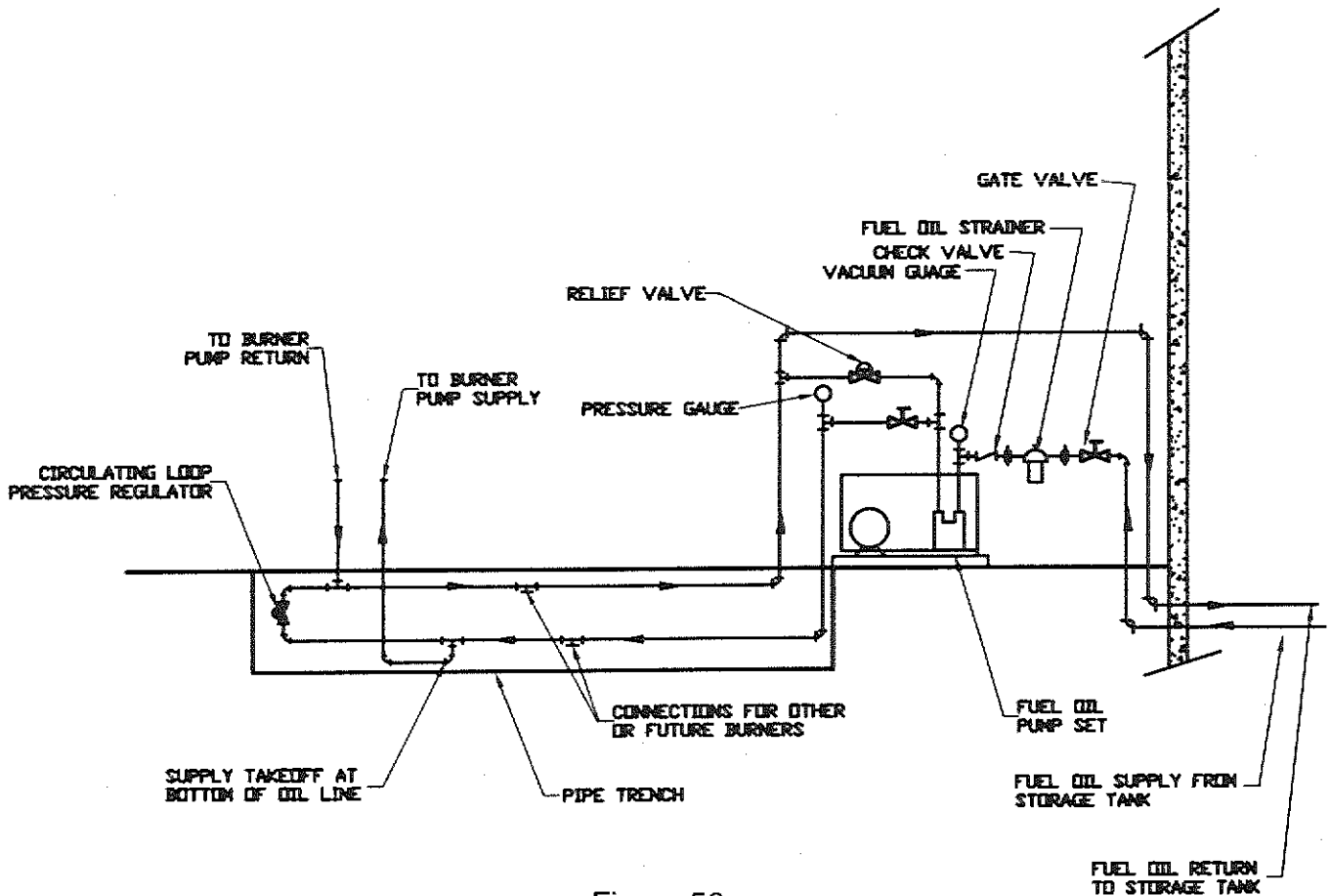


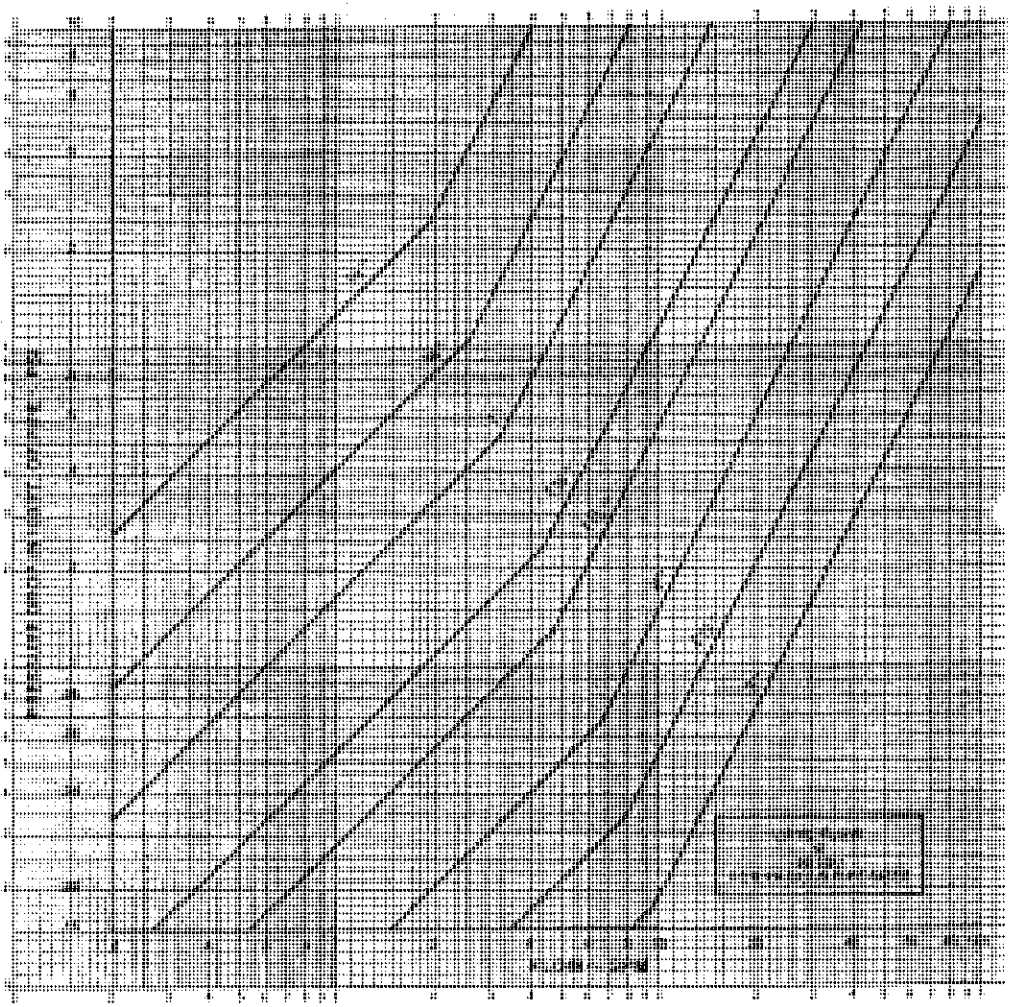
Figure 56

No gate valve shall be installed in the return line without a relief bypass. Note that the use of a remote pump for heavy or light oil installation with long runs may cause the burner oil pump suction to exceed 10" Hg. Cavitation can develop from vacuum exceeding 10" Hg. This will cause pressures produced by the pump to fluctuate and possibly cause flame failure. Consult factory for selecting sizes of remote pumps.

See Figures 57,58 and 59 for pressure drops through several size pipes to aid in selecting lines for various viscosity oils. The use of Teflon tape on oil line connections is discouraged

PRESSURE DROP

50 SSU

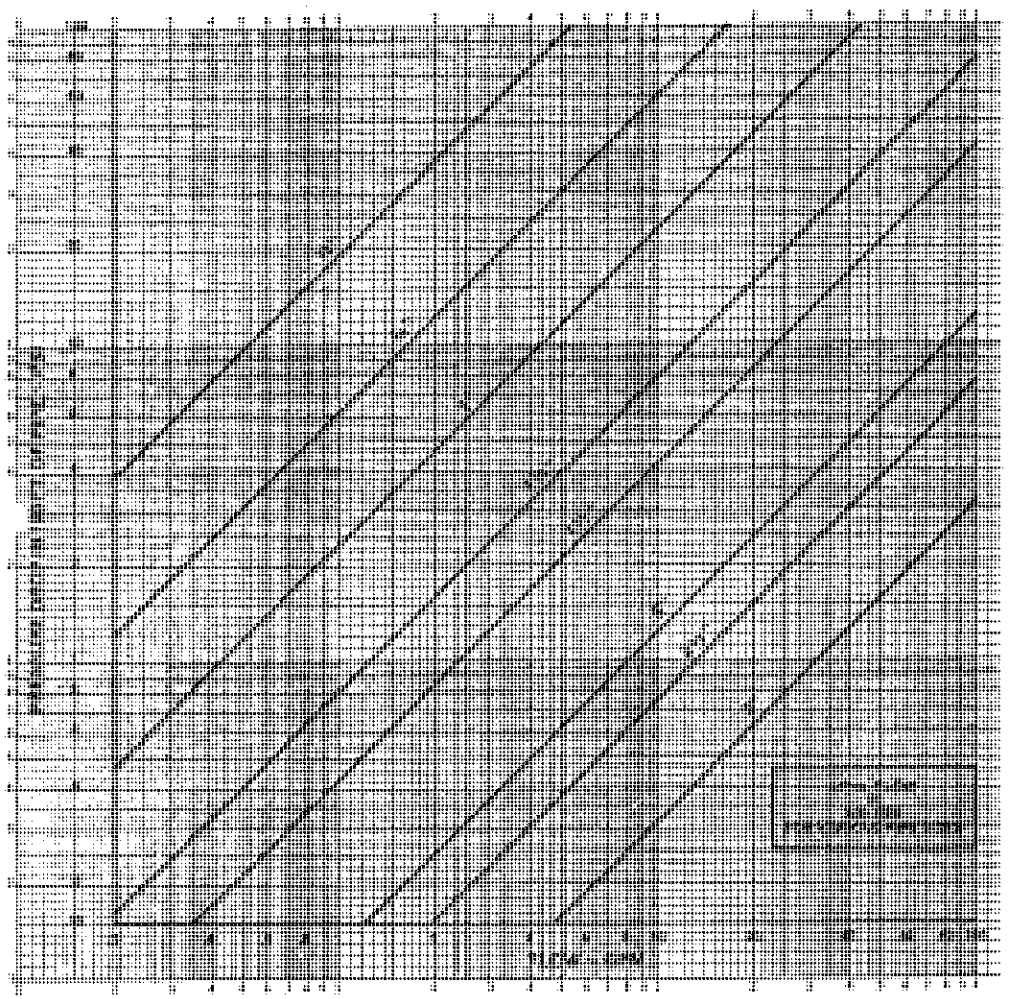


(1 PSI = 2.036" Hg.)

Figure 57

PRESSURE DROP

500 SSU



(1 PSI = 2.036" Hg.)

Figure 58

PRESSURE DROP

2000 SSU

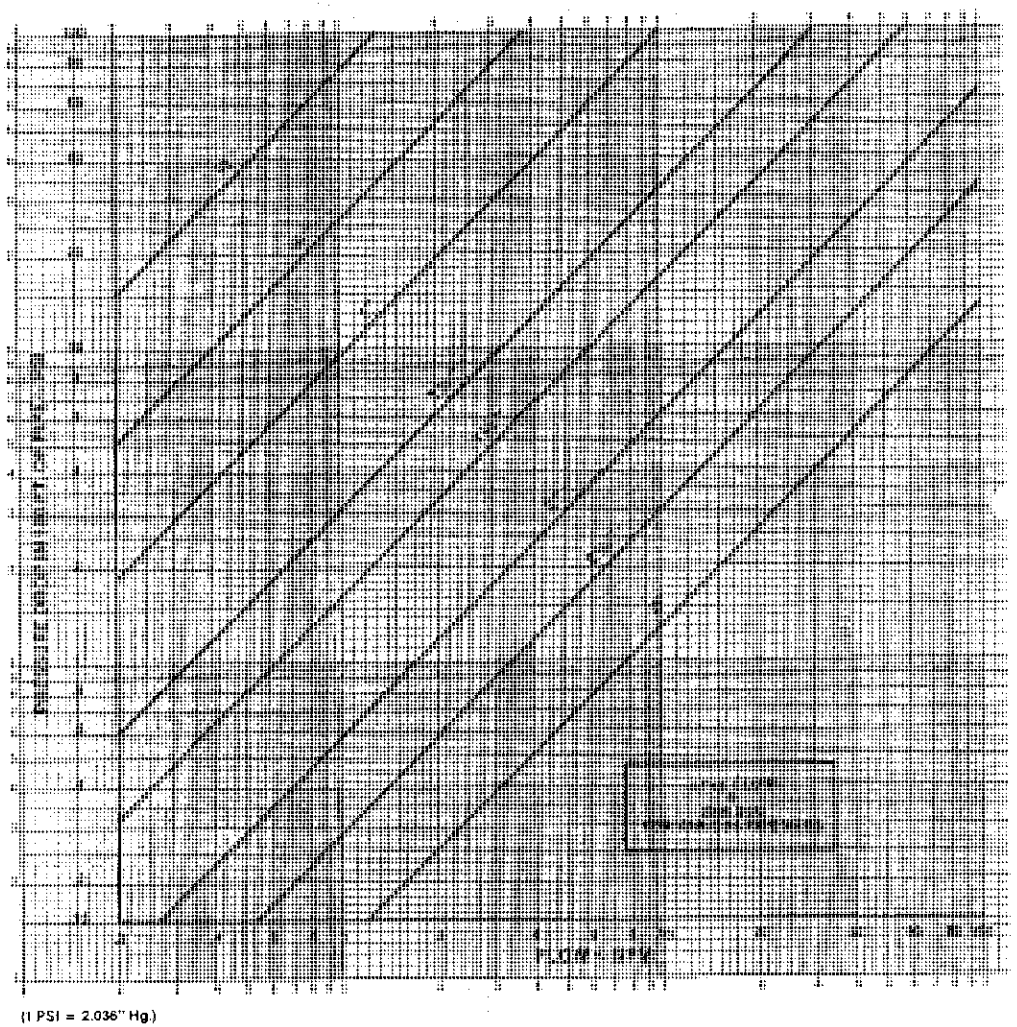


Figure 59

H. Oil Heating - The air atomizing burner can be equipped to fire No. 2, 4, 5 or 6 oil.

For easy pumping, oils must have a viscosity of 3000 SSU or less. For air atomization they must have a viscosity less than 100 SSU. No. 2 oil does not require heating to meet those requirements.

I. Oil Tank Location - The rules of the NFPA-31 and of State and City regulations, if any, should be followed in locating and installing oil storage tanks.

J. Tank Oil Heaters - All installations using high pour point oils should include equipment for heating the oil in the tank to a pumpable temperature (3000 SSU maximum pumping viscosity). A tank coil or suction bell heater may be used with either steam or forced hot water as a heating medium. The steam or hot water lines supplying heat to the tank coil should be insulated and water-proofed in the same covering with the oil suction and return lines (see Figure 60).

NOTE: Check local code requirements.

K. Installing Oil Tank - Consult local authorities for specifications on installing inside tanks.

4. ELECTRICAL SUPPLY

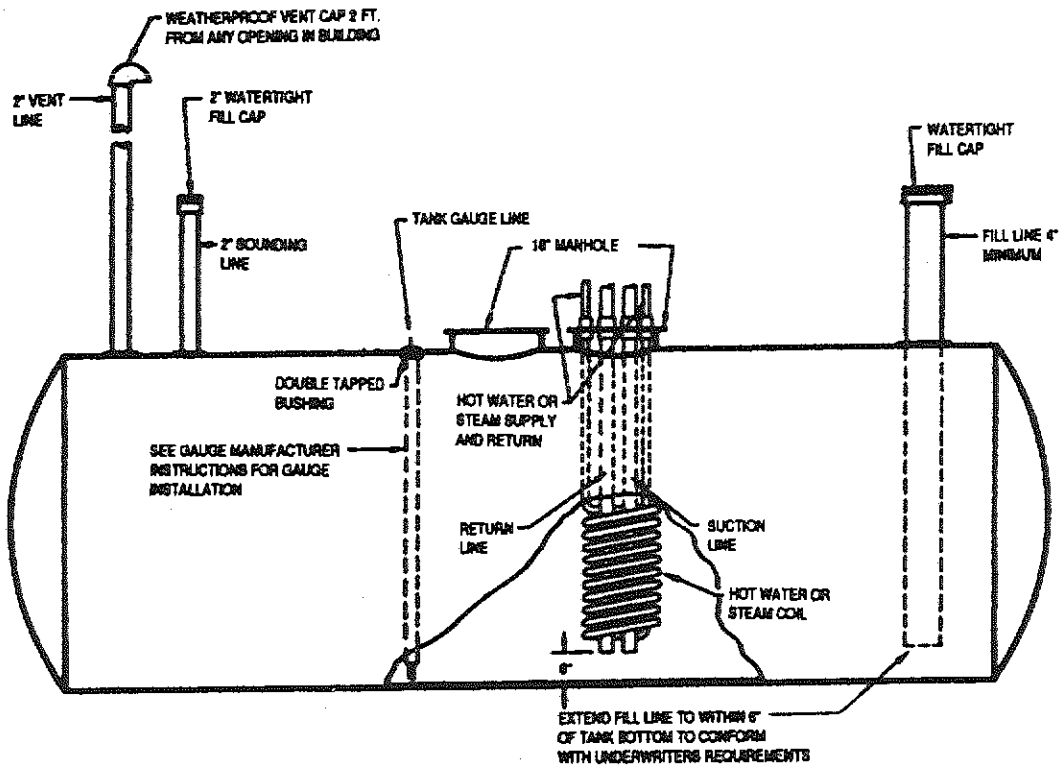
All burners are prewired at the factory as far as practical. Refer to the specific wiring diagram shipped with the burner to complete the wiring to the gas train, oil train and boiler controls.

The wiring diagram for your particular unit is located inside the control cabinet. Study this wiring diagram thoroughly before making any connections to assure application of correct voltages. Make sure all terminal post screws in the control cabinet are tight, since vibration during shipment may have caused some screws to loosen.

Wiring done on the job shall conform to the rules of the NFPA-70 (National Electric Code) or other local codes having jurisdiction.

Electrical power should be provided from a separate fused disconnect switch located in the boiler room. Fuse protection should be of the "slow-blow" type. Refer to burner data plate for burner current load. Check wiring diagram and follow Code requirements in selecting wire and fuse sizes.

TYPICAL OIL STORAGE TANK



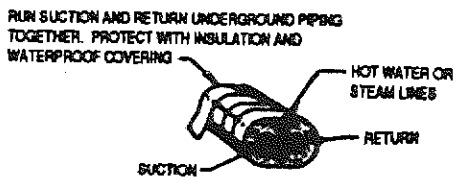


Figure 60

Section 4

PRE-START-UP - ON/OFF FIRING SEQUENCE

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

1. GENERAL INSTRUCTIONS - PRE-START-UP

A. Kewanee units are functionally tested at the factory under simulated operating conditions. Even though all electrical and mechanical control settings have been made in accordance with the type of operation specified, some additional adjustments will normally be necessary in order to provide for local fuel conditions, draft conditions, altitude shipping damages, or changes in operating procedures. Starting service provided by an authorized Service Representative consists of the initial start-up of the unit, checking the general operation of the unit, instructing the operator in proper operating maintenance procedures and service for a specified period after the initial start-up.

B. The firing sequence assigned to the burner has been dictated by code requirements (ASME, UL, etc.), local jurisdictional code requirements and customer preference. How this end is attained is determined by the primary safety control, flame safeguard or programmer utilized on the burner. The sequence of operation for any number of manufacturers' controls is basically the same. The specific control is identified on the system wiring diagram and details regarding its operation are in the controls Component Literature.

C. A representative of the owner or the operator of the unit should be present during the original start-up in order that he may be instructed in the proper care and adjustment of the unit.

D. Some gas companies require that one of their service representatives be present at the original start-up of a gas fired boiler. Consult your local utility.

E. Fill the boiler with water to its proper operating level. The safety or a vent valve should be opened to vent the boiler of air during the filling operation. Vent should be left open during warm up until a solid stream of steam is expelled to ensure all air is driven out of the boiler.

F. Check fuses in main panel and see that wiring to the boiler control cabinet is completed in accordance with the wiring diagram and local code requirements.

G. Boiler breeching and stack passages must be open and unobstructed.

H. Make certain that all steam piping is tight or uncompleted sections valved off.

I. Make sure that the steam or hot water generated by the boiler can be used by the heating units. Steam from a steam unit may be vented outside the boiler room provided that proper safety precautions are observed.

J. Check for proper rotation of blower motor, by momentarily making contact in the motor starters. (Counterclockwise fan rotation when viewed through the air inlet.)

K. Be sure all operating and limit controls are calling for burner operation. These controls include the low water cut-off, steam pressure or hot water temperature controls, combustion control reset and remote switches or controls.

L. Make sure adequate gas pressure is available at the utility meter. On oil fired units ensure adequate oil volume is available at a maximum of 5 psi to burner pump suction.

M. Check boiler room fresh air supply opening to avoid negative room pressure. When local codes do not dictate boiler room ventilation area, ABMA recommends the following. 4000 BTU/HR requires 1 square inch of open area. Allowing 20% for ventilation air supply, CFM equals boiler horsepower times 10.8.

N. Check stack draft to assure that the boiler outlet draft is contained between +1/2" water column and -1/2" water column. Best burner operation is obtained at balanced draft or 0" WC.

2. GENERAL INSTRUCTIONS - CONTROLS

A. The primary safety controls used on Kewanee PHX-40 and PHX-50 burners with on-off firing sequence utilizes ultraviolet flame sensing.

B. All instructions in this manual should be studied carefully and followed closely to obtain best results from the Kewanee burner.

C. The operator should become familiar with the location and purpose of all controls governing the burner's operation. Schematic wiring diagrams and master bills show the most important valves, instruments and electrical controls which regulate the operation of the unit. Section 2 of this manual describes operation of the burner's components and systems.

3. GENERAL INSTRUCTIONS - IGNITION

A. Burners are provided with gas electric ignition as standard on gas only and gas-oil combination burners. Oil only units 125 BHP and below are equipped with direct spark ignition. Rates larger than 125 BHP use gas electric ignition. Local preferences or codes can change this. Exceptions are made on application.

B. Gas piping, controls and valves should be checked for compliance with local code and customer insurance and underwriter's requirements. Proper venting of appliances is essential to safe operation of the unit.

C. Purge the air from the pilot gas line. (Some local gas companies require that this be done by their personnel.) Close the main gas cock and the pilot gas cock.

D. Check the pilot burner for the proper settings for spark gap. Open the gas cock to the gas-electric igniter.

E. Turn the burner switch to "On" or "Gas" on combination units. Observe pre-determined prepurge for the unit. The programmer will advance to ignition trials. The pilot should ignite. Observe through inspection port in the burner or from the rear of the boiler. If the pilot fails to ignite, make checks as shown in the Troubleshooting Section of this manual and applicable control bulletin.

F. The pilot flame must be carefully adjusted for stability and proper sighting. Flame response signal should be checked with the relevant data sheet. The signal strength should be a steady acceptable reading. If the signal is not steady, or is less than the minimum, check the size of the pilot and the scanner sighting. Normal pressure to the pilot burner is nominally 3" WC for PHX-40 through PHX-400 burners.

G. Direct spark ignition is used only to light oil fueled burners with rates of 125 BHP or less. Direct spark ignition utilizes the energy of a 10,000 volt ignition transformer through a pair of electrodes that ignite the flame.

H. To assure a safe, smooth light-off for a direct spark ignition system, the gap between the electrodes must be set the proper distance apart and the right distance from the spray pattern of the nozzles. Electrodes should be examined periodically to ensure that there is no carbon or soot build up. If upon inspection there is build up, clean the electrodes and adjust them back off the spray pattern. A simple template made at the spray pattern angle is useful tool for this job (Figure 61).

NOTE: Electrodes must be more than 1/4" from any other metal surface.

4. SEQUENCE OF OPERATION

A. The primary safety control is a "non-recycle" control capable of providing prepurge, ignition and flame safeguard functions.

B. The control is provided with a purge timer that affords a prepurge, which is more than adequate to supply the required four air changes in the boiler and a 10 second trial for ignition.

C. The Primary Safety Control is suitable for both pilot ignition and direct spark ignited burners.

D. A typical sequence of operation is as follows:

1. With power applied and the limit-operating control circuit closed, the burner blower motor is energized. Once the blower motor is up to speed, the air flow circuit closes. (Not required for oil only units with blower driven pumps.)

2. Following the predetermined prepurge cycle, the pilot gas valve and ignition transformer are energized. For direct spark ignition the transformer and main oil valve(s) are energized. A 10 second trial for ignition is initiated.

3. When the pilot flame is detected, the main fuel valve(s) open permitting main flame to light. Once main flame is established, the gas ignited pilot is shut off (ignition transformer on direct spark units).

4. Main flame operates until demand is satisfied, at which time the operating control opens, shutting off the burner.

5. In the event pilot flame is not detected during ignition trials, the pilot gas valve and ignition transformer are de-energized and a safety lockout occurs.

6. In the event of a flame failure during the firing period, the fuel valves are de-energized and a safety lockout occurs.

7. Manual reset is required following any safety lockout.

E. Testing the control requires the use of a test AC-DC multimeter, with at least 20,000 ohm/volt DC rating. The test meter leads are inserted into the test jacks.

F. Unsafe operating conditions result in the following variations from standard operating sequence:

   1. Ignition Failure - On units with direct spark ignition, if the flame is not ignited or not properly scanned within the standard 10 second trial for ignition time, the main fuel valve will close and the unit will go to flame failure mode as shown by the indicating light.

   2. On units with gas-electric ignition, if the pilot is not ignited or scanner does not properly monitor the pilot, the main fuel valve will not open and the unit will go into flame failure mode as shown by the indicating light.

   3. Main Flame Failure - Following a normal cycle...pilot on, burner on, pilot off...if the main flame is extinguished or not properly monitored by the scanner, the main fuel valve will close and the unit will go to flame failure mode as shown by the indicating light.

4. Combustion Air Failure - If a failure of the air blower or the sensing air switch occurs, the programming safety control will go into safety lockout at any time during the control cycle.

5. Restarting the Unit - To restart the unit after the burner is in lockout position:

   a. Turn off the burner switch
   b. Correct the faulty condition
   c. Reset lockout switch of flame safeguard and other manual reset controls

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SPRAY ANGLE TEMPLATE

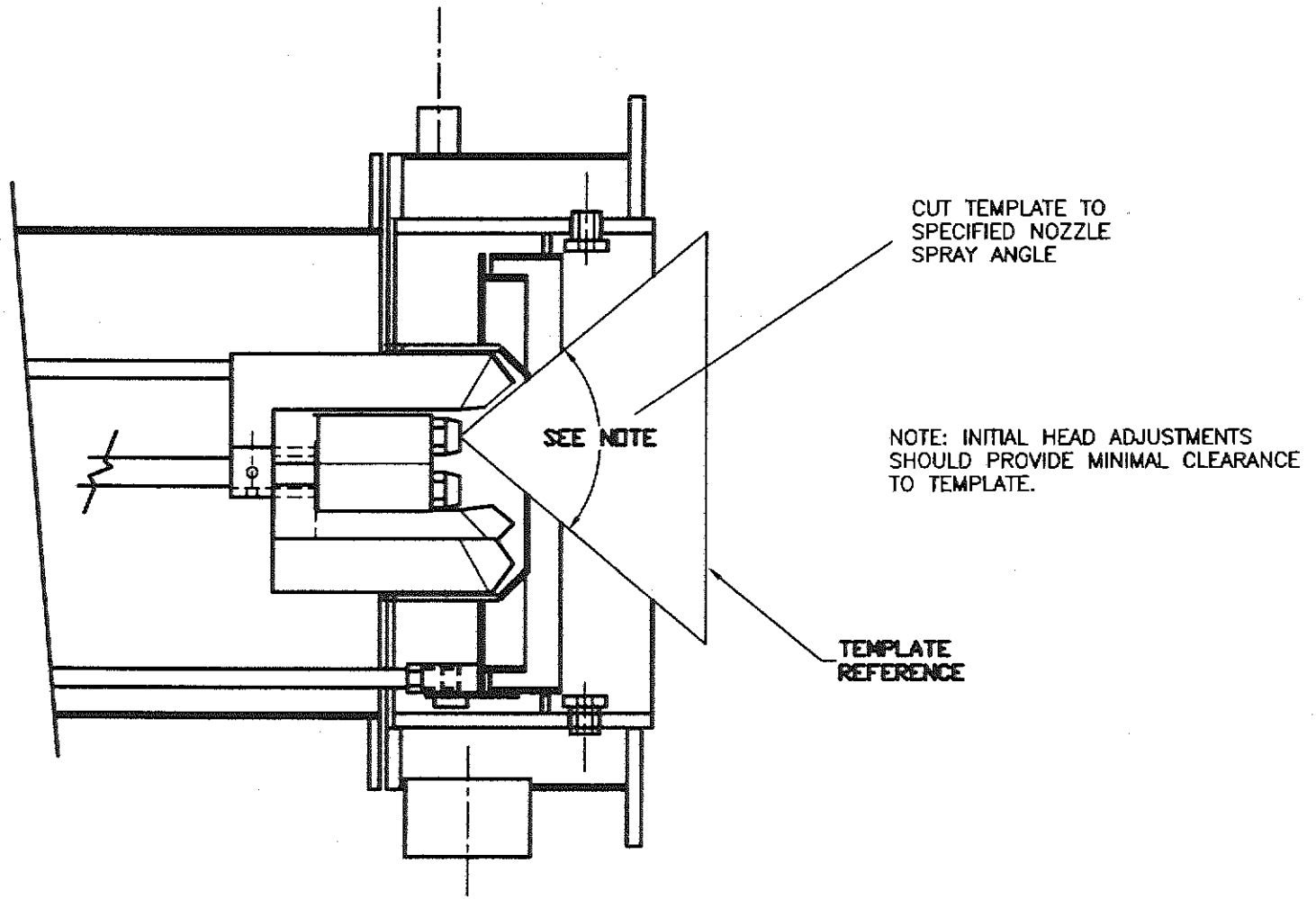

Figure 61

Section 5

PRE-START-UP
HIGH-LOW FIRING SEQUENCE

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

1. GENERAL INSTRUCTIONS - PRE-START-UP

A. Kewanee units are functionally tested at the factory under simulated operating conditions. Even though all electrical and mechanical control settings have been made in accordance with the type of operation specified, some additional adjustments will normally be necessary in order to provide for local fuel conditions, draft conditions, altitude, shipping damages or changes in operating procedures. Starting service provided by an authorized Service Representative consists of the initial start-up of the unit, checking the general operation of the unit, instructing the operator in proper operating and maintenance procedures, and service for a specified period after initial start-up.

B. The firing sequence assigned to the burner has been dictated by code requirements (ASME, UL, etc.), local jurisdictional code requirements and customer preference. How this end is attained is determined by the primary safety control, flame safeguard or programmer utilized on the burner. The sequence of operation for any number of manufacturers' controls is basically the same. The specific control is identified on the system wiring diagram and details regarding its operation are in the control's Component Literature.

C. A representative of the owner or the operator of the unit should be present during the original start-up in order that he may be instructed in the proper care and adjustment of the unit.

D. Some gas companies require that one of their service representatives be present at the original start-up of a gas fired boiler. Consult your local utility.

E. Fill the boiler with water to its proper operating level. The safety or a vent valve should be opened to vent the boiler of air during the filling operation. Vent should be left open during warm up until a solid stream of steam is expelled to ensure all air is driven out of the boiler.

F. Check fuses in main panel and see that wiring to the boiler control cabinet is completed in accordance with the wiring diagram and local code requirements.

G. Boiler breeching and stack passages must be open and unobstructed.

H. Make certain that all steam piping is tight or uncompleted sections valved off.

I. Make sure that the steam or hot water generated by the boiler can be used by the heating units. Steam from a steam unit may be vented outside the boiler room provided that proper safety precautions are observed.

J. Check for proper rotation of blower motor, by momentaring making contact in the motor starters. (Counterclockwise fan rotation when viewed through the air inlet.)

K. Be sure all operating and limit controls are calling for burner operation. These controls include the low water cut-off, steam pressure or hot water temperature controls, auxiliary switch on electric oil heater, low fire switch on modutrol motor, combustion control reset and remote switches or controls.

L. Make sure adequate gas pressure is available at the utility meter. On oil fired units ensure adequate oil volume is available at a maximum of 5 psi to the burner pump suction.

M. Check boiler room fresh air supply opening to avoid negative room pressure. When local codes do not dictate boiler room ventilation area, ABMA recommends the following. 4000BTU/HR requires 1 square inch of open area. Allowing 20% for ventilation air supply, CFM equals boiler horsepower times 10.8.

N. Check stack draft to assure that the boiler outlet draft is contained between +1/2" water column and -1/2" water column. Best burner operation is obtained at balanced draft or 0" WC.

2. GENERAL INSTRUCTIONS - CONTROLS

A. Programmer used on PHX-40 - PHX-80 burners with high-low firing sequence utilizes ultraviolet flame sensing.

B. All instructions in this manual should be studied carefully and followed closely to obtain best results from the Kewanee burner.

C. The operator should become familiar with the location and purpose of all controls governing the burner's operation. Schematic wiring diagrams and master bills show the most important valves, instruments and electrical controls which regulate the operation of the unit. Section 2 of this manual describes operation of the burner's components and systems.

3. GENERAL INSTRUCTIONS - IGNITION

A. Burners are provided with gas electric ignition as standard on gas only and gas-oil combination burners. Oil only units 125 BHP and below are equipped with direct spark ignition. Rates larger than 125 BHP use gas electric ignition. Local preferences or codes can change this. Exceptions are made on application.

B. Gas piping, controls and valves should be checked for compliance with local code and customer insurance and underwriter's requirements. Proper venting of appliances is essential to safe operation of the unit.

C. Purge the air from the pilot gas line. (Some local gas companies require that this be done by their personnel.) Close the main gas cock and the pilot gas cock.

D. Check the pilot burner for the proper settings for spark gap. Open the gas cock to the gas-electric igniter.

E. Turn the burner switch to "On" or "Gas" on combination units. Observe pre-determined prepurge for the unit. The programmer will advance to ignition trials. The pilot should ignite. Observe through inspection port in the burner or from the rear of the boiler. If the pilot fails to ignite, make checks as shown in the Troubleshooting Section of this manual and applicable control bulletin.

F. The pilot flame must be carefully adjusted for stability and proper sighting. Flame response signal should be checked with the relevant data sheet. The signal strength should be a steady acceptable reading. If the signal is not steady, or is less than the minimum, check the size of the pilot and the scanner sighting. Normal pressure to the pilot burner is nominally 3" WC for PHX-40 through PHX-400 burners.

G. Direct spark ignition is used only to light oil fueled burners with rates of 125 BHP or less. Direct spark ignition utilizes the energy of a 10,000 volt ignition transformer through a pair of electrodes that ignite the flame.

H. To assure a safe, smooth light-off for a direct spark ignition system, the gap between the electrodes must be set the proper distance apart and the right distance from the spray pattern of the nozzles. Electrodes should be examined periodically to ensure that there is no carbon or soot build up. If upon inspection there is build up, clean the electrodes and adjust them back off the spray pattern. A simple template made at the spray pattern angle is a useful tool for this job (Figure 62).

NOTE: Electrodes must be more than 1/4" from any other metal surface.

4. SEQUENCE OF OPERATION

A. Programmer is a "non-recycle" control capable of providing prepurge, ignition and flame safeguard functions.

B. The control is provided with a purge timer that affords a prepurge, which is more than adequate to provide the required four air changes in the boiler and a 10 second trial for ignition.

C. The programmer is suitable for both pilot ignition and direct spark ignited burners.

D. A typical sequence of operation is as follows:

1. With power applied and the limit-operating control circuit closed, the burner blower motor is energized. Once the blower motor is up to speed, the air flow circuit closes. (Not required for oil only units with blower driven pumps.)

2. Following the predetermined prepurge cycle, the pilot gas valve and ignition transformer are energized. For direct spark ignition the transformer and main oil valve(s) are energized. A 10 second trial for ignition is initiated.

3. When the pilot flame is detected, the main fuel valve(s) open permitting main flame to light. Once main flame is established, the gas ignited pilot is shut off (ignition transformer on direct spark units).

4. Main flame operates until demand is satisfied, at which time the operating control opens, shutting off the burner.

5. In the event pilot flame is not detected during ignition trials, the pilot gas valve and ignition transformer are de-energized and a safety lockout occurs.

6. In the event of a flame failure during the firing period, the fuel valves are de-energized and a safety lockout occurs.

7. Manual reset is required following any safety lockout.

E. Testing the control requires the use of a test AC-DC multimeter, with at least 20,000 ohm/volt DC rating. The test meter leads are inserted into the test jacks.

F. Unsafe operating conditions result in the following variations from standard operating sequence:

1. Ignition Failure - On units with direct spark ignition, if the flame is not ignited or not properly scanned within the standard 10 second trial for ignition time, the main fuel valve will close and the unit will go to flame failure mode as shown by the indicating light.

2. On units with gas-electric ignition, if the pilot is not ignited or scanner does not properly monitor the pilot, the main fuel valve will not open and the unit will go into flame failure mode as shown by the indicating light.

3. Main Flame Failure - Following a normal cycle... pilot on, burner on, pilot off...if the main flame is extinguished or not properly monitored by the scanner, the main fuel valve will close and the unit will go to flame failure mode as shown by the indicating light.

4. Combustion Air Failure - If a failure of the air blower or the sensing air switch occurs, the programming safety control will go into safety lockout at any time during the control cycle.

5. Restarting the Unit - To restart the unit after the burner is in lockout position:

   a. Turn off the burner switch
   b. Correct the faulty condition
   c. Reset lockout switch of flame safeguard and other manual reset controls

5. HIGH-LOW FIRING

A. After main flame has been established, (10 seconds after main fuel valves have opened and pilot has been de-energized) and load demand requires, the unit transitions to high fire.

B. Power is applied to the spring return two position motor through the firing switch (low/auto) on the burner console, the firing rate controller (aquastat or pressurestat on boiler) and the low fire hold aquastat (if used).

C. With power applied to the spring return two position motor the burner transitions to high fire as follows:

   1. Gas Firing - Increased input is accomplished by opening a gas fuel metering (butterfly) valve in conjunction with the air inlet damper which characterizes the fuel air mix.

   2. Oil Firing - Increased input is accomplished by the spring return two position motor opening the damper At approximately 40% damper opening, the high-low changeover switch in the two position motor closes, powering the normally open low fire oil valve. This applies full oil pump pressure to the nozzles, increasing input to full rate. Damper opening continues to the high fire position.

6. ADJUSTMENT OF LOW/HIGH OIL CHANGEOVER SWITCH - See Figure 63

A. The low/high oil changeover switch is a single pole double throw auxiliary switch situated in the damper drive motor and can be adjusted to operate at any point of the motor rotation. It has a 1 to 10 degree adjustable differential. The switch makes the R-B terminals during the power stroke.

B. The switch should typically be set to operate after 35 to 40 degrees of motor rotation from the low fire position, and under no circumstances should it be adjusted to operate closer than 5 degrees from the top end of the motor stroke (85 degrees).

C. To check the operating point of the switch the motor must be powered so that it runs to the OPEN (high fire) position. (This may be accomplished by disconnecting the wiring from the L1 and L2 terminals in the motor, and then connecting a slave 115V, 60 HZ power supply to the L1 and L2 terminals.) Note the point in the motor rotation at which the switch operates (audible click or continuity check across R-B terminals). If the switch needs adjustment, proceed as follows:

CAUTION: Disconnect power supply while adjusting switch CAM.

1. Insert a screwdriver in a slot in the switch CAM (Red plastic), located near the center of the motor (Figure 63). Each slot in the CAM equals approximately 15 degrees of motor rotation. To set the activation point on the high fire switch to a higher point in the low to high fire stoke, move the red CAM counterclockwise. The red CAM is also responsible for proving low fire position in the flame safeguard controls. The blue CAM (when used) controls the high fire proving switch for the flame safeguard.

2. Repower the motor and check the point at which the switch "makes" and "breaks".

3. When satisfactory switch operation has been accomplished, disconnect the slave power supply from L1 and L2 terminals and reconnect damper motor wiring in accordance with the relevant wiring diagram. Reattach motor cover.

NOTE: Minor adjustments to the operating point of the changeover switch may be necessary depending upon local conditions at the installation site. The prime consideration in making adjustments to the operating point is to obtain a smooth changeover from low to high fire and vice versa without the flame having any tendency to blowout.

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SPRAY ANGLE TEMPLATE

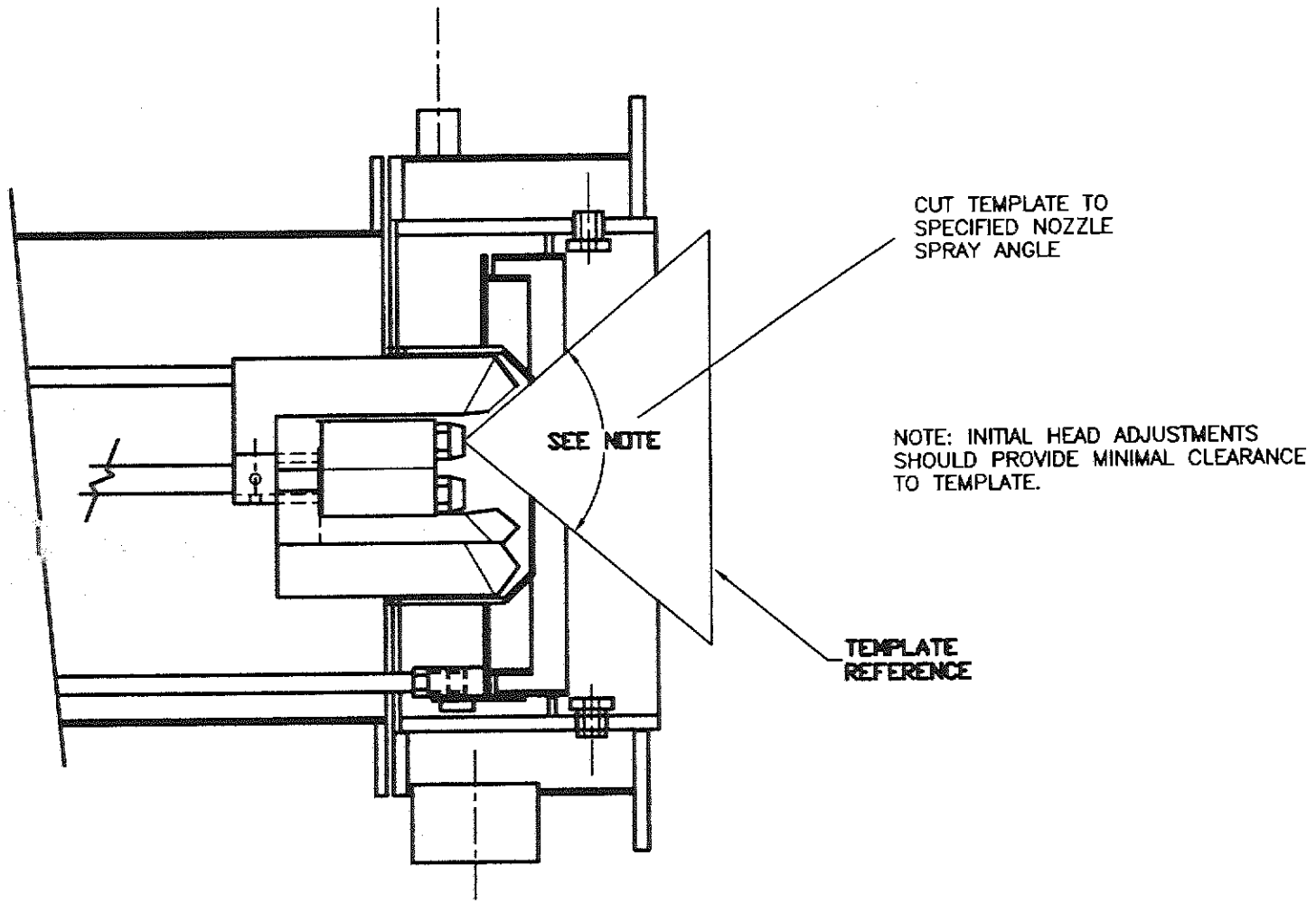

Figure 62

AUXILIARY SWITCH ADJUSTMENTS

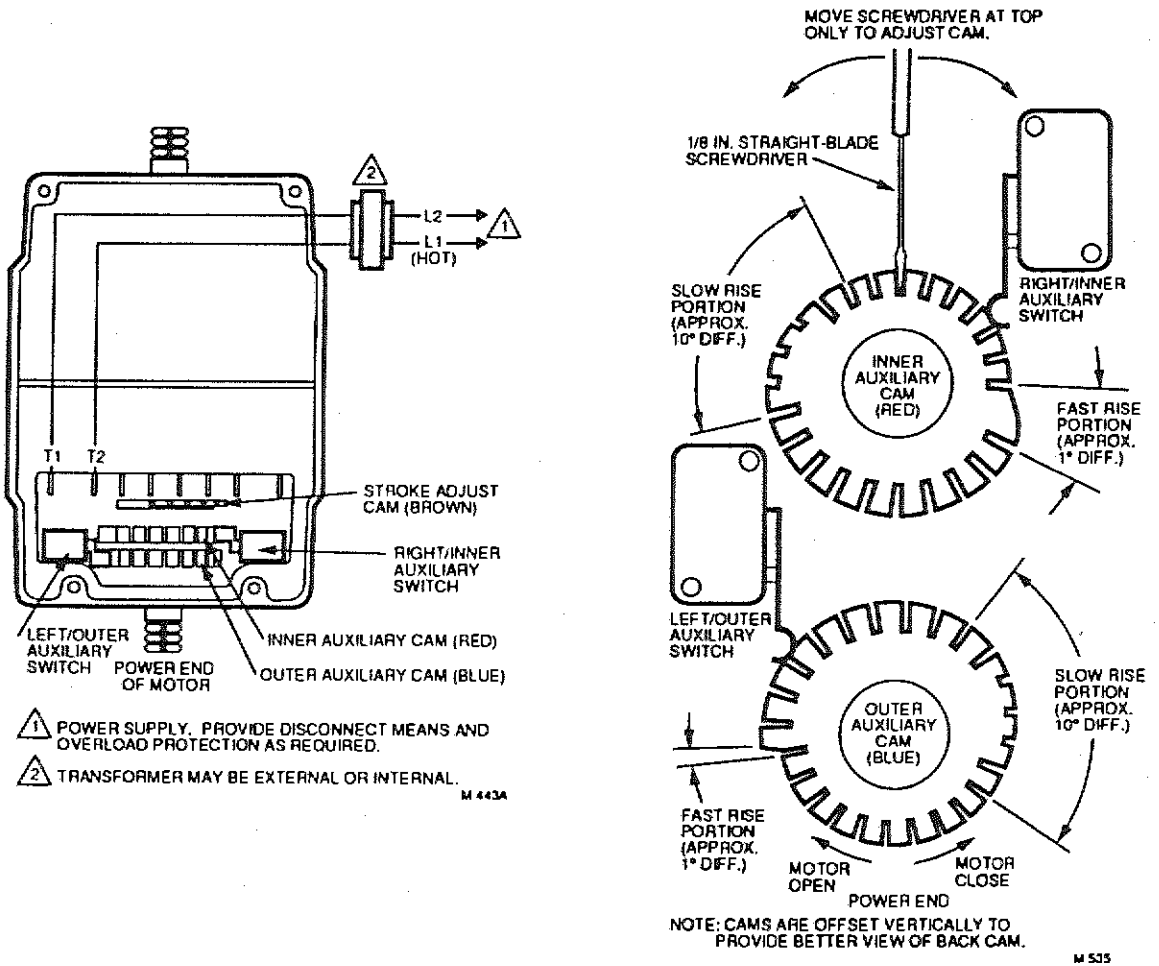

Figure 63

Section 6

PRE-START-UP
MODULATION FIRING SEQUENCE

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

1. GENERAL INSTRUCTIONS - PRE-STARTUP

A. Kewanee units are functionally tested at the factory under simulated operating conditions. Even though all electrical and mechanical control settings have been made in accordance with the type of operation specified, some additional adjustments will normally be necessary order to provide for local fuel conditions, draft conditions, altitude, shipping damages, or changes in operating procedures. Starting service provided by an authorized Service Representative consists of the initial start-up of the unit, checking the general operation of the unit, instructing the operator in proper operating maintenance procedures and service for a specified period after the initial start-up.

B. The firing sequence assigned to the burner has been dictated by code requirements (ASME, UL, etc.), local jurisdictional code requirements and customer preference. How this end is attained is determined by the primary safety control, flame safeguard or programmer utilized on the burner. The sequence of operation for any number of manufacturers' controls is basically the same. The specific control is identified on the system wiring diagram found in Appendix section of this manual. Details regarding its operation is in the Component Literature section of this manual.

C. A representative of the owner or the operator of the unit should be present during the original startup in order that he may be instructed in the proper care and adjustment of the unit.

D. Some gas companies require that one of their service representatives be present at the original startup of a gas fired boiler. Consult your local utility.

E. If heavy oil is to be used, make sure that the oil system controls produce correct system temperatures for circulating and atomizing the oil.

F. Fill the boiler with water to its proper operating level. The safety or a vent valve should be opened to vent the boiler of air during the filling operation. Vent should be left open during warm up until a solid stream of steam is expelled to ensure all air is driven out of the boiler.

G. Check fuses in main panel and see that wiring to the boiler control cabinet is completed in accordance with the wiring diagram and local code requirements.

H. Boiler breeching and stack passages must be open and unobstructed.

I. Make certain that all steam piping is tight or uncompleted sections valved off.

J. Make sure that the steam or hot water generated by the boiler can be used by the heating units. Steam from a steam unit may be vented outside the boiler room provided that safety precautions are observed.

K. Check for proper rotation of blower motor, air compressor motor and oil pump motor by momentarily making contact in the motor starters. (Counter-clockwise fan rotation when viewed through the air inlet; Counterclockwise air compressor rotation when viewed from the fan end. Fan blows cooling air across heads.) Motors for combustion air fans and remote pump sets are provided with arrows indicating rotation direction.

L. Be sure all operating and limit controls are calling for burner operation. These controls include the low water cut-off, steam pressure or hot water temperature controls, auxiliary switch on electric oil heater, low fire switch on modutrol motor, combustion control reset and remote switches or controls. For location, consult wiring diagram and master bill.

M. Check all handhole gaskets, gage glass fittings and piping connections for leaks during the startup and initial firing of the boiler. Tighten such fittings or connections as required.

N. Make sure adequate gas pressure is available at the utility meter. On oil fired units ensure adequate oil volume is available at a maximum of 5 PSI to burner pump suction.

O. Check boiler room fresh air supply opening to avoid negative room pressure. In the absence of an evaluation by a qualified engineer or local code requirements, ABMA recommends the following: 4000 BTU/H requires 1 square inch of open area. Allowing 20% for ventilation air supply, CFM equals boiler horsepower times 10.8.

P. Check stack draft to assure that the boiler outlet draft is contained between +1/2" water column and -1/2" water column. Best burner operation is obtained at balanced draft or 0" WC.

2. GENERAL INSTRUCTIONS - FLAME SAFEGUARD CONTROLS

A. The Scanner and Amplifier selections in Flame Safeguard Controls used on Kewanee PhoenX burners are as follows:

1. For single fuel gas, single fuel No. 2 oil, or combination gas and No. 2 oil firing

burners, Flame Safeguard controls will use ultraviolet scanners and their accompanying amplifiers as standard, or will allow substitution of infrared scanners and their accompanying amplifiers at customer request.

2. For single fuel heavy oil (No. 4, 5 and 6) or combination gas and heavy oil (No. 4, 5 and 6) firing burners, Flame Safeguard controls will use only infrared scanners and their accompanying amplifiers.

B. Flame safeguards may have a built in flame response signal meter. For those that do not, a response signal. Meter leads plug directly into the flame safeguard control (amplifier). Do not connect leads when power is on.

C. A manual potentiometer with "manual-automatic" operation is mounted on the control cabinet of units equipped for fully modulated firing. By setting the dial of the manual potentiometer at any position less than high fire, the travel of the modulating motor, and therefore, the burner firing rate, will be limited by the dial position. When the switch is in the "automatic" position the firing rate of the burner will modulate in response to the modulating pressure or temperature control between the low-fire rate, and the maximum permitted by the dial position. When in the "manual" position, the burner firing rate will advance to the maximum rate permitted by the dial position and remain there until the normal firing cycle is completed. The modutrol motor always returns to the low-fire position at the completion of a normal firing cycle.

D. The operator should become familiar with the location and purpose of all controls governing the burner's operation. Schematic wiring diagrams and master bill show the most important valves, instruments and electrical controls which regulate the operation of the unit.

3. GENERAL INSTRUCTIONS - IGNITION

A. Burners are provided with gas electric ignition as standard on gas only and gas-oil combination burners. Oil only units 125 BHP and below are equipped with direct spark ignition. Rates larger than 125 HP use gas electric ignition. Local preferences or codes can change this. Exceptions are made on application.

B. Gas piping, controls and valves should be checked for compliance with local code and customer insurance and underwriter's requirements. Proper venting of appliances is essential to safe operation of the unit.

C. Purge the air from the pilot gas line. (Some local gas companies require that this be done by their personnel.) Close the main gas cock and the pilot gas cock.

D. Check the pilot burner for the proper settings for spark gap. Open the gas cock to the gas-electric igniter.

E. Turn the burner switch to "On" or "Gas" on combination units. Observe pre-determined prepurge for the unit. The programmer will advance to ignition trials. The pilot should ignite. Observe through inspection port in the burner or from the rear of the boiler. If the pilot fails to ignite, make checks as shown in the service section of this manual and applicable control bulletin.

F. The pilot flame must be carefully adjusted for stability and proper sighting. Flame response signal should be checked with the flame safeguard operators manual. The signal strength should be a steady acceptable reading. If the signal is not steady, or is less than the minimum, check the size of the pilot and the scanner sighting. Normal pressure to the pilot burner is nominally 3" WC for burners operating 400 BHP and below and 4-6" WC for burners above 400 BHP firing natural gas.

G. Direct spark ignition is used only to light oil fueled burners with rates of 125 BHP or less. Direct spark ignition utilized the energy of 10,000 volt ignition transformer through a pair of electrodes that ignite the flame.

H. To assure a safe, smooth light-off for a direct spark ignition system, the gap between the electrodes must be set the proper distance apart and the right distance from the spray pattern of the nozzles. Electrodes should be examined periodically to ensure that there is no carbon or soot build up. If upon inspection there is build up, clean the electrodes and adjust them back off the spray pattern. A simple template made at the spray pattern angle is a useful tool for this job.

NOTE: Electrodes must be more than 1/4" from any other metal surface.

I. Oil pilot ignition is available on PHX-150 through PHX-800 burners. When required, it utilizes a 100 PSI supply on No. 2 fuel oil to a direct spark ignited oil pilot burner which provides ignition energy to the main burner. It uses the same proven pilot sequencing from the flame safeguard as do gas pilots. The pilot's oil nozzle and spark electrodes require periodic cleaning and replacement much like a small pressure atomized burner would.

4. SEQUENCE OF OPERATION

A programmer/flame safeguard with non-recycling running interlock circuit provides the following burner operation: (Consult flame safeguard bulletin found in Component Literature.)

A. START-UP

1. With power applied, the operating control circuit closed and the main fuel valve interlock closed, the burner/blower motor is energized, the running interlock circuit (air flow switch) closes.

NOTE: If the main fuel valve interlock (proof of closure switch) is not closed at the start, the control will not initiate a startup. If it opens during prepurge, the programming sequence will not proceed. The burner/blower motor will de-energized and the control will lockout.

2. The firing rate motor is driven toward the open damper position.

3. When the firing rate motor reaches its open damper position (high fire), the open damper interlock (high fire proving switch) closes and initiates the pre-determined prepurge interval. If the interlock does not close, the programming will pause until it closes or lockout in a pre-determined amount of time.

4. When the prepurge is completed, the firing rate motor is driven to the low fire position.

5. When the firing rate motor reaches the low fire position, a check is made for the low fire start interlock. If it is not closed, the programming sequence will pause until it closes or lockout in a pre-determined amount of time.
6. With proven low fire position, the burner advances to ignition trials.
7. Following a 10 second proven pilot stabilization period, the main fuel valves are energized.

8. Following a main flame establishing period, the pilot is de-energized. The firing rate motor is released to automatic control, and the modulating motor establishes the firing rate necessary to satisfy demand.

9. End of supervised startup program.

B. NORMAL SHUTDOWN

1. When the operating control circuit opens, the main fuel valve is de-energized, the firing rate motor is driven to the closed damper position.

2. Following a post purge, the burner/blower motor is de-energized.

C. SAFETY SHUTDOWN

1. If the running interlock circuit does not close, the control will lock out, and the blower motor will be de-energized. If the running interlock circuit opens during a firing period, all fuel valves will be de-energized, and the control will lock out.
2. If pilot flame is not detected during the pilot trial for ignition period, the pilot valve and ignition transformer will be de-energized and the control will lockout.
3. If main flame is not detected at the end of the main flame trial for ignition period, all fuel valves will be de-energized and the control will lock out.
4. If the main flame fails during a firing cycle, all fuel valves will be de-energized after loss of flame signal and the control will lock out.

5. Manual reset is required following any safety lockout.

NOTE: As there are some subtle differences between controls, no timing has been detailed in this outline. Variations in program between older models and new state-of-the-art controls may vary from this outline. For finite details relative to the actual control utilized, consult individual control bulletin.

Section 7

START-UP
GAS ELECTRIC IGNITION

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

1. Gas and combination gas-oil burners at all firing rates and oil only burners above 125 BHP have gas electric ignition as standard equipment.

2. Gas piping, controls and valves should be checked for compliance with all local utility and insurance requirements.

CAUTION: Vent valves, relief valves and vent tappings from all pressure regulators and pressure switches shall be piped to outside atmosphere by the installing contractor.

3. Purge the air from the pilot gas line. (Some local gas companies require that this be done by their personnel.) Close the main gas cock and the pilot gas cock.

4. Check the pilot burner for the proper settings for spark gap. Open the gas cock to the gas-electric ignited pilot.

5. When starting the burner for the first time, the pilot should be observed through inspection port in the burner or from the rear of the boiler. If the pilot fails to ignite, make checks as shown in the flame safeguard data sheets.

6. The pilot flame must be carefully adjusted for stability and proper sighting. The flame response signal should be checked with the relevant section of manual. If the signal is not steady, or is less than the minimum, check the size of the pilot and the scanner sighting. Normal pressure to the pilot burner is nominally 3" WC for burners operating at 400 BHP and below and 4-6" WC for burners above 400 BHP firing natural gas, based on regulator spring range. In some installations a higher gas volume may be required so a higher spring range may be utilized.

7. Installations requiring propane for pilot gas supply should be aware that due to higher energy value of propane, (2500 BTU/Cu. Ft. in lieu of 1000 BTU/ Cu. Ft.) there will be lower pilot gas pressures. Burners firing at 400 BHP and below should produce pilot pressures of 1.2" WC nominally and burners above 400 BHP should have pressures of 1.6"-2.4" WC.

mounted on the control cabinet and senses oil pump regulator discharge pressure. Once proper oil pressures have been established, this device should be set at 10% above optimum oil pressure. Testing in this case requires that caution be exercised. To test, with burner off and oil pump running, adjust regulator to increase oil pressure until switch trips. Record setting and return pressure to proper setting.

12. Low Atomizing Air Pressure Switch - This device is installed to prove availability of atomizing medium on air atomized oil burners. Loss of the atomizing air compressor seriously affects burner performance. This device is mounted on the control cabinet and senses atomizing air compressor discharge pressure. Once nozzle "free air" has been established, the switch should be set 10% below that point. To test, record "free air" pressure. Record compressor bleed valve position and open bleed valve and observe switch trip point. Set if required and return bleed valve to proper setting.

13. If an emergency shut-off switch is used, check to be certain it shuts down the burner when opened.

14. Pilot flame failure and main flame failure should be checked as outlined in the flame safeguard manual.

15. Remove any temporary electrical jumper wires, used in the control circuit. If the unit has a modulating firing sequence, set the "Man-Auto" toggle switch and potentiometer to match the heating requirements.

16. After the above procedures have been completed, the operator should be carefully instructed in the proper operation, maintenance, and service of the equipment.

Section 13

PHOENX BURNER ILLUSTRATIONS AND SCHEMATICS

NOTE: This section of the manual contains illustration and schematics of those systems and their intended adjustments for your Kewanee PhoenX burner. Study the portions of those sections which apply to your burner before proceeding with this section

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GENERAL ASSEMBLY DRAWING

PHX-40 and PHX-50 Burners
(Shown with Optional Modulating Controls)

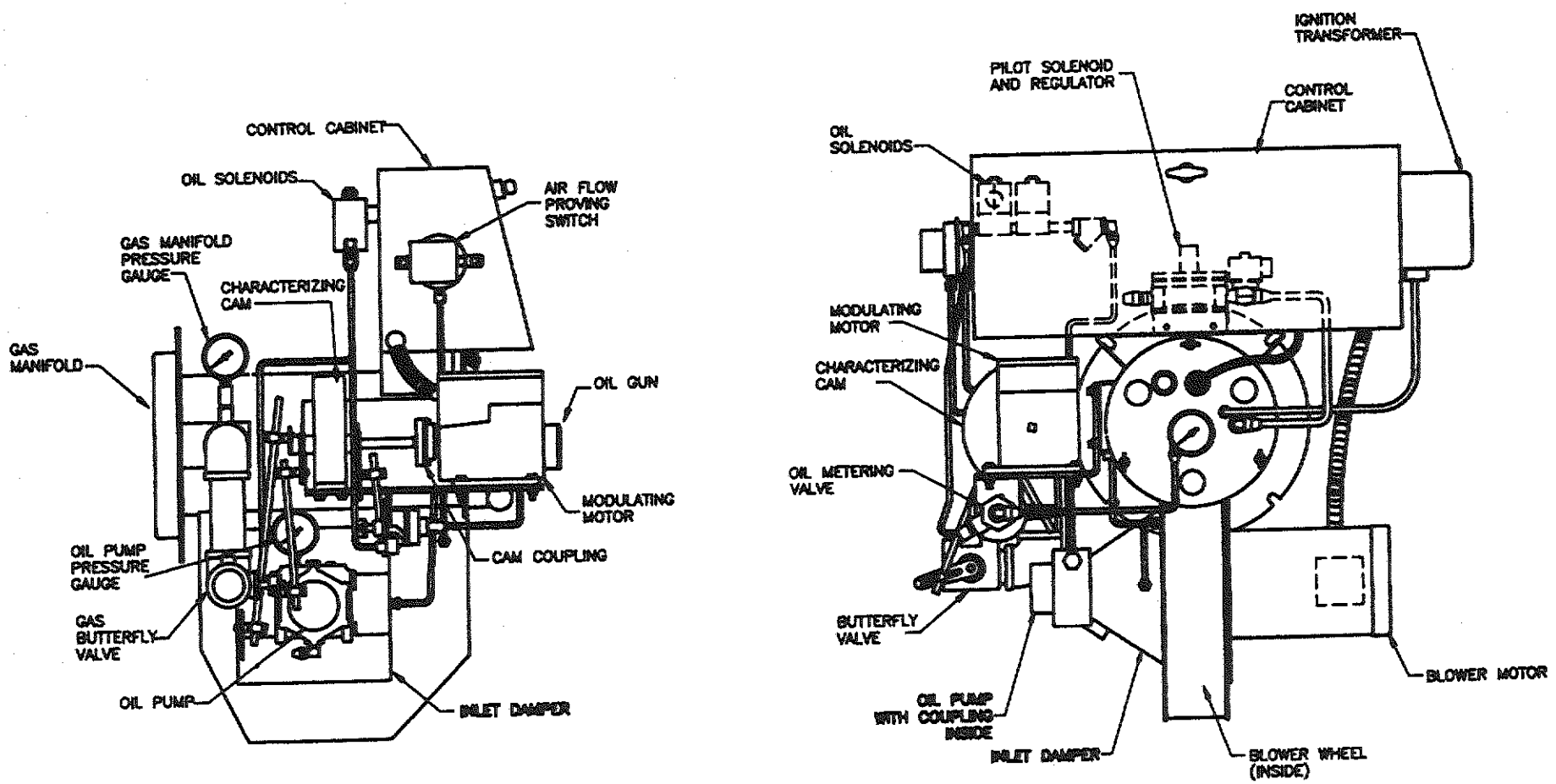


Figure 71

DATA SHEET

PHX-40 and PHX-50 Burners

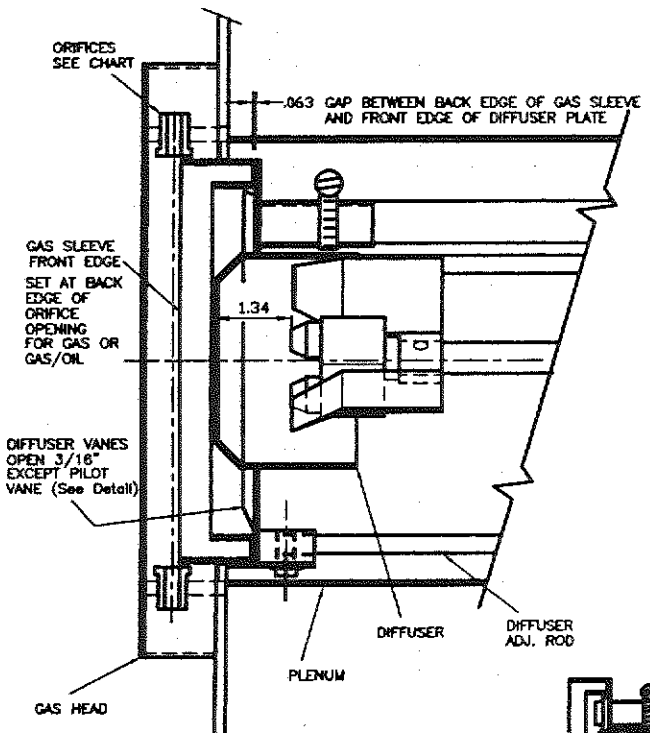
	PHX-40	PHX-50
Nominal Air Flow CFM: (@ 20% Excess Air)	345	345
Blower Wheel Type	Forward Curve	Forward Curve
Blower Wheel: Diameter x Width	7 x 2	8.25 x 1.75
Blower Wheel: Static Pressure @ CFM	3.62" WC @ 345	7.36" WC @ 430
Blower Motor: HP	1/2 HP	1 HP
Blower Motor: RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	56C	56C
Air Damper: (Number of Vanes)	(1)	(1)
Area H x W	4.5 x 8.5	4.5 x 8.5
Burner Head Throat Diameter	7.50"	7.50"
Nominal Air Velocity Thru Diffuser	105 Ft./Sec.	105 Ft./Sec.
Burner Head Attachment to Plenum	Welded	Welded
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	11.5	14.4
Oil Nozzle Type	Simplex	Simplex
Standard Make/Spray Pattern	Delavan B	Delavan B
Approved Makes	Monarch PLP/	Monarch PLP/
Spray Patterns	Hago P	Hago P
Oil Nozzles: (Quantity) GPH x Spray Angle	(3) 2.5 x 60°	(3) 3.0 x 60°
Oil Pump Capacity: GPH @ PSI	14 @ 300	23 @ 300
Oil Pump Mounting: Direct Drive/Remote	Direct Drive	Direct Drive
Oil Pressure Regulator: In Pump/Separate	In Pump	In Pump
Regulated Oil Pressure	300 PSI	300 PSI

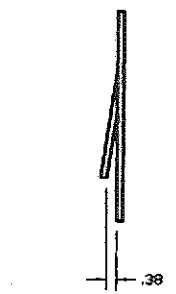
	PHX-40	PHX-50
Gas Firing Rate (Nat. Gas @ 80% Eff.)	1,674	2,092
Gas Orifices: Body Size	1/4 - 18 NPT	1/4 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(12) .257	(12) .290
Nominal Gas Velocity Thru Orifices	106.4 Ft./Sec.	104.4 Ft./Sec.
Butterfly Valve Pipe Size	1-1/2"	1-1/2"
Gas Head Pressure (@ 0.0" Furnace Pressure)	2.3" WC	2.2" WC
Standard Firing Rate Control System	On/Off w/LFS	On/Off w/LFS
Optional Firing Rate Control System	Hi/Low w/LFS	Hi/Low w/LFS
Optional Firing Rate Control System	Modulation	Modulation
Standard Turndown Ratio Gas (Oil)	3 : 1 (1.73 : 1)	3 : 1 (1.73 : 1)
Standard Ignition System - Gas or Combination Gas/Oil	Gas Pilot	Gas Pilot
Std Ignition System - Oil	Direct Spark	Direct Spark
Optional Ignition System - Oil	Gas Pilot	Gas Pilot
Standard Main Power Supply	115 / 1 / 60	115 / 1 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2 Oil	Nat. Gas, LP, #2 Oil
Code Constructions Available	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI

Figure 72

DIFFUSER SETTINGS AND NATURAL GAS ORIFICES

PHX-40 through PHX-50 Burners





NATURAL GAS ORIFICE USAGE CHART PHX-40 / PHX50

BOILER MODEL	DRILL SIZE	DIA	PART NUMBER	QUAN
M-115K	#1	.2280	3-190-5-901-02-05	12
M-135K	F	.2570	3-190-5-901-02-09	12
M-155K	I	.2720	3-190-5-901-02-11	12
M-175K	L	.2900	3-190-5-901-02-13	12
K4.0-142	C	.2420	3-190-5-901-02-07	12
K4.0-166	I	.2720	3-190-5-901-02-11	12
K4.0-192	L	.2900	3-190-5-901-02-13	12
K4.5-142	#1	.2280	3-190-5-901-02-05	12
K4.5-166	F	.2570	3-190-5-901-02-09	12
K4.5-192	I	.2720	3-190-5-901-02-11	12
K4.5-220	L	.2900	3-190-5-901-02-13	12
K5.0-166	C	.2420	3-190-5-901-02-07	12
K5.0-192	F	.2570	3-190-5-901-02-09	12
K5.0-220	I	.2720	3-190-5-901-02-11	12
3R7-K	#3	.2130	3-190-5-901-02-04	12
3R8-K	#1	.2280	3-190-5-901-02-05	12
3R9-K	C	.2420	3-190-5-901-02-07	12
3R10-K	F	.2570	3-190-5-901-02-09	12
3R11-K	I	.2720	3-190-5-901-02-11	12
3R12-K	L	.2900	3-190-5-901-02-13	12
HS 40	F	.2570	3-190-5-901-02-09	12
HS 50	L	.2900	3-190-5-901-02-13	12

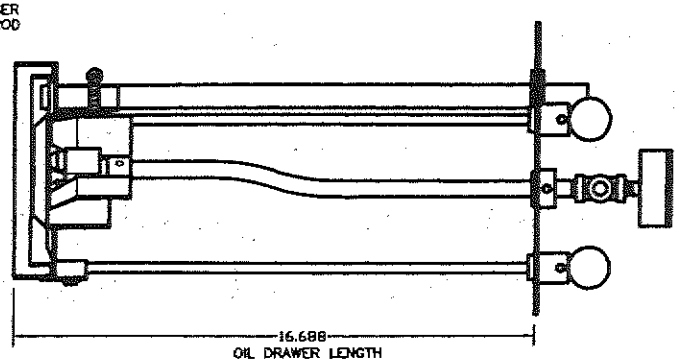


Figure 73

NOZZLE USAGE CHART

PHX-40 and PHX-50 Burners
(Delavan Type B 60° Spray Angle)

Boiler	Qty.	Size (GPH x Degree)	Kewanee Part Number
M115K	3	2.0 X 60°	2-229-2-902-60-15
M135K	3	2.5 X 60°	2-229-2-902-60-17
M155K	3	2.75 X 60°	2-229-2-902-60-18
M175K	3	3.0 X 60°	2-229-2-902-60-19
K4.0-142	3	2.25 X 60°	2-229-2-902-60-16
K4.0-166	3	2.75 X 60°	2-229-2-902-60-18
K4.0-192	3	3.0 X 60°	2-229-2-902-60-19
K4.5-142	3	2.0 X 60°	2-229-2-902-60-15
K4.5-166	3	2.5 X 60°	2-229-2-902-60-17
K4.5-192	3	2.75 X 60°	2-229-2-902-60-18
K4.5-220	3	2.75 X 60°	2-229-2-902-60-20
K5.0-166	3	2.25 X 60°	2-229-2-902-60-16
K5.0-192	3	2.5 X 60°	2-229-2-902-60-17
K5.0-220	3	2.75 X 60°	2-229-2-902-60-18
3R7-K	3	1.75 X 60°	2-229-2-902-60-14
3R8-K	3	2.0 X 60°	2-229-2-902-60-15
3R9-K	3	2.25 X 60°	2-229-2-902-60-16
3R10-K	3	2.5 X 60°	2-229-2-902-60-17
3R11-K	3	3.0 X 60°	2-229-2-902-60-19
3R12-K	3	3.25 X 60°	2-229-2-902-60-20
HS-40	3	2.5 X 60°	2-229-2-902-60-17
HS-50	3	3.0 X 60°	2-229-2-902-60-19

Figure 74

BLOWER USAGE CHART

PHX-40 and PHX-50 Burners

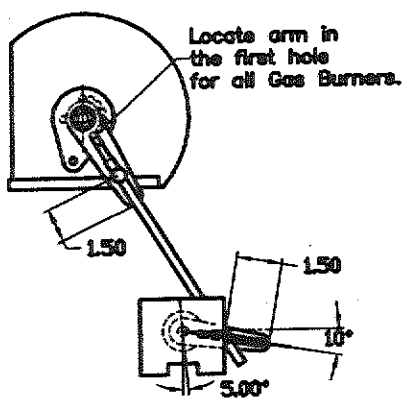
Boiler Model	HP	Blower	Motor HP
M115	34.4	7 X 2	1/2
M135	40.3	7 X 2	1/2
M155	46.3	8-1/8 X 1-7/8	1
M175	52.3	8-1/8 X 1-7/8	1
K4.0 - 142	38.5	7X2	1/2
K4.0 - 166	45.0	8-1/8 X 1-7/8	1
K4.0 - 192	52.2	8-1/8 X 1-7/8	1
K4.5 - 142	34.2	7X2	1/2
K4.5 - 166	40.0	7X2	1/2
K4.5 - 192	46.4	8-1/8 X 1-7/8	1
K4.5 - 220	63.1	8-1/8 X 1-7/8	1
K5.0 - 166	36.0	7X2	1/2
K5.0 - 192	41.8	8-1/8 X 1-7/8	1
K5.0 - 220	47.8	8-1/8 X 1-7/8	1
3R7	28.0	7X2	1/2
3R8	32.0	7X2	1/2
3R9	38.0	7X2	1/2
3R10	43.0	8-1/8 X 1-7/8	1
3R11	48.0	8-1/8 X 1-7/8	1
3R12	54.0	8-1/8 X 1-7/8	1
HS - 40	40.0	7X2	1/2
HS -50	50.0	8-1/8 X 1-7/8	1

Figure 75

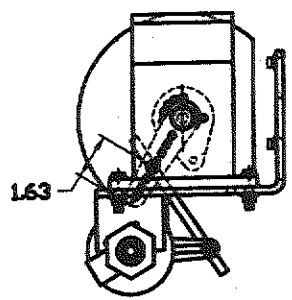
KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-40 and PHX-50 Burners

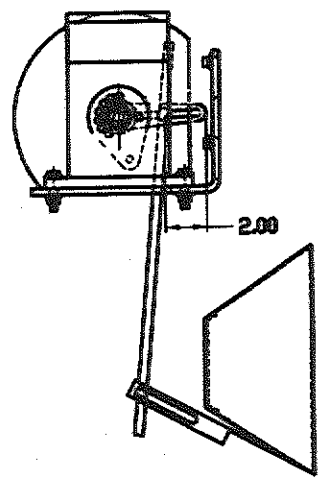
GAS
MODULATION



PRESSURE ATOMIZED OIL
MODULATION



AIR
MODULATION



AIR
ON-OFF

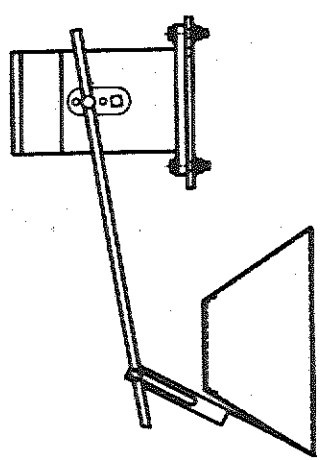


Figure 76

KEWANEE CAMCOMMAND

PHX-40 and PHX-50 Burners

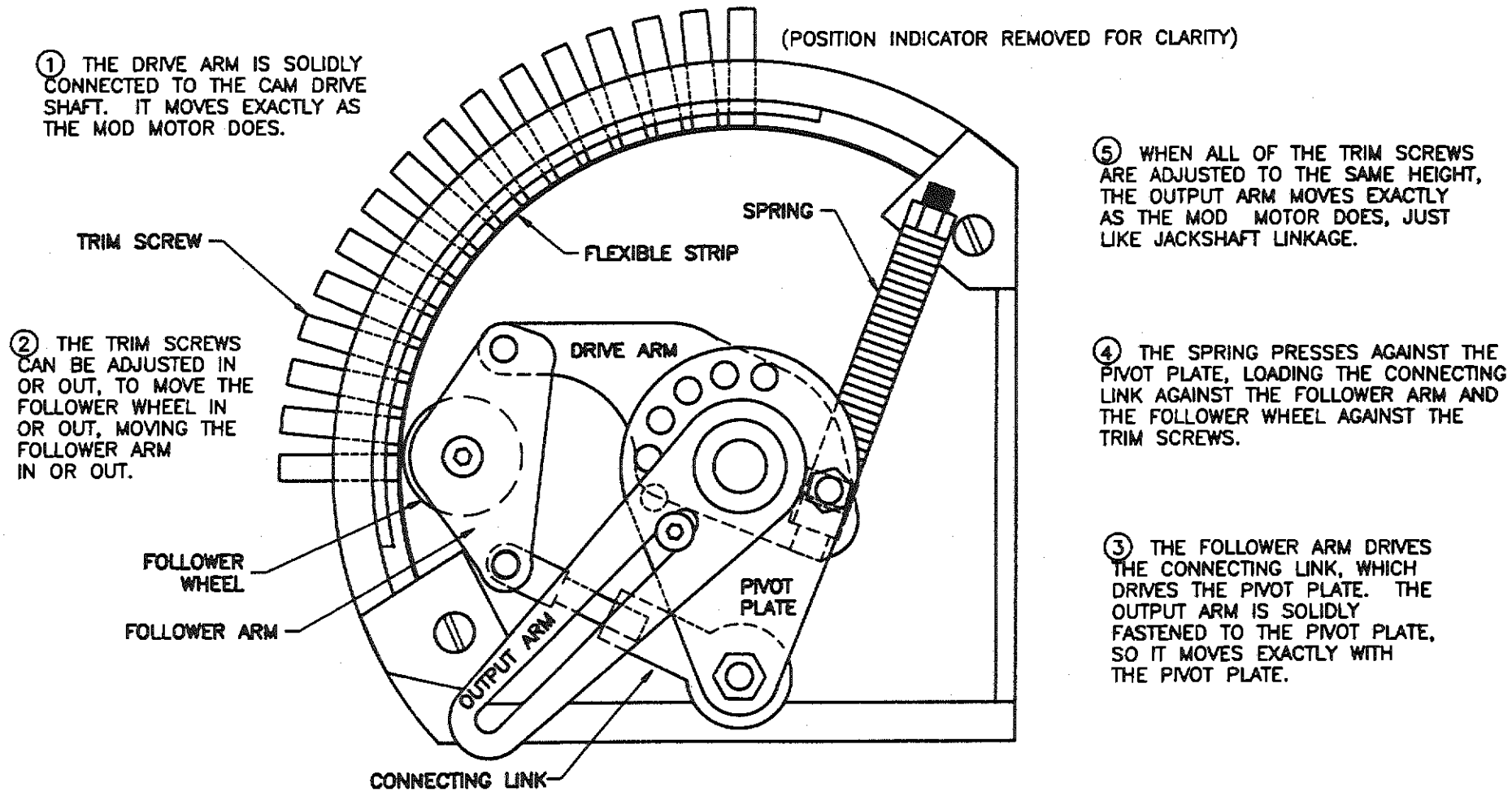
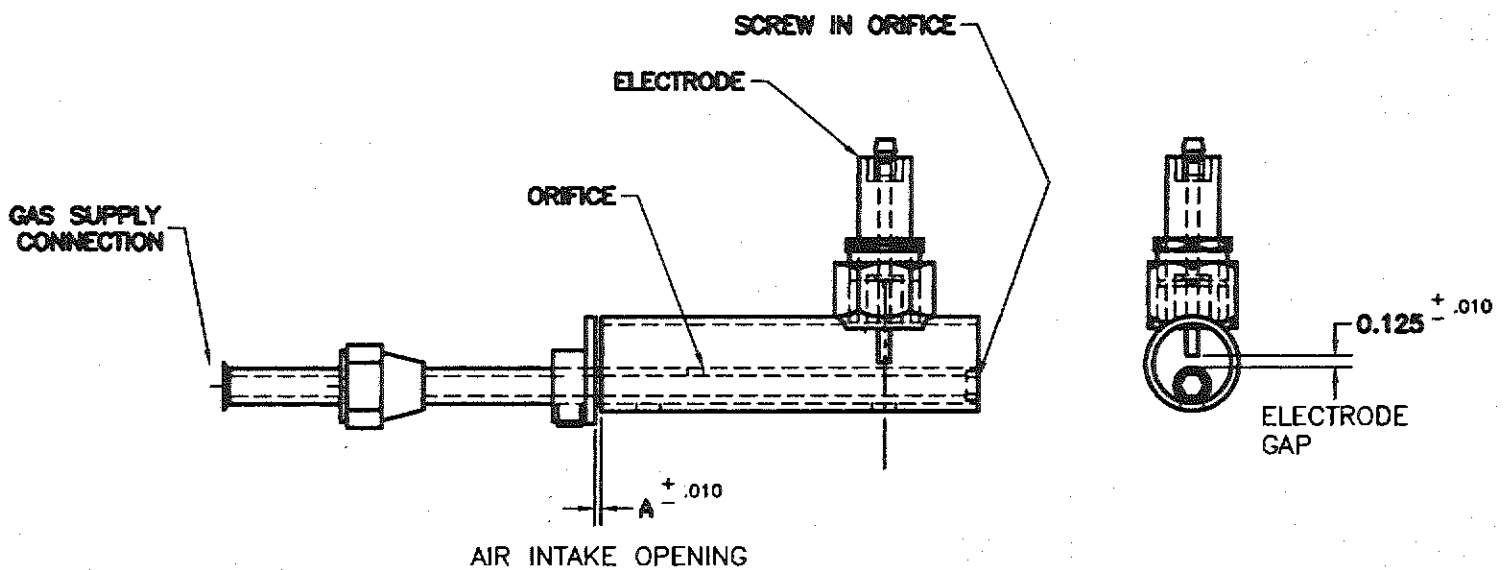


Figure 77

GAS PILOT SETTINGS

PHX-40 and PHX-50 Burners



DIMENSION A	BURNER SIZE
.063	PHX–40 Through PHX–400
.093	PHX–500 Through PHX–800

Figure 78

GAS TRAIN

On-Off
UL and FM - (0 to 2,500,000 BTU)
10 to 50 HP

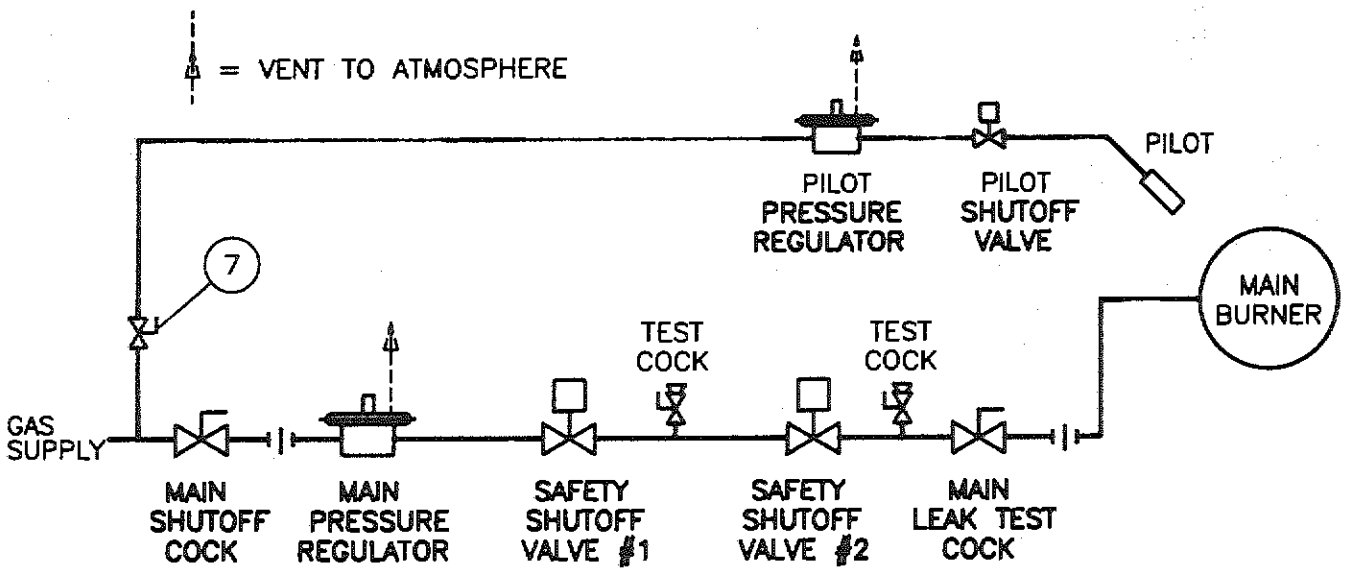


Figure 79

GAS TRAIN

Modulation
UL and FM - (0 to 2,500,000 BTU)
10 to 50 HP

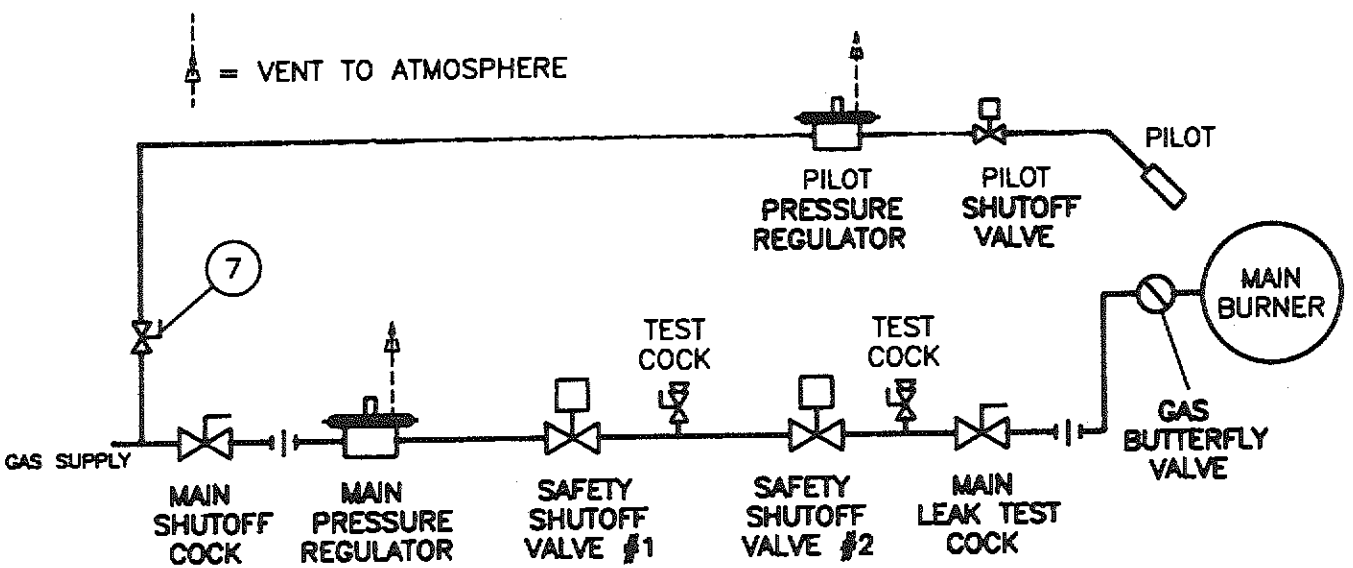


Figure 80

GAS TRAIN

IRI - (0 to 12,000,000 BTU)
10 to 250 HP

UL, FM and IRI - (12,000,000 and Over BTU)
300 HP and Over

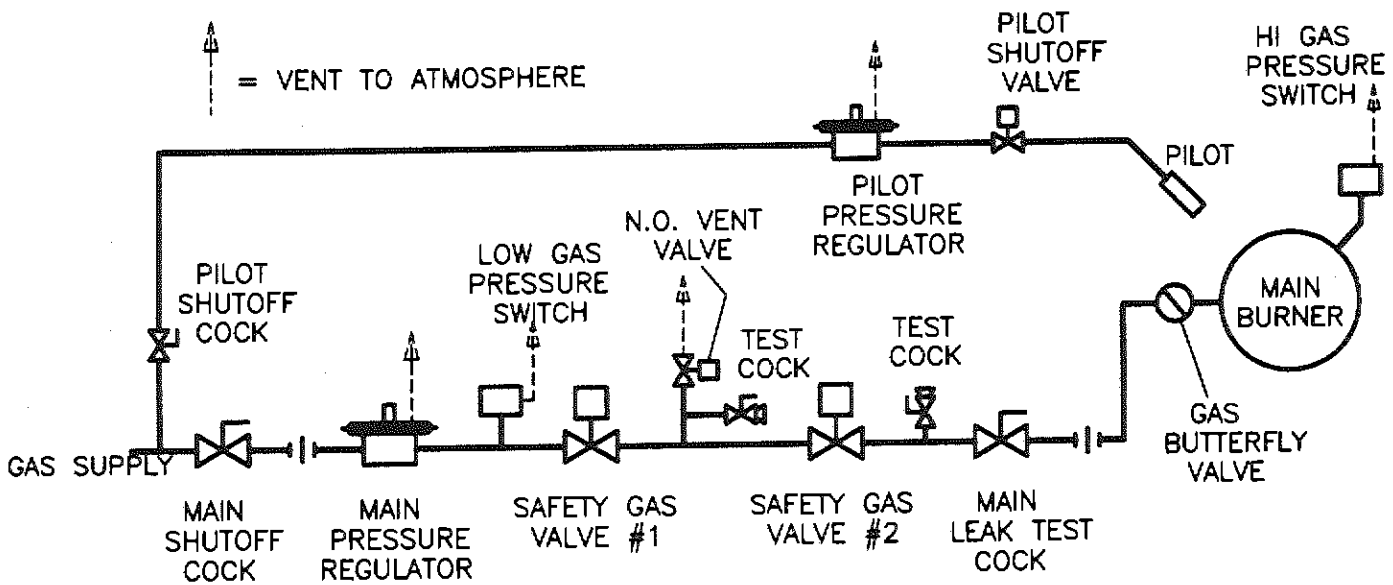


Figure 81

DIRECT SPARK IGNITION SETTINGS

PHX-40 and PHX-50 Burners

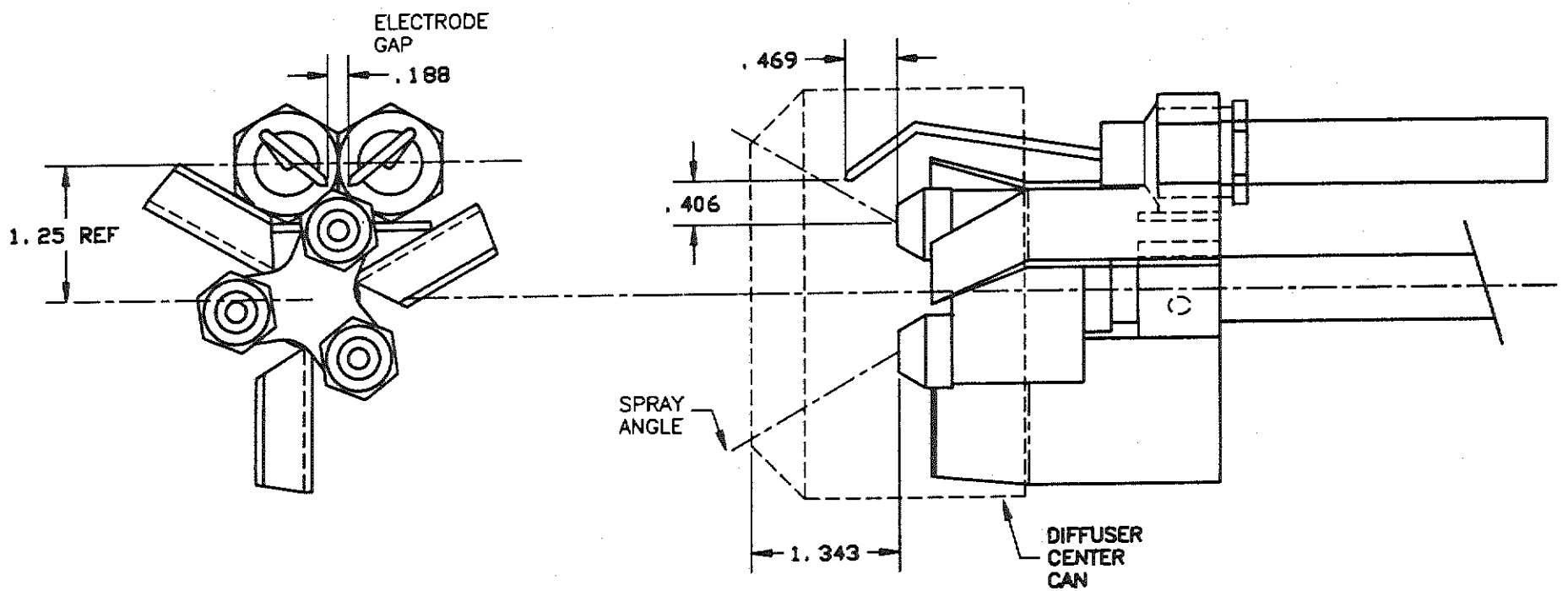
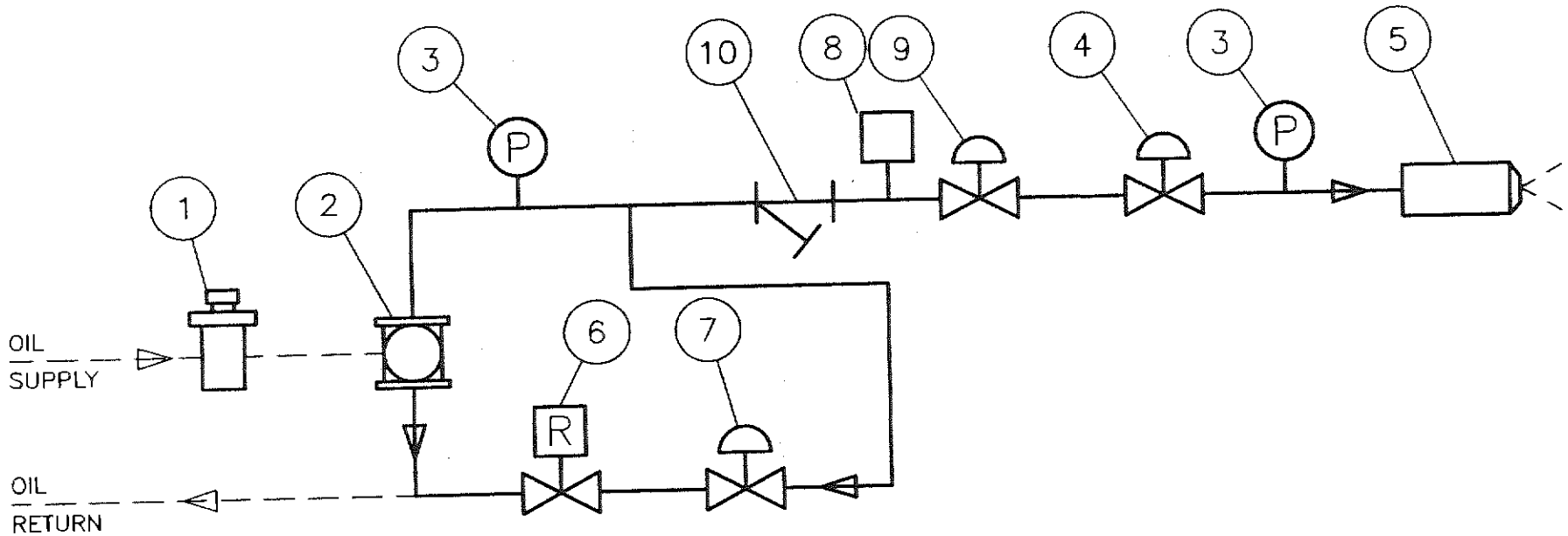


Figure 82

SIMPLEX NOZZLE SYSTEM

High-Low or On-Off with Low Fire Start
Pressure Atomized No. 2 Oil



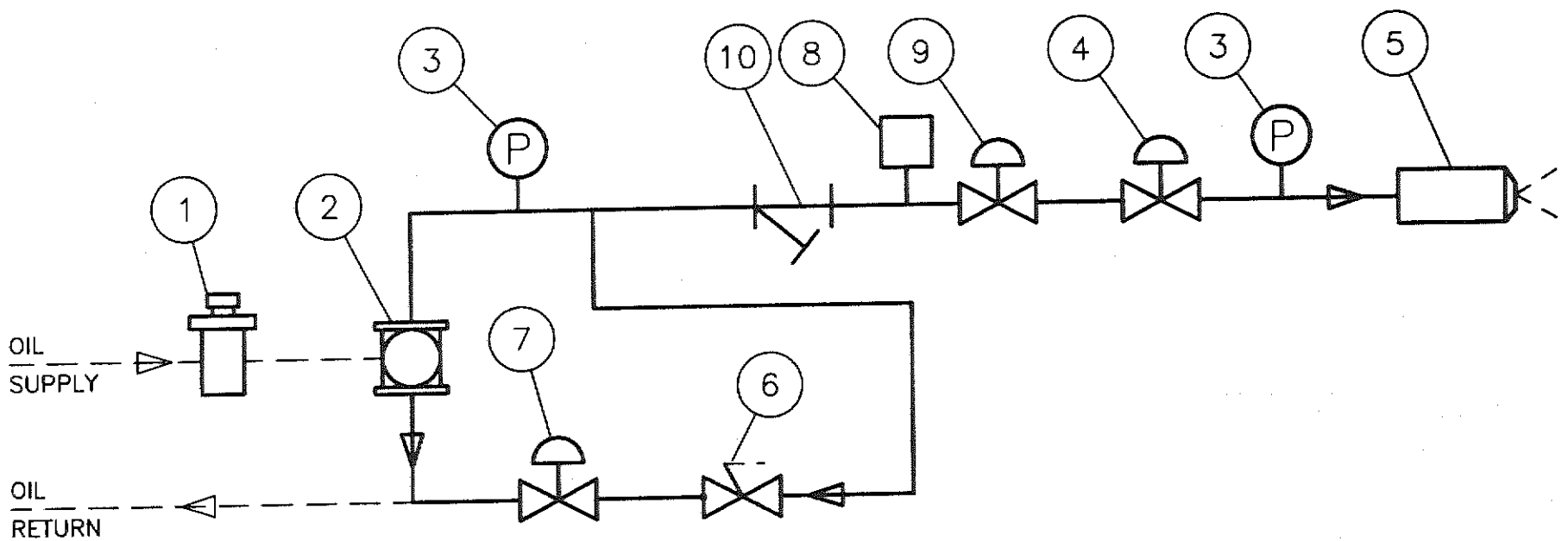
*NOTE: Pump discharge line is piped from pump's gauge port to avoid hydraulic interference between low fire regulator (6) and pump's internal low pressure cut-off.

1. Oil Filter (s)
2. Oil Pump
3. Pressure Gauge(s)
4. Main Oil Valve
5. Oil Nozzle(s)
6. Pressure Regulator
7. By-Pass Oil Valve
8. Low Oil Pressure Interlock
9. Safety Oil Valve
10. Strainer

Figure 83

SIMPLEX NOZZLE SYSTEM

Modulation
Pressure Atomized No. 2 Oil
PHX-40 and PHX-50 Burners



1. Oil Filter (s)
2. Oil Pump
3. Pressure Gauge(s)
4. Main Oil Valve
5. Oil Nozzle(s)
6. Oil Metering Valve
7. By-Pass Oil Valve
8. Low Oil Pressure Interlock
9. Safety Oil Valve
10. Strainer

Figure 84

GENERAL ASSEMBLY DRAWING

PHX-60 and PHX-80 Burners

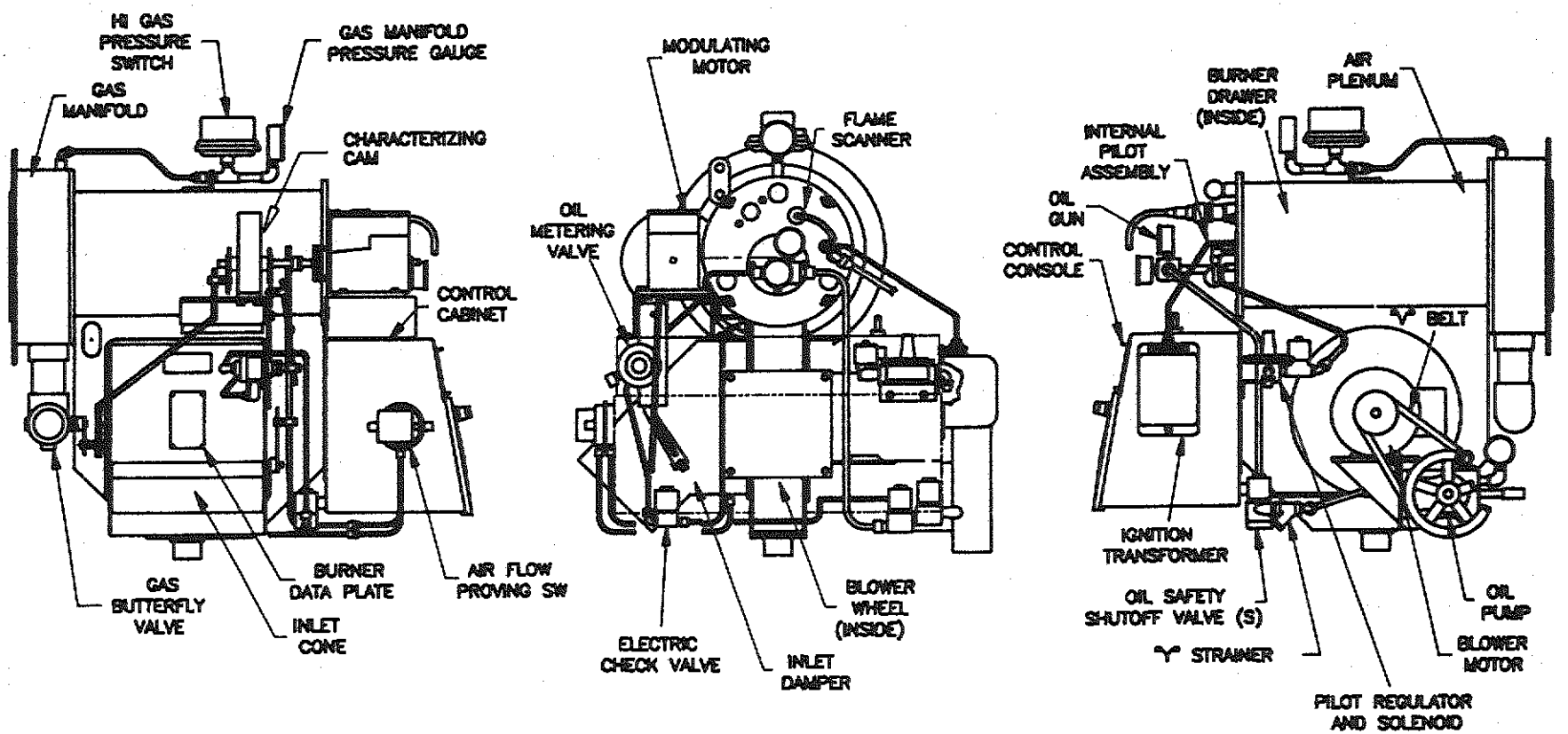


Figure 85

DATA SHEET

PHX-60 and PHX-80 Burners

	PHX-60	PHX-70	PHX-80
Nominal Air Flow CFM: (@ 20% Excess Air)	518	604	690
Blower Wheel Type	Forward Curve	Forward Curve	Forward Curve
Blower Wheel:Diameter x Width	8.25 x 1.75	8.25 x 1.75	9.12 x 2.25
Blower Wheel: Static Pressure @ CFM	7.50" WC @ 518	7.48" WC @ 604	8.50" WC @ 690
Blower Motor: HP	1-1/2 HP -	1-1/2 HP -	1-1/2 HP -
Blower Motor: RPM	3600 RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	56C	56C	56C
Air Damper: (Number of Vanes)	(2)	(2)	(2)
Flow Area H x W	9.5 x 6.56	9.5 x 6.56	9.5 x 6.56
Burner Head Throat Diameter	8.50"	8.50"	8.50"
Nominal Air Velocity Thru Diffuser	125 Ft./Sec.	125 Ft./Sec.	125 Ft./Sec.
Burner Head Attachment to Plenum	Bolted	Bolted	Bolted
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	17.3	20.2	23
Oil Nozzle Type	Simplex	Simplex	Simplex
Standard Make/Spray Pattern	Delavan B	Delavan B	Delavan B
Approved Makes/Spray Patterns	Monarch PLP/ Hago P	Monarch PLP/ Hago P	Monarch PLP/ Hago P
Oil Nozzles:(Quantity)	(3)	(3)	(3)
GPH x Spray Angle	4.0 x 80°	4.0 x 80°	5.0 x 80°
Oil Pump Capacity: GPH @ PSI	23.0 @ 300	23.0 @ 300	23.0 @ 300
Oil Pump Mounting: On Burner/Remote	On Burner	On Burner	On Burner
Oil Pressure Regulator: In Pump/Separate	In Pump	In Pump	In Pump
Regulated Oil Pressure	300 PSI	300 PSI	300 PSI

	PHX-60	PHX-70	PHX-80
Gas Firing Rate (Nat. Gas @ 80% Eff.)	2,511	2,929	3,348
Gas Orifices: Body Size	3/8 - 18 NPT	3/8 - 18 NPT	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(15) .242	(15) .261	(15) .281
Nominal Gas Velocity Thru Orifices	144.0 Ft./Sec.	144.4 Ft./Sec.	142.4 Ft./Sec.
Butterfly Valve Pipe Size	1-1/2"	1-1/2"	1-1/2"
Gas Head Pressure (@ 0.0" Furnace Pressure)	4.20" WC	4.22" WC	4.11" WC
Standard Firing Rate Control System	Hi/Low w/LFS	Hi/Low w/LFS	Hi/Low w/LFS
Optional Firing Rate Control System	Modulation	Modulation	Modulation
Standard Turndown Ratio Gas (Oil)	3 : 1 (1.73 : 1)	3 : 1 (1.73 : 1)	3 : 1 (1.73 : 1)
Standard Ignition System - Gas or Oil Firing	Gas Pilot	Gas Pilot	Gas Pilot
Standard Ignition System - Oil Firing Only	Direct Spark	Direct Spark	Direct Spark
Standard Main Power Supply	230 / 3 / 60 115 / 1 / 60	230 / 3 / 60 115 / 1 / 60	230 / 3 / 60 115 / 1 / 60
Control Circuit Power Supply	Nat. Gas, LP,	Nat. Gas, LP,	Nat. Gas, LP,
Standard Fuels Available	#2-#5 Oil	#2-#5 Oil	#2-#5 Oil
Code Constructions Available	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI

Figure 86

INITIAL ADJUSTMENTS GAS SLEEVE AND DIFFUSER

PHX-60 through PHX-80 Burners

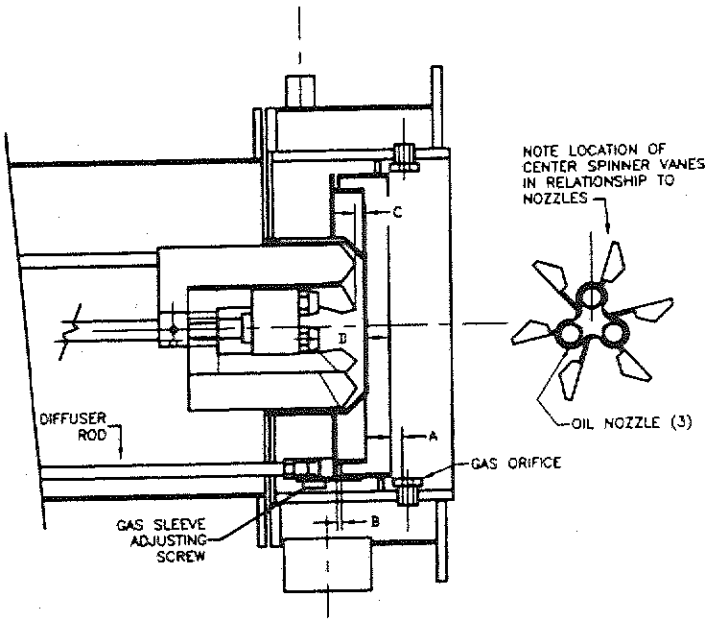
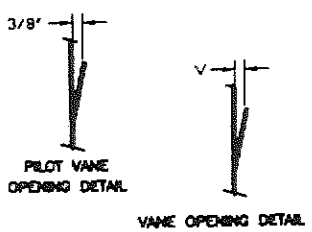


TABLE OF ADJUSTMENT ON SIZE 3

BOILER	BHP	ORIFICE	OIL NOZZLE	A	B	C	D	V	>	BLOWER
K4.0-220	59.7	C	3 Del. 4.0 GPH 80°B	1/2	0	7/8	1 1/16	1/8	40°	RB25-175
K5.0-253	55	A	3 Del. 3.5 GPH 80°B	1/2	0	27/32	1	1/8	40°	RB25-175
L3SW, L3W L3S, H3S	60	C	3 Del. 4.0 GPH 80°B	1/2	0	29/32	1 1/16	1/8	40°	RB25-175
K4.5-253, M205K K5.0-284	61.1	C	3 Del. 4.0 GPH 80°B	1/2	0	29/32	1 3/32	1/8	40°	RB25-175
K5.0-315	61.8	C	3 Del. 4.0 GPH 80°B	1/2	0	15/16	1 3/32	1/8	40°	RB25-175
K4.0-253	68.6	G	3 Del. 4.5 GPH 80°B	1/2	0	1	1 9/32	1/8	40°	RB25-175
K4.5-284	68.7	G	3 Del. 4.5 GPH 80°B	1/2	0	1	1 9/32	1/8	40°	RB25-175
M235K L3SW, L3W L3S, H3S	70	G	3 Del. 4.5 GPH 80°B	1/2	0	1	1 11/32	3/16	30°	RB25-175
K4.5-315	76.2	I	3 Del. 5.0 GPH 80°B	1/2	1/32	1 1/16	1 1/2	3/16	30°	RB12-225
K4.0-284	77.2	I	3 Del. 5.0 GPH 80°B	1/2	1/32	1 1/16	1 1/2	3/16	30°	RB12-225
7L280-K	79	I	3 Del. 5.0 GPH 80°B	1/2	1/32	1 3/32	1 9/16	3/16	30°	RB12-225
M 285-K L3SW, L3W L3S,H3S	80	9/32	3 Del. 5.0 GPH 80°B	1/2	1/32	1 3/32	1 19/32	3/16	30°	RB12-225
K4.0-315	85.7	9/32	3 Del. 5.5 GPH 80°B	1/2	3/32	1 7/32	1 3/16	3/16	30°	RB12-225

A=GAS SLEEVE POSITION--FOR GAS OR GAS/OIL
B=GAS SLEEVE GAP
C=CENTER SPINNER POSITION
D=NOZZLE POSITION
V=DIFFUSER VANE GAP
>=CENTER SPINNER ANGLE



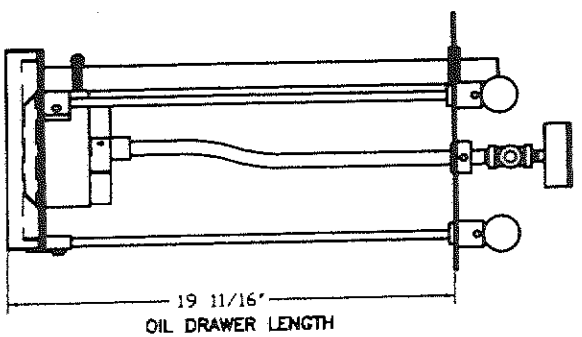
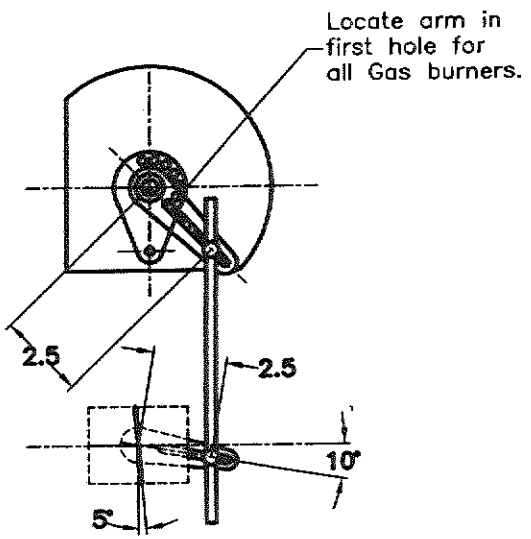


Figure 87

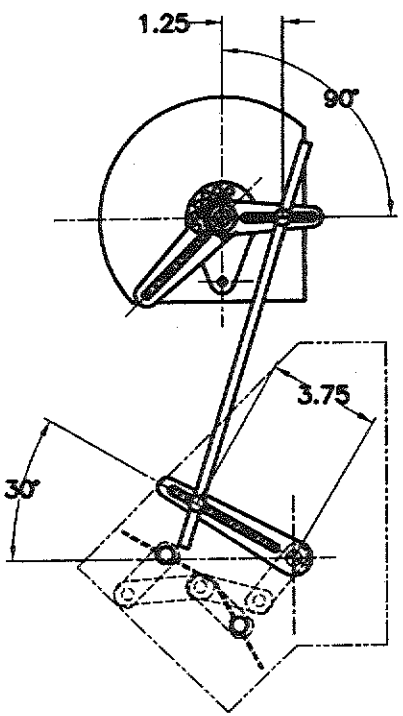
KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-60 and PHX-80 Burners

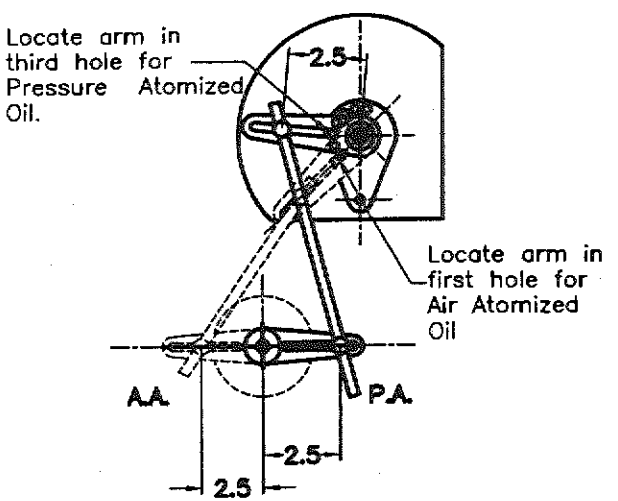
GAS



AIR



OIL



NOTE: on "Oil" drawing above, A.A. represents Air Atomized and P.A. represents Pressure Atomized

Figure 88

KEWANEE CAMCOMMAND

PHX-60 through PHX-80 Burners

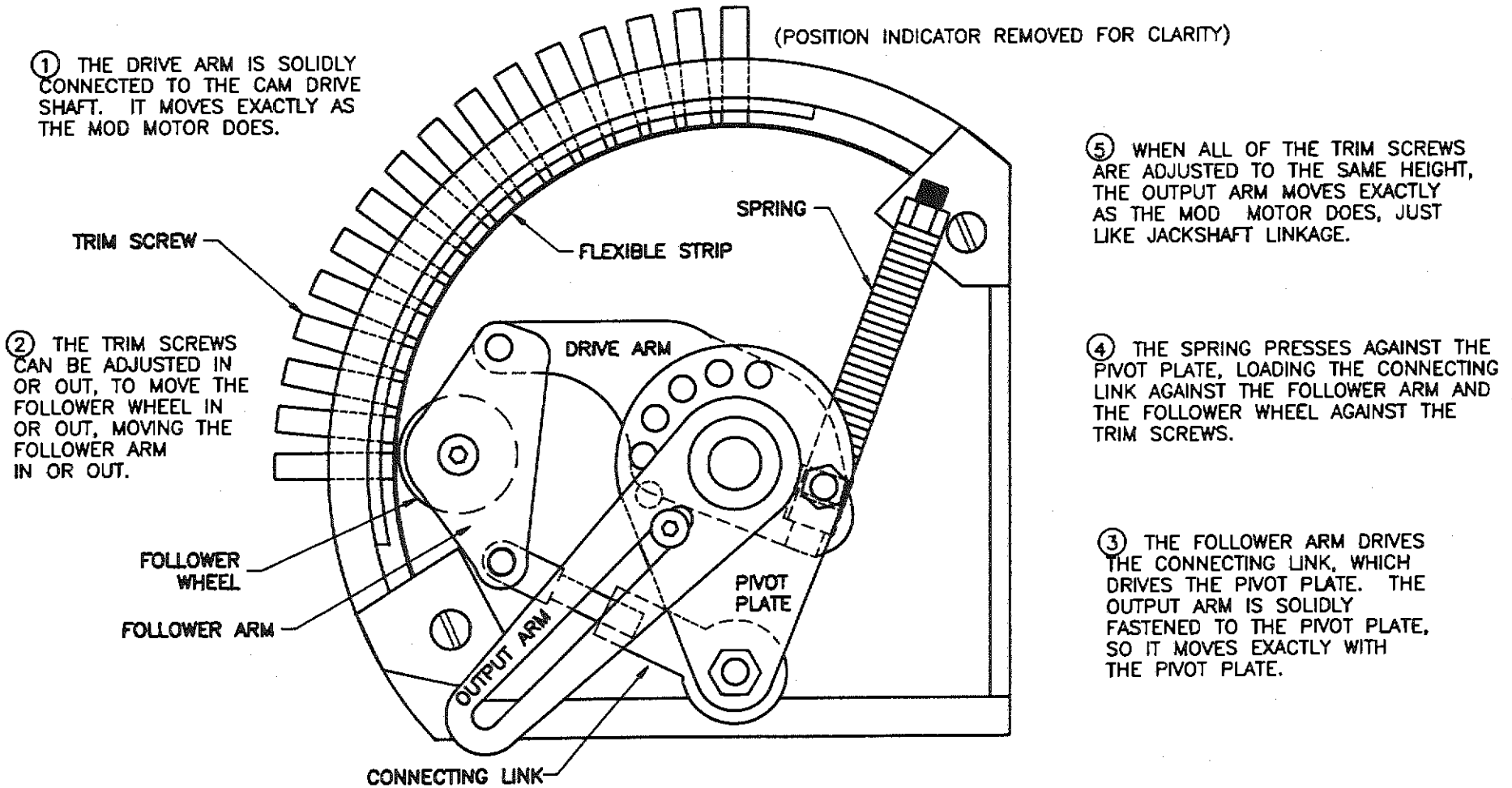
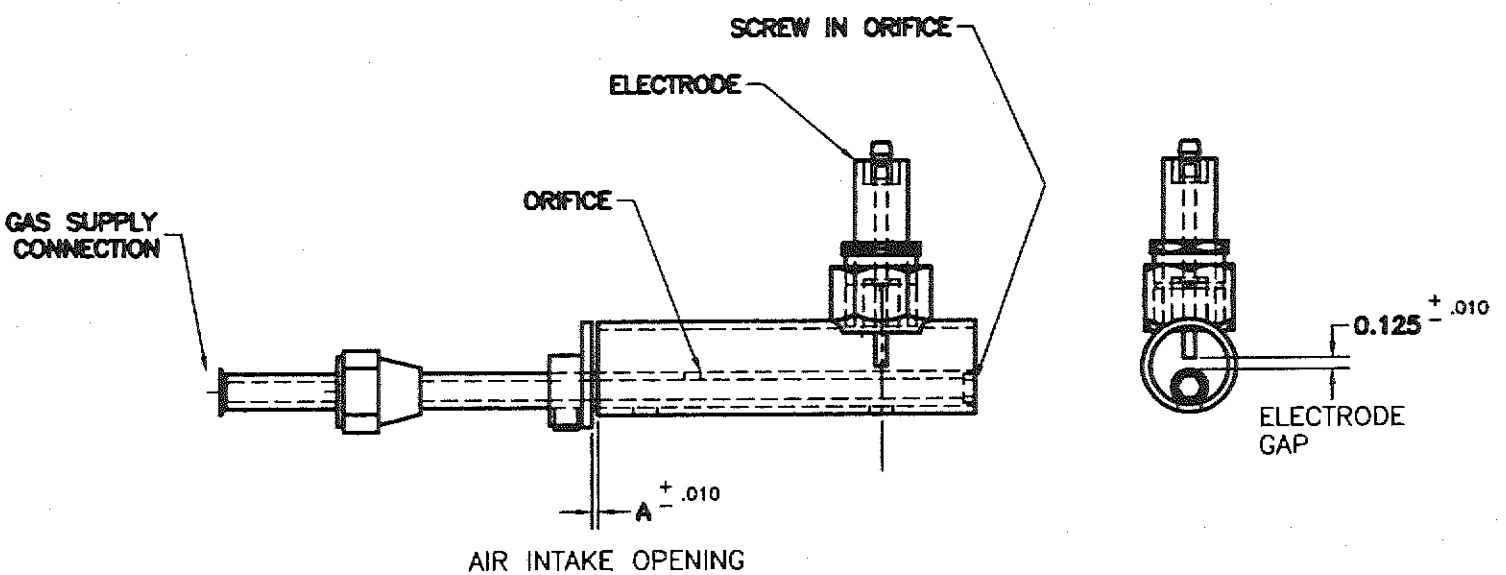


Figure 89

GAS PILOT SETTINGS

PHX-60 through PHX-80 Burners



DIMENSION A	BURNER SIZE
.063	PHX-40 Through PHX-400
.093	PHX-500 Through PHX-800

Figure 90

GAS TRAIN

UL and FM - (2,500,000 to 12,000,000 BTU)
60 to 250 HP

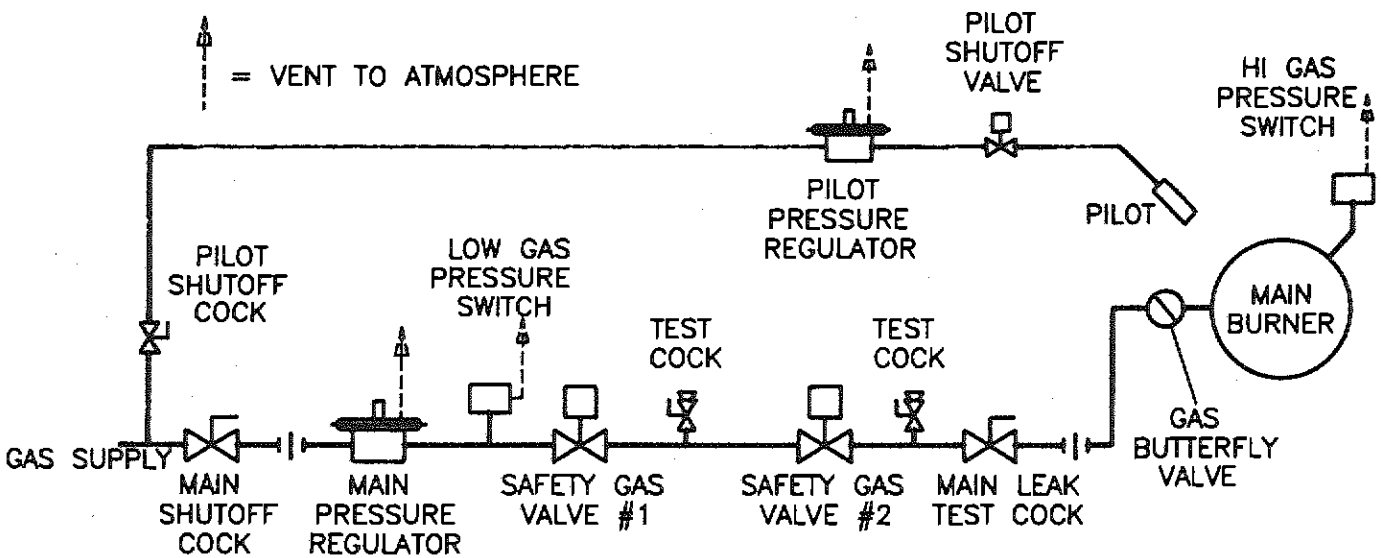


Figure 91

GAS TRAIN

IRI - (0 to 12,000,000 BTU)
10 to 250 HP

UL, FM and IRI - (12,000,000 and Over BTU)
300 HP and Over

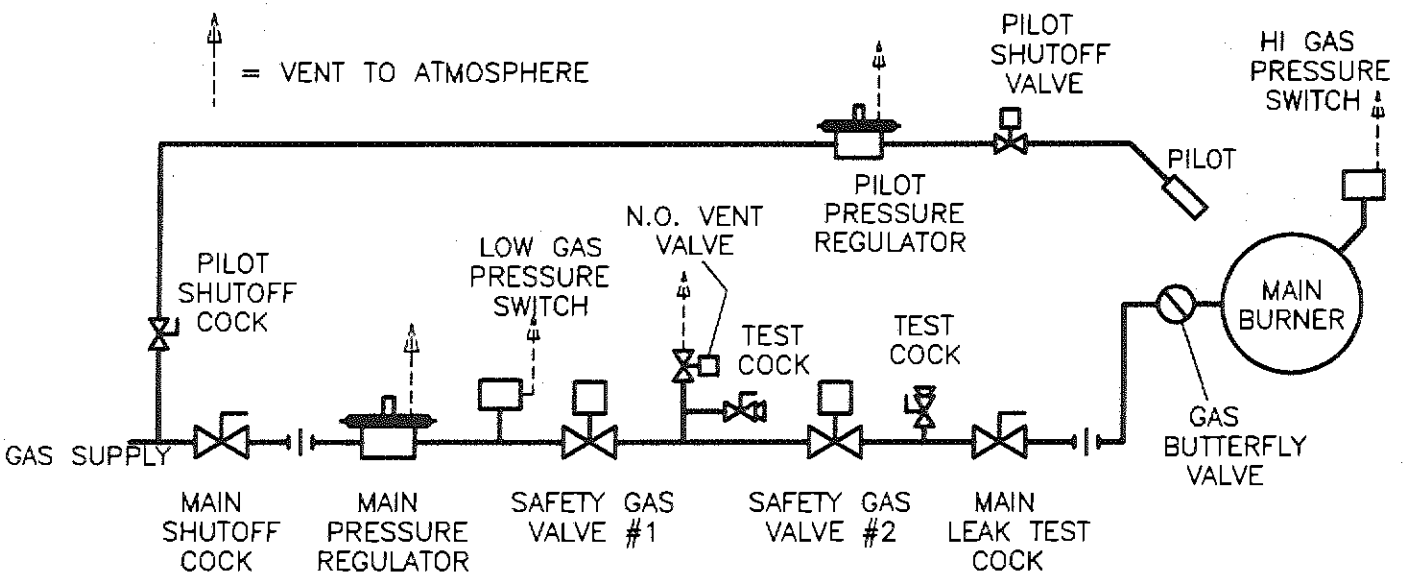


Figure 92

DIRECT SPARK IGNITION SETTINGS

PHX-60 through PHX-80 Burners

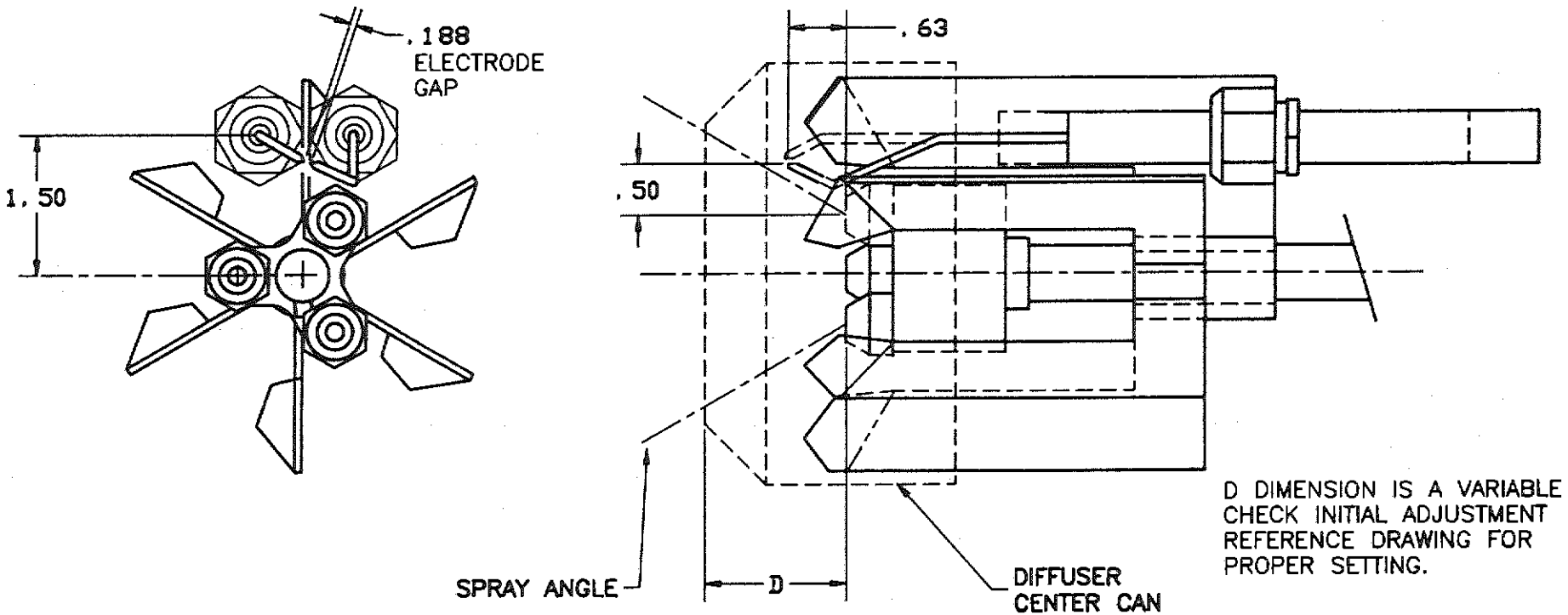
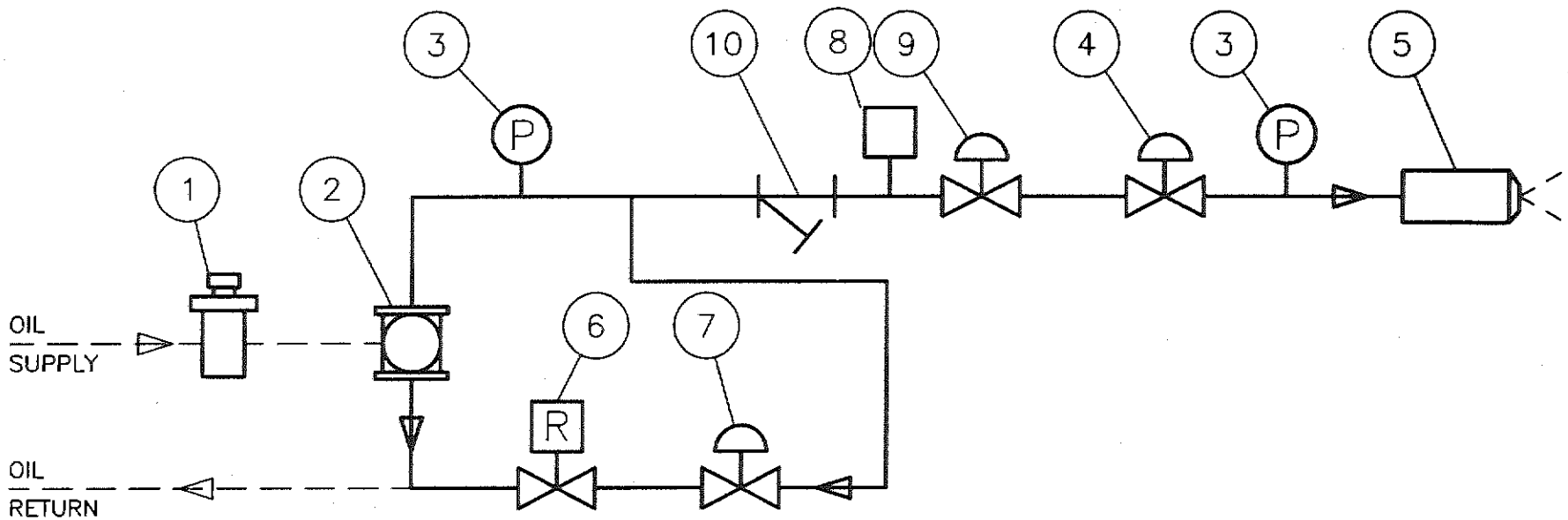


Figure 93

SIMPLEX NOZZLE SYSTEM

High-Low or On-Off with Low Fire Start
Pressure Atomized No. 2 Oil



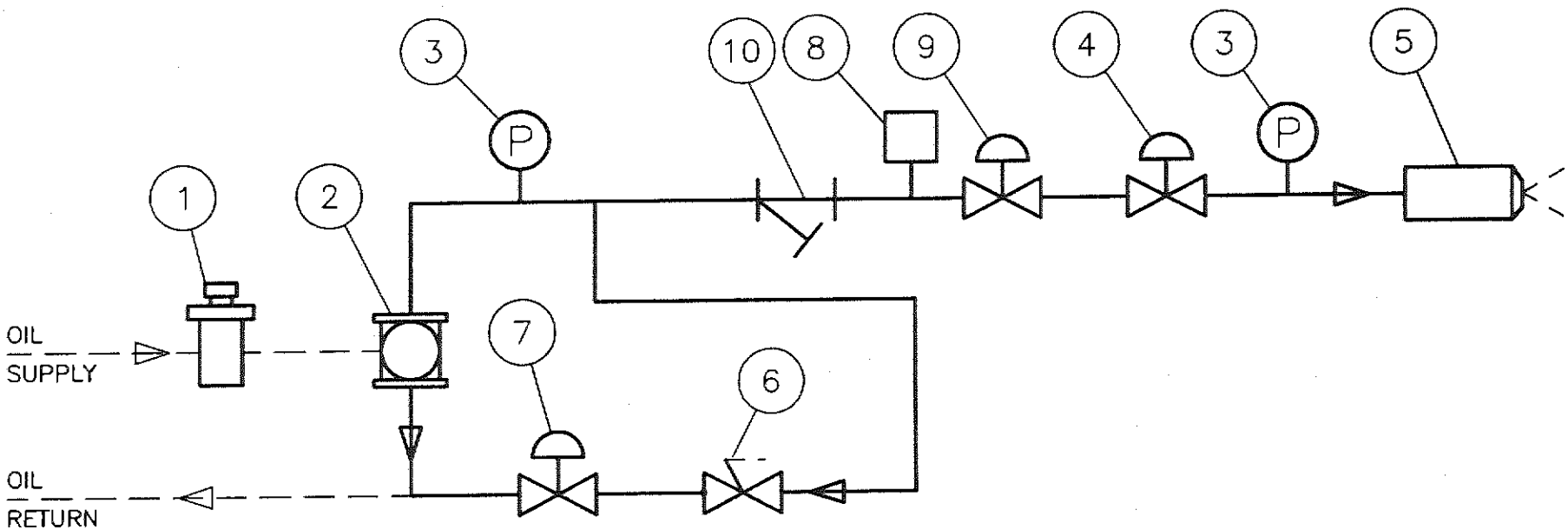
*NOTE: Pump discharge line is piped from pump's gauge port to avoid hydraulic interference between low fire regulator (6) and pump's internal low pressure cut-off.

1. Oil Filter (s)
2. Oil Pump
3. Pressure Gauge(s)
4. Main Oil Valve
5. Oil Nozzle(s)
6. Pressure Regulator
7. By-Pass Oil Valve
8. Low Oil Pressure Interlock
9. Safety Oil Valve
10. Strainer

Figure 94

SIMPLEX NOZZLE SYSTEM

Modulation
Pressure Atomized No. 2 Oil
PHX-60 and PHX-80 Burners

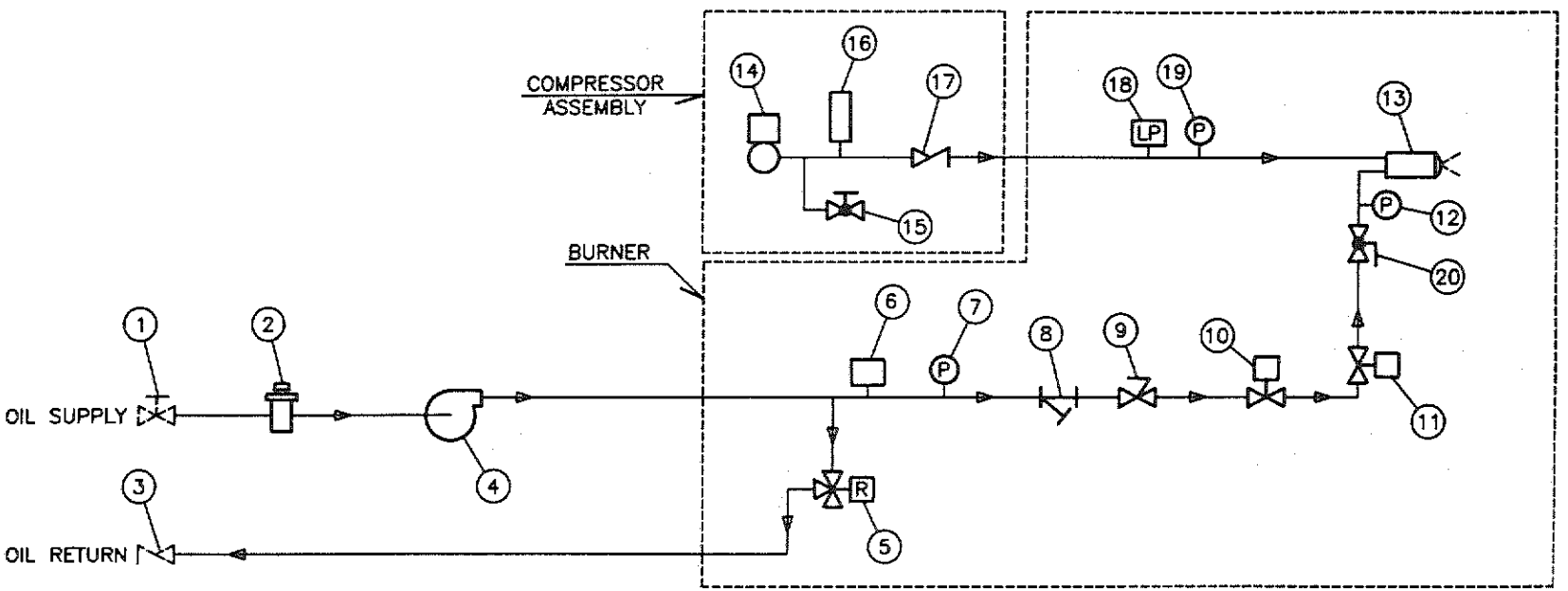


1. Oil Filter (s)
2. Oil Pump
3. Pressure Gauge(s)
4. Main Oil Valve
5. Oil Nozzle(s)
6. Oil Metering Valve
7. By-Pass Oil Valve
8. Low Oil Pressure Interlock
9. Safety Oil Valve
10. Strainer

Figure 95

AIR ATOMIZING OIL NOZZLE SYSTEM

Modulation
Air Atomized No. 2 Oil
PHX-60 through PHX-80 Burners



1. Oil Supply Gate Valve (By Others)
2. Oil Strainer
3. Oil Return Check Valve (By Others)
4. Oil Pump
5. Oil Pressure Regulating Valve
6. Low Oil Pressure Switch
7. Oil Pressure Gauge
8. Secondary Oil Strainer
9. Oil Metering Valve
10. Main Oil Valve, N.C.
11. Safety Oil Valve, N.C.
12. Nozzle Oil Pressure Gauge
13. Air Atomizing Oil Nozzle
14. Air Compressor
15. Air Bleed Needle Valve (If Used)
16. Compressor Dampening Tank
17. Air Check Valve
18. Low Atomizing Air Switch
19. Nozzle Air Pressure Gauge
20. Oil Shutoff Valve (If Used)

Figure 96

GENERAL ASSEMBLY DRAWING

PHX-100 and PHX-125 Burners

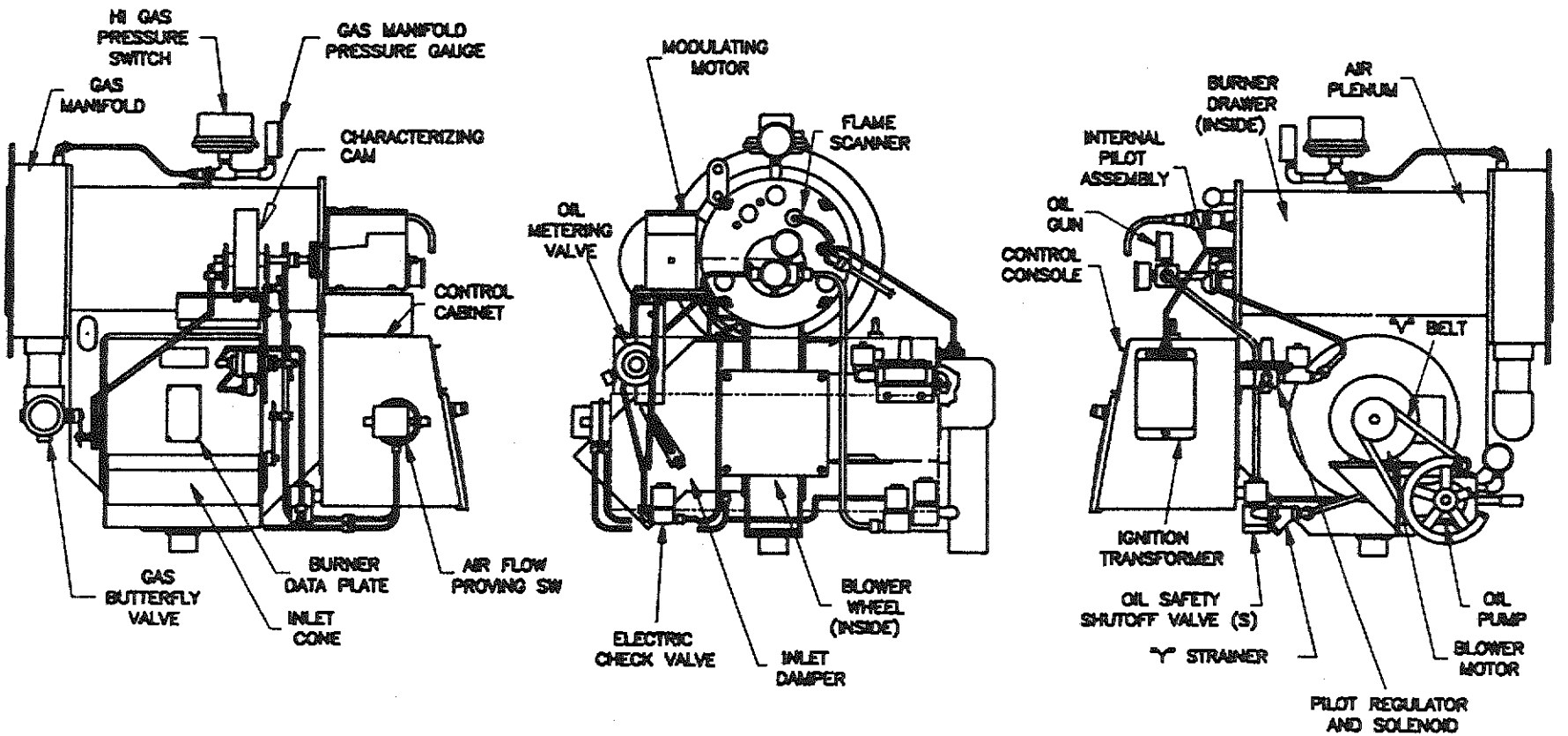


Figure 97

DATA SHEET

PHX-100 and PHX-125 Burners

	PHX-100	PHX-125
Nominal Air Flow CFM: (@ 20% Excess Air)	863	1078
Blower Wheel Type	Forward Curve	Forward Curve
Blower Wheel: Diameter x Width	9.12 x 2.25	9.87 x 3.25
Blower Wheel: Static Pressure @ CFM	8.44" WC @ 863	10.97" WC @ 1078
Blower Motor: HP	3 HP	5 HP
Blower Motor: RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	56C	182T
Air Damper: (Number of Vanes)	(2)	(2)
Flow Area H x W	11.5 x 7.716	11.5 x 7.716
Burner Head Throat Diameter	9.50"	9.50"
Nominal Air Velocity Thru Diffuser	126 Ft./Sec.	143 Ft./Sec.
Burner Head Attachment to Plenum	Bolted	Bolted
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	28.8	36
Oil Nozzle Type	Return Flow	Return Flow
Standard Make/Spray Pattern	Delavan Variflo	Delavan Variflo
Approved Makes/Spray Patterns	Monarch BPS	Monarch BPS
Oil Nozzles:(Quantity)	(3)	(3)
GPH x Spray Angle	6.0 x 80°	7.5 x 80°
Oil Pump Capacity: GPH @ PSI	50 @ 300	50 @ 300
Oil Pump Mounting: On Burner/Remote	On Burner	Remote
Oil Pressure Regulator:In Pump/Separate	In Pump	In Pump
Regulated Oil Pressure	300 PSI	300 PSI

	PHX-100	PHX-125
Gas Firing Rate (Nat. Gas @ 80% Eff.)	4,184	5,230
Gas Orifices: Body Size	3/8 - 18 NPT	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(15) .328	(15) .358
Nominal Gas Velocity Thru Orifices	130.6 Ft./Sec.	137.1 Ft./Sec.
Butterfly Valve Pipe Size	2"	2"
Gas Head Pressure (@ 0.0" Furnace Pressure)	3.45" WC	3.80" WC
Standard Firing Rate Control System	Modulation	Modulation
Standard Turndown Ratio Gas and Oil	3 : 1	3 : 1
Standard Ignition System -		
Gas or Oil Firing	Gas Pilot	Gas Pilot
Optional Ignition System - Oil Firing Only	Direct Spark	Direct Spark
Standard Power Supply	230 / 3 / 60	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2-#6 Oil	Nat. Gas, LP, #2-#6 Oil
Code Constructions Available	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI

Figure 98

INITIAL ADJUSTMENTS GAS SLEEVE AND DIFFUSER

PHX-100 through PHX-125 Burners

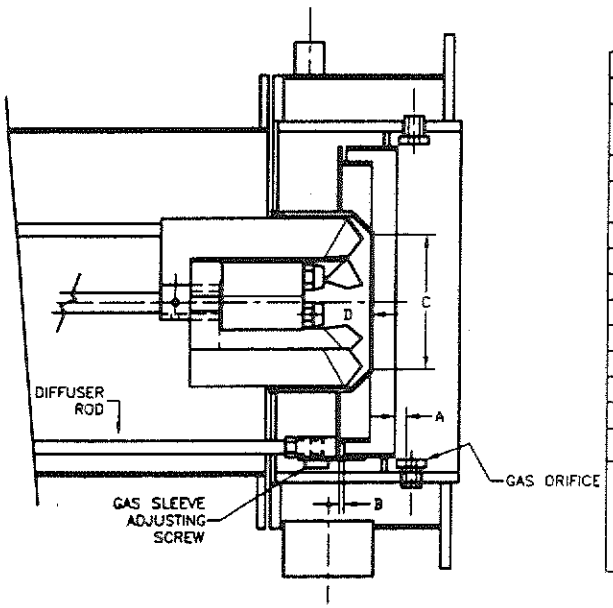
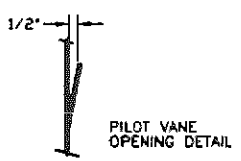


TABLE OF ADJUSTMENT ON SIZE 4

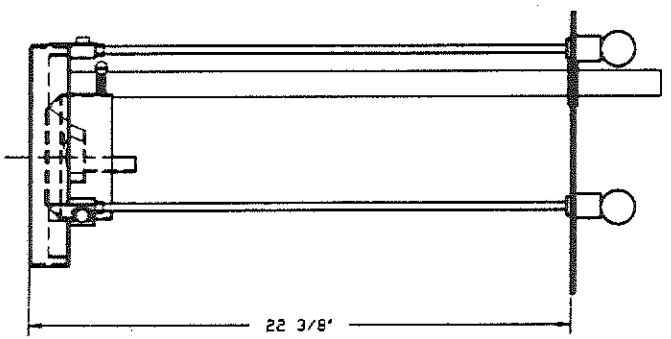
BOILER	BHP	ORIFICE	OIL NOZZLE	A	B	C	D	V	>	BLOWER
K5.0-418	90	N (.3020)	3 Del. 5.5 GPH 80°B	1/2	1/32	3.78	1 11/16	1/8	40°	R912x225
M-335K K4.5-418 CLASSIC III	100	21/64 (.3281)	3 Del. 6.0 GPH 80°B	1/2	1/32	3.78	1 11/16	3/16	40°	R912x225
K5.0-521	112.4	Q (.3320)	3 Del. 6.5 GPH 80°B	1/2	1/32	3.78	1 11/16	3/16	40°	R912x225
K4.0-418	112.5	Q (.3320)	3 Del. 6.5 GPH 80°B	1/2	1/32	3.78	1 11/16	3/16	40°	R912x225
7L282K	113	Q (.3320)	3 Del. 7.0 GPH 80°B	1/2	1/32	3.78	1 11/16	3/16	40°	R912x225
K4.5-521	124.9	T (.3580)	3 Del. 7.5 GPH 80°B	1/2	1/16	3.78	1 11/16	1/4	40°	R987x325
CLASSIC III	125	T (.3580)	3 Del. 7.5 GPH 80°B	1/2	1/32	3.78	1 11/16	1/4	40°	R987x325
M425K	126.9	T (.3580)	3 Del. 7.5 GPH 80°B	1/2	1/32	4.09	2 1/4	1/4	40°	R987x325
7L283K	132	T (.3580)	3 Del. 8.0 GPH 80°B	1/2	1/32	4.09	2 1/4	1/4	40°	R987x325
K5.0-619	135	U (.3680)	3 Del. 8.0 GPH 80°B	1/2	1/32	4.09	2 1/4	5/16	40°	R987x325
K4.0-521	140.5	V (.3770)	3 Del. 8.0 GPH 80°B	1/2	1/32	4.09	2 1/4	5/16	40°	R987x325

A=GAS SLEEVE POSITION FOR GAS OR GAS/OIL
B=GAS SLEEVE GAP
C=EXIT DIA. OF CENTER CONE
D=NOZZLE POSITION
V=DIFFUSER VANE GAP
>=CENTER SPINNER ANGLE

VANE OPENING DETAIL



PILOT VANE OPENING DETAIL

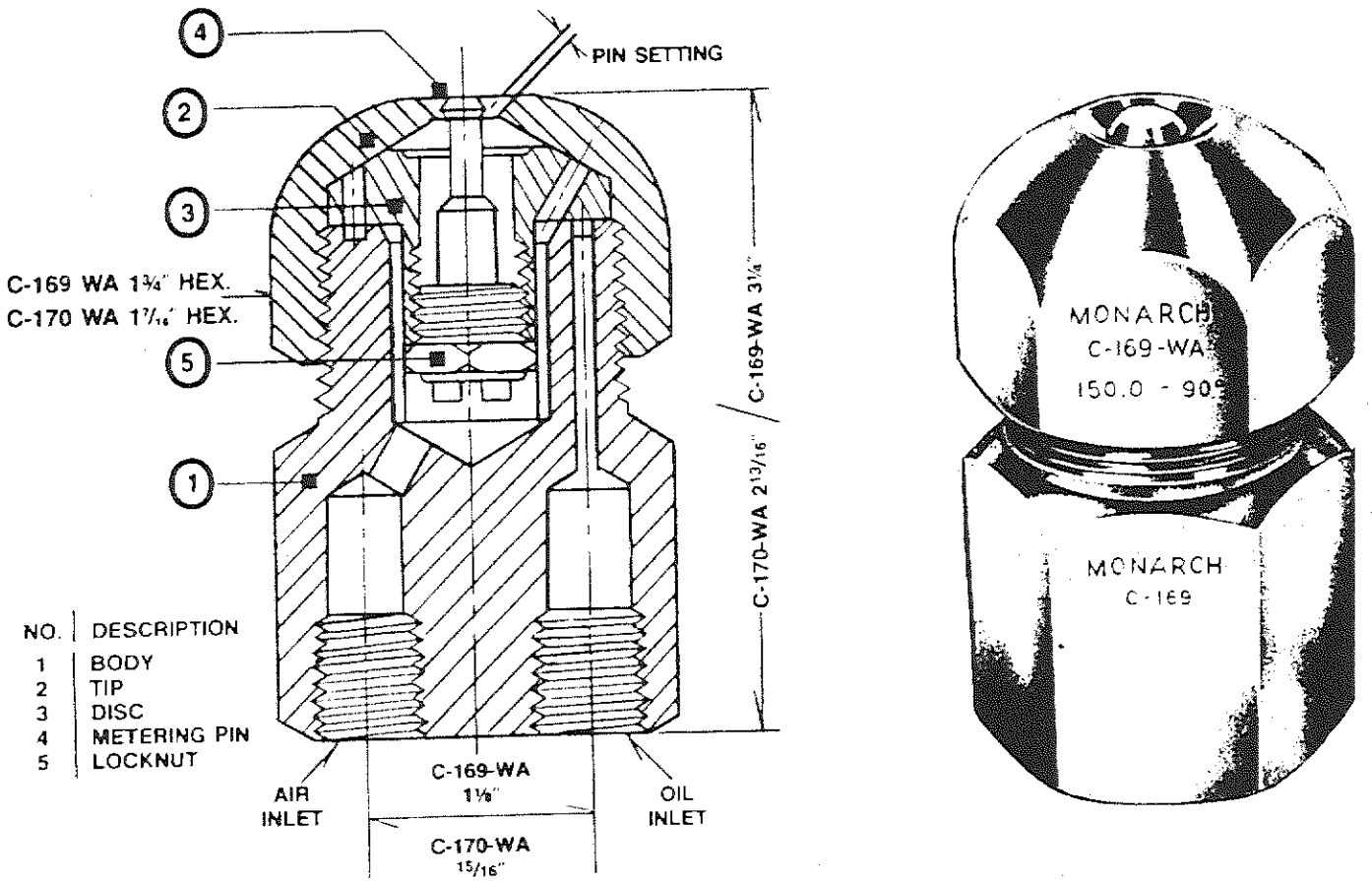


OIL DRAWER LENGTH

Figure 99

MONARCH AIR ATOMIZED NOZZLE ASSEMBLY

PHX-100 through PHX-125 Burners



NOTE: Application will vary with burner configuration and firing rate

Figure 100

INITIAL NOZZLE PIN SETTINGS

PHX-100 through PHX-125 Burners

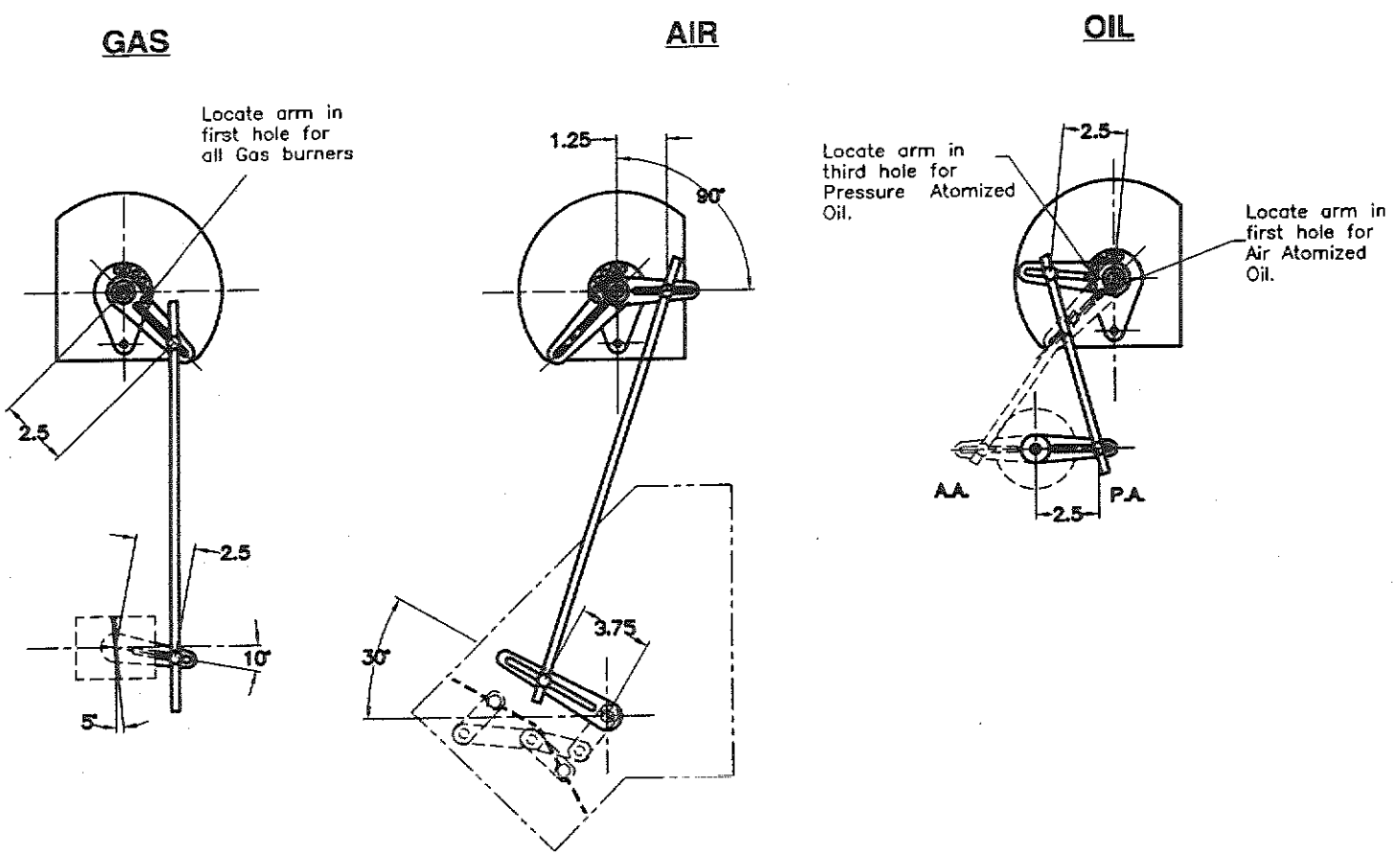
BURNER MODEL	FIGURE NUMBER	RATED GPH*	NPT CONNECTIONS		PIN SETTING
			AIR	OIL	
PHX–100	C–169–WA	30	1/4"	1/4"	.062"
PHX–125		40	1/4"	1/4"	.062"

* With air at 15 PSI and No. 2 oil at 26 PSI **OR** with air at 21 PSI and No. 2 oil at 31 PSI

Figure 101

KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-100 and PHX-125 Burners



NOTE: on "Oil" drawing above, A.A. represents Air Atomized and P.A. represents Pressure Atomized

Figure 102

KEWANEE CAMCOMMAND

PHX-100 through PHX-125 Burners

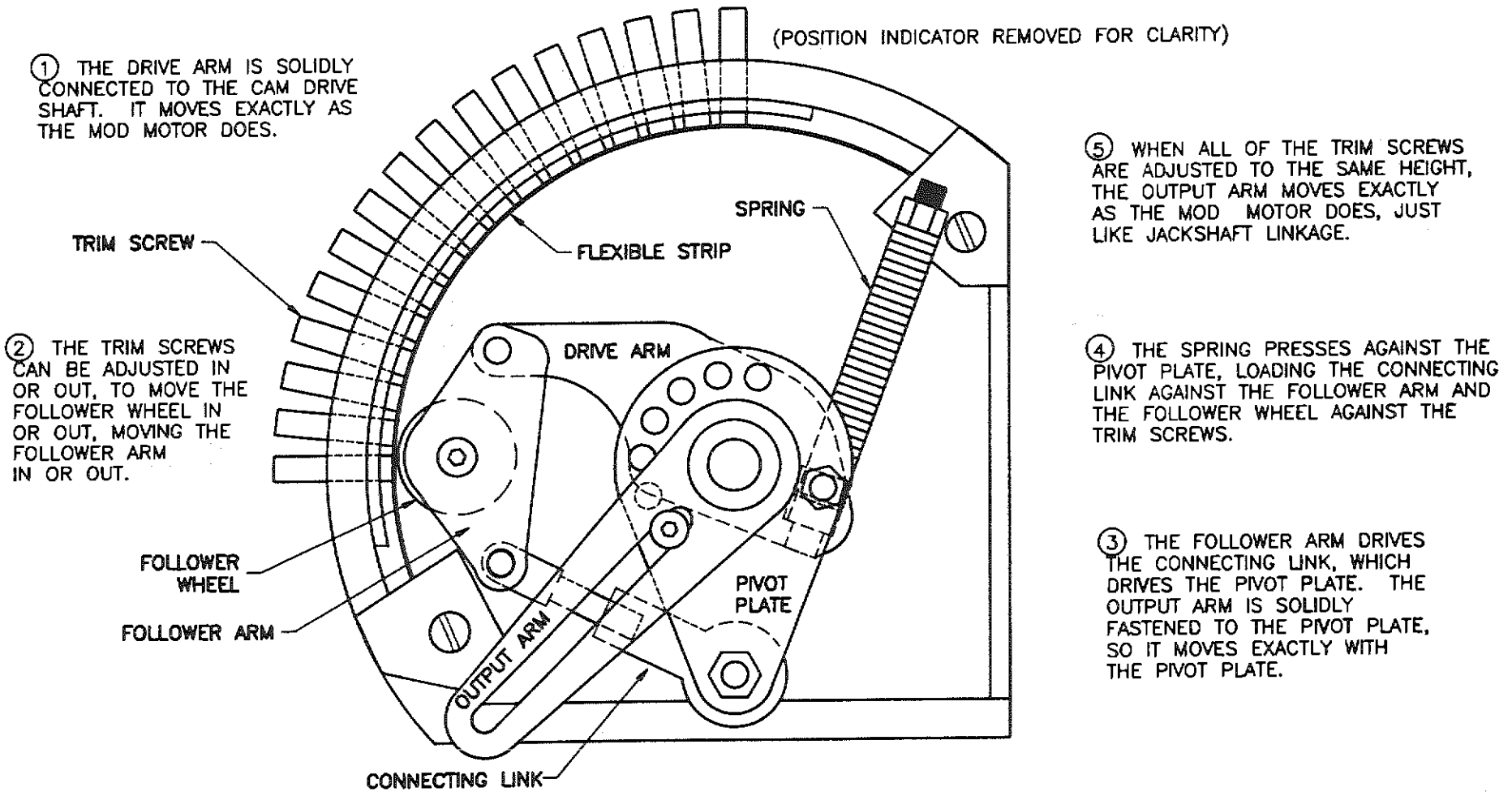
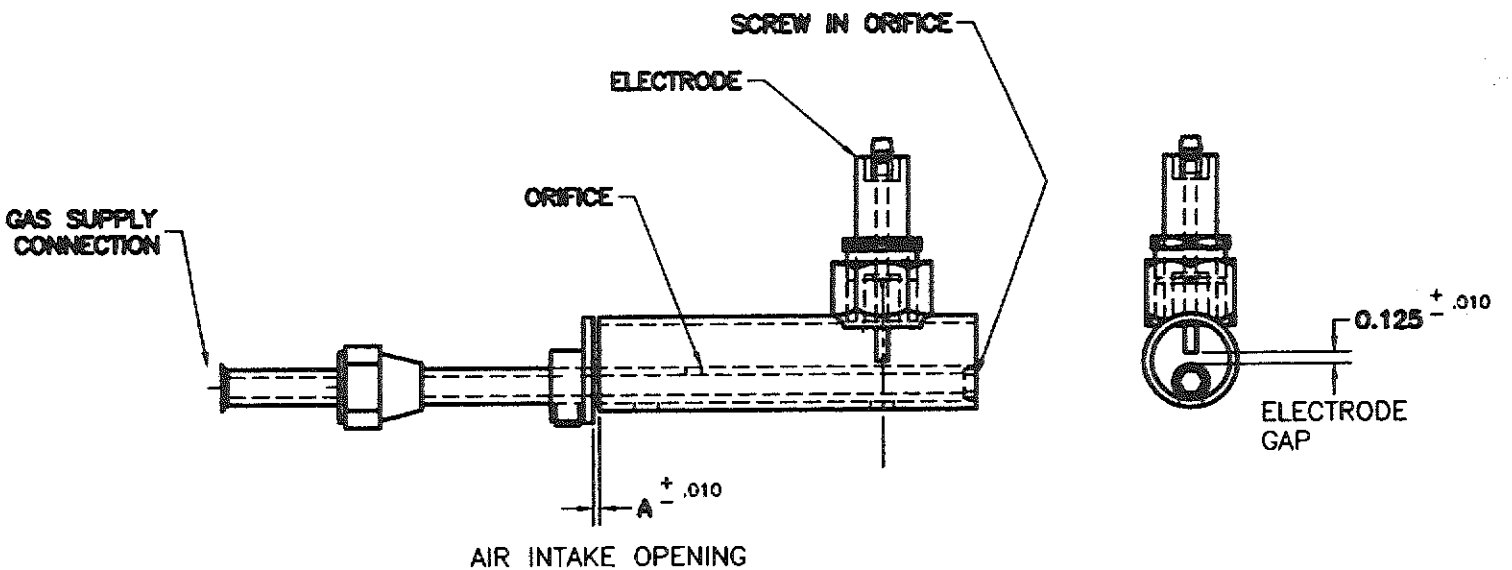


Figure 103

GAS PILOT SETTINGS

PHX-100 through PHX-125 Burners



DIMENSION A	BURNER SIZE
.063	PHX-40 Through PHX-400
.093	PHX-500 Through PHX-800

Figure 104

GAS TRAIN

UL and FM - (2,500,000 to 12,000,000 BTU)
60 to 250 HP

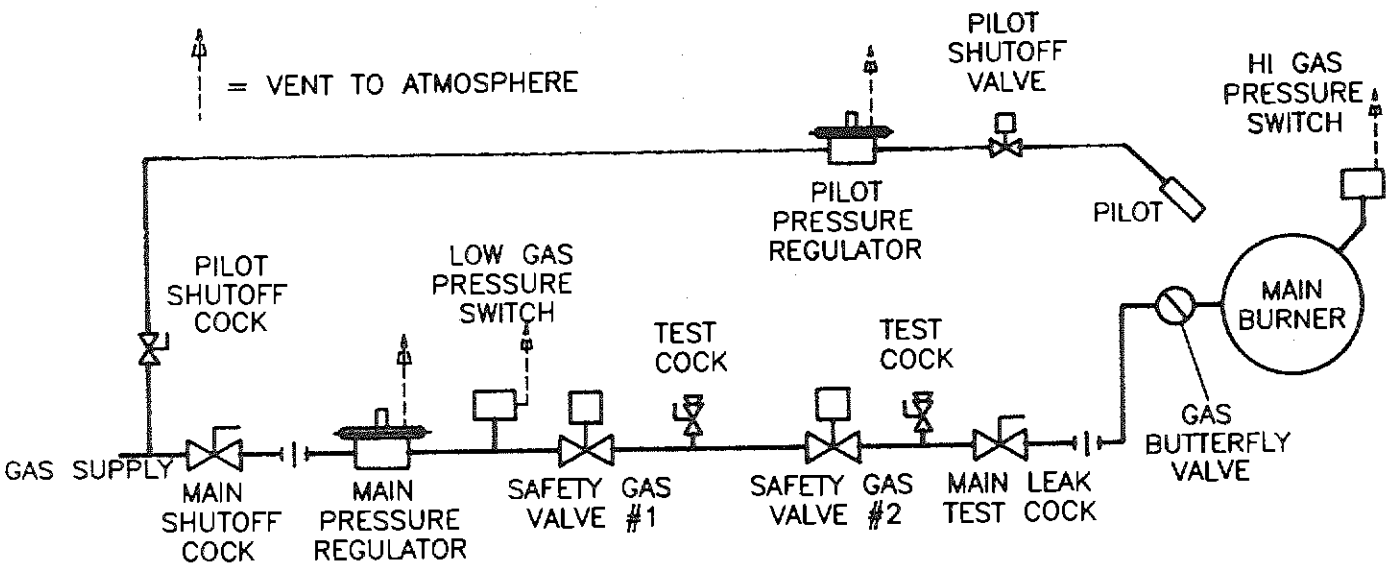


Figure 105

GAS TRAIN

IRI - (0 to 12,000,000 BTU)
10 to 250 HP

UL, FM and IRI - (12,000,000 and Over BTU)
300 HP and Over

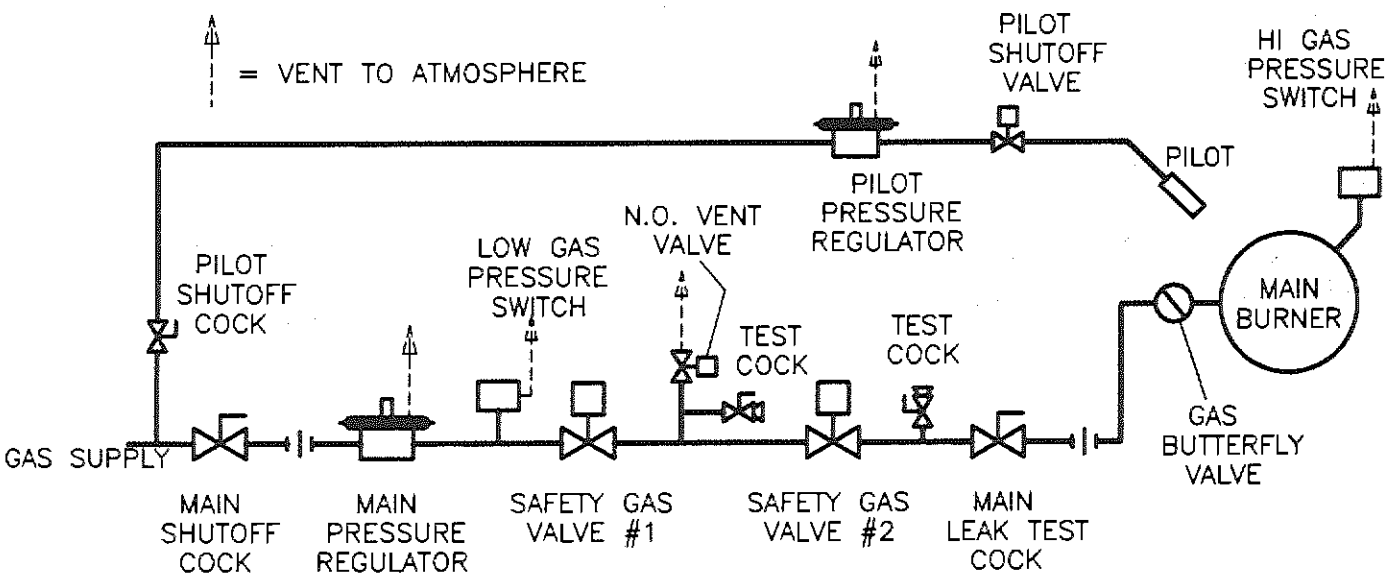


Figure 106

DIRECT SPARK IGNITION SETTINGS

PHX-100 and PHX-125 Burners

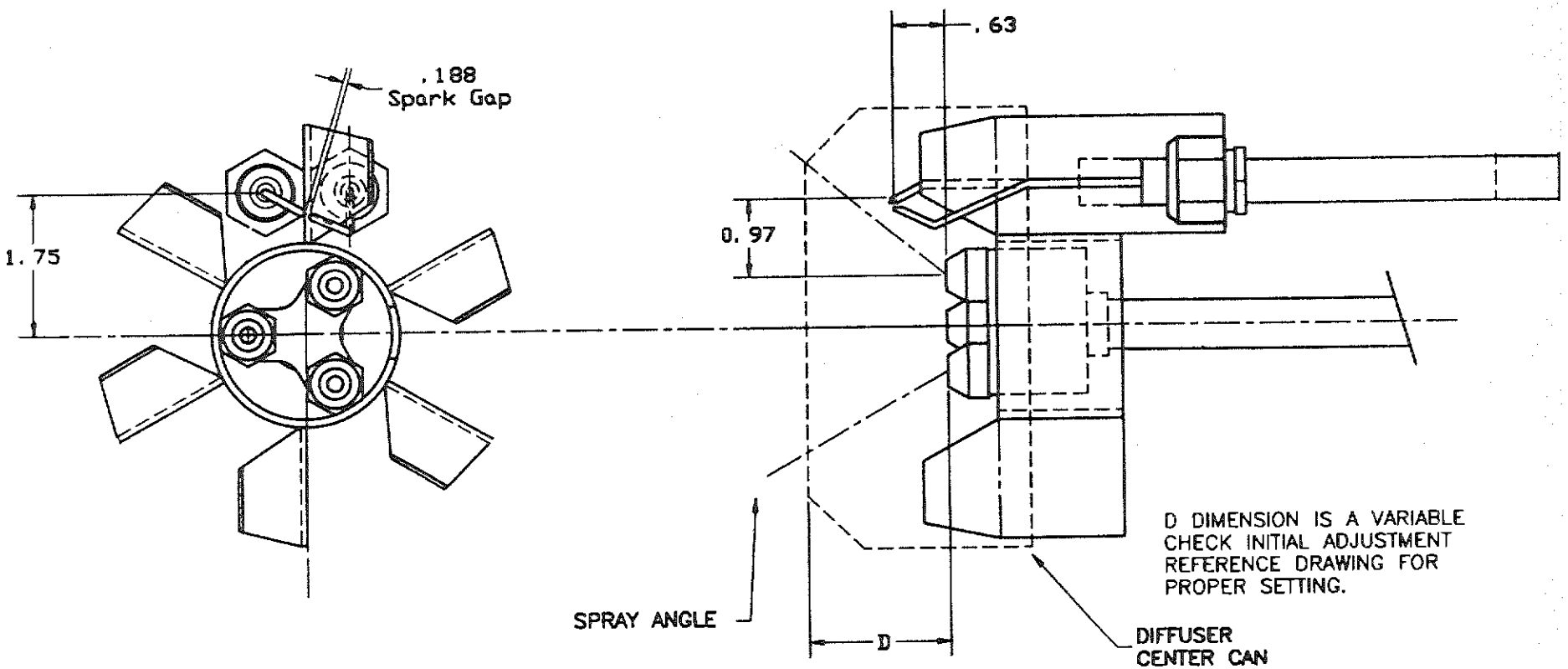
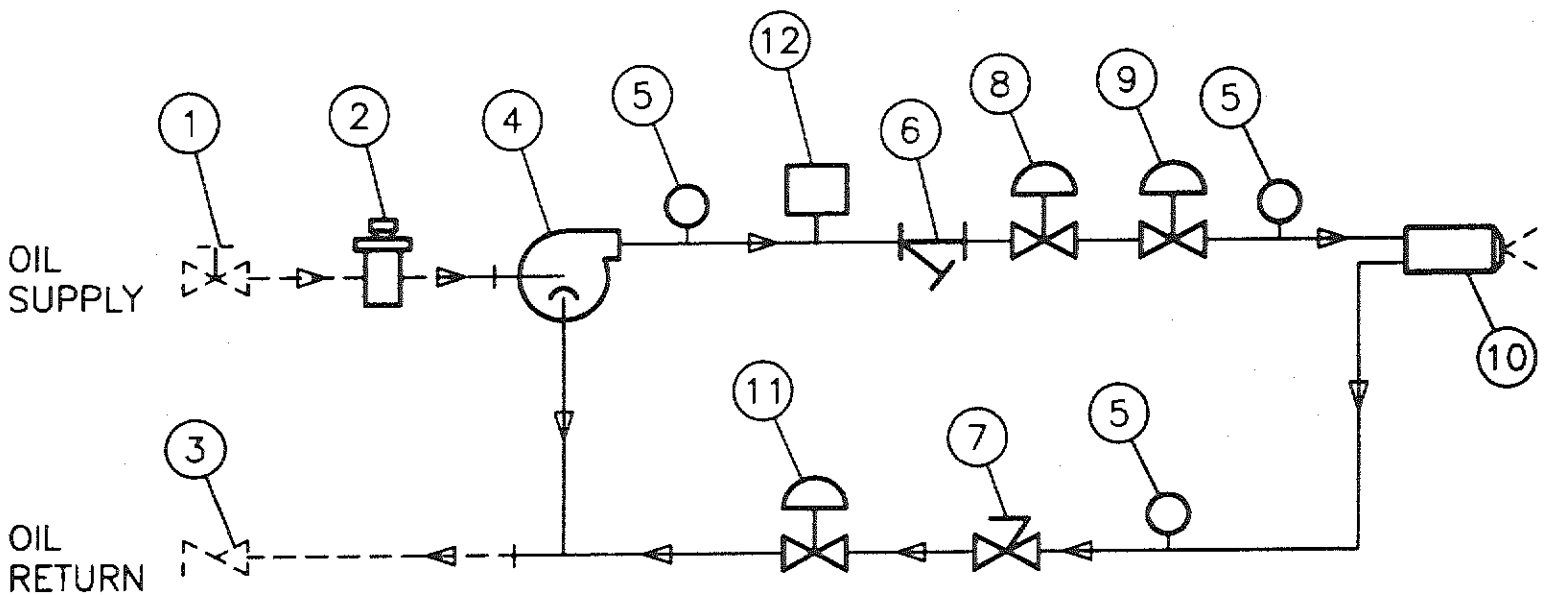


Figure 107

PRESSURE ATOMIZED OIL NOZZLE SYSTEM

Modulation
Pressure Atomized No. 2 Oil
PHX-100 and PHX-125 Burners

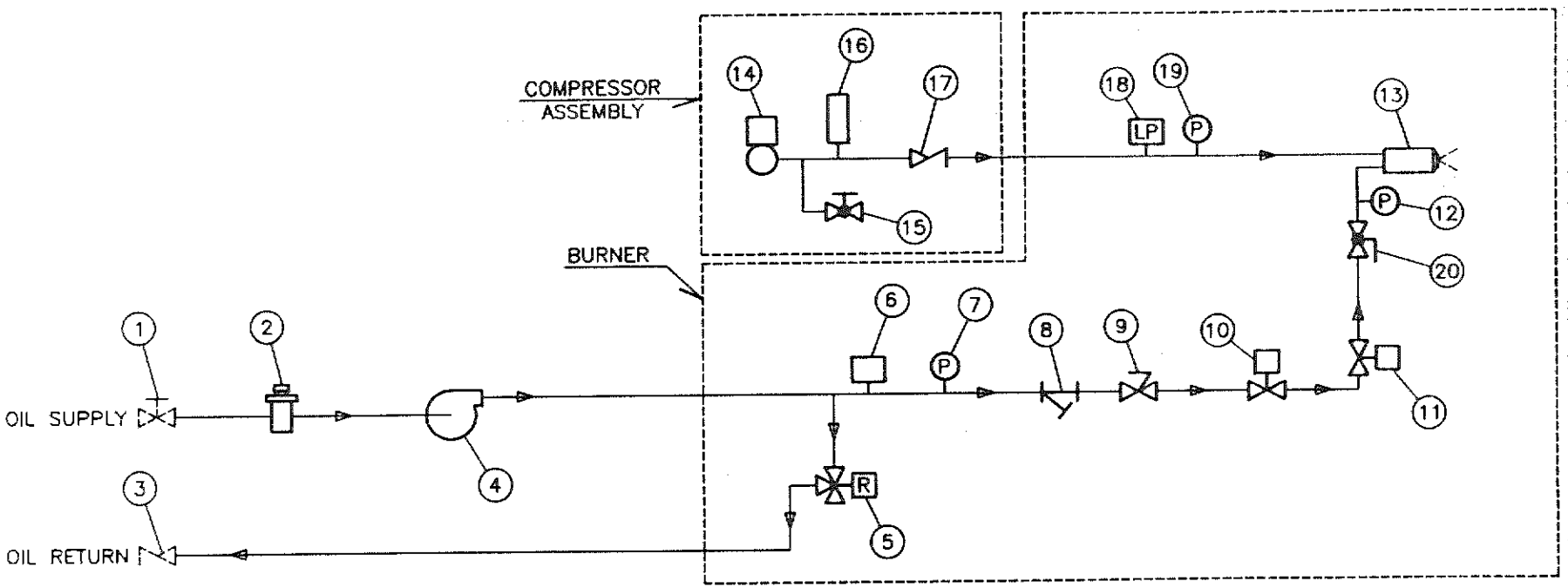


1. Oil Supply Gate Valve
2. Oil Strainer
3. Oil Return Check Valve
4. Oil Pump Assembly
5. Oil Pressure Gauge
6. Secondary Oil Strainer
7. Oil Metering Valve
8. Main Oil Valve, N.C.
9. Safety Oil Valve, N.C.
10. Pressure Atomizing Oil Nozzle
11. Oil Check Valve
12. Low Oil Pressure Switch

Figure 108

AIR ATOMIZING OIL NOZZLE SYSTEM

Modulation
Air Atomized No. 2 Oil
PHX-100 through PHX-125 Burners

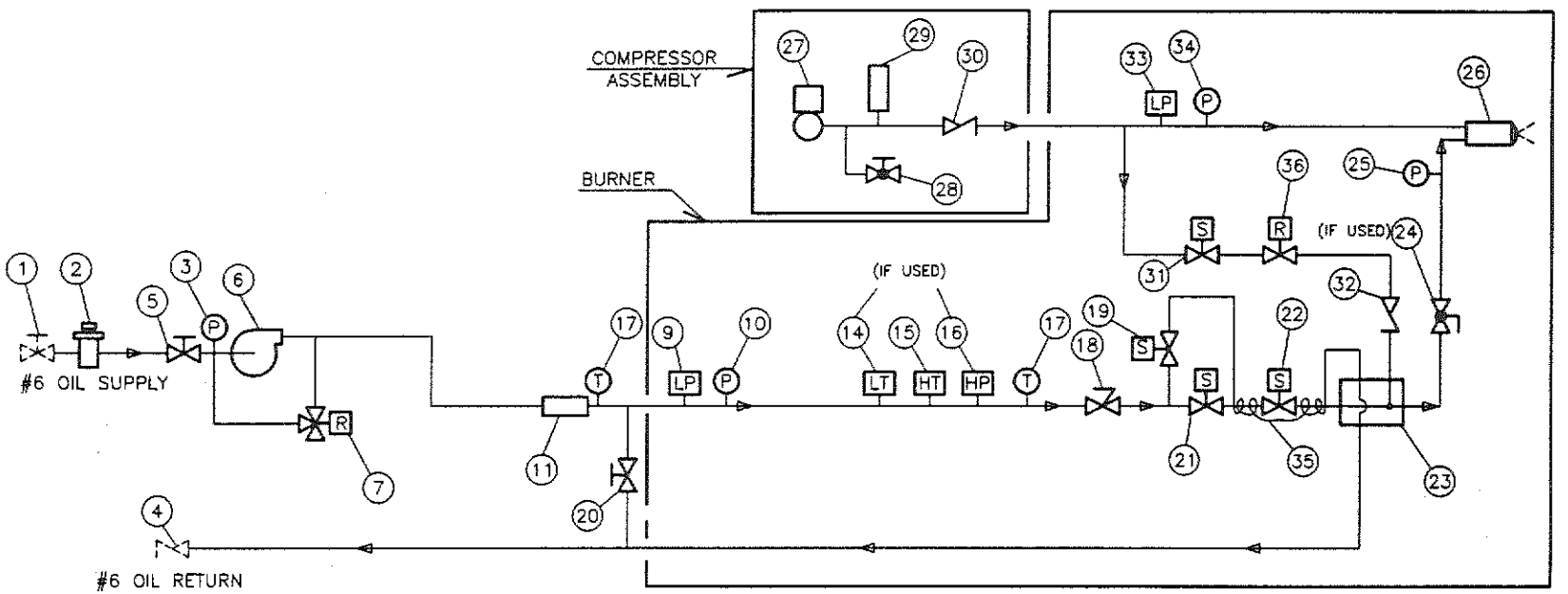


1. Oil Supply Gate Valve (By Others)
2. Oil Strainer
3. Oil Return Check Valve (By Others)
4. Oil Pump
5. Oil Pressure Regulating Valve
6. Low Oil Pressure Switch
7. Oil Pressure Gauge
8. Secondary Oil Strainer
9. Oil Metering Valve
10. Main Oil Valve, N.C.
11. Safety Oil Valve, N.C.
12. Nozzle Oil Pressure Gauge
13. Air Atomizing Oil Nozzle
14. Air Compressor
15. Air Bleed Needle Valve (If Used)
16. Compressor Dampening Tank
17. Air Check Valve
18. Low Atomizing Air Switch
19. Nozzle Air Pressure Gauge
20. Oil Shutoff Valve (If Used)

Figure 109

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 4 and No. 5 Oil
PHX-100 and PHX-125 Burners

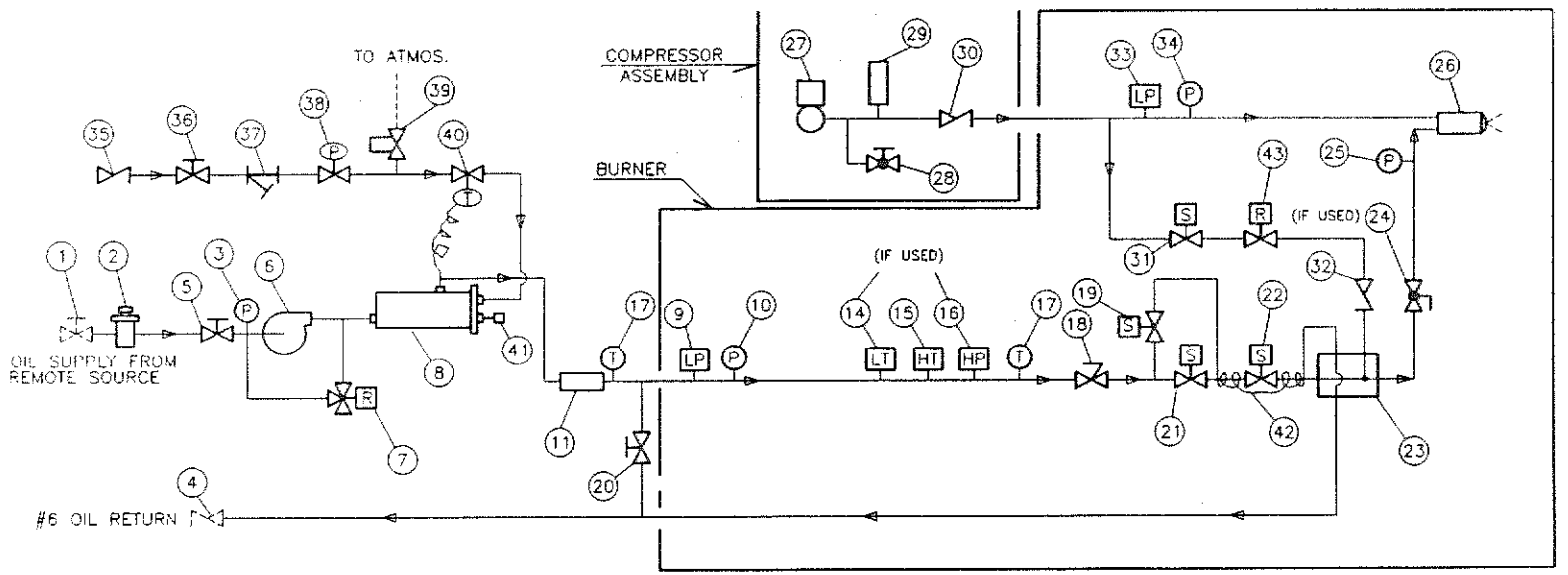


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. 1/4" Heat Tracing Line
36. Air Purge Pressure Regulator

Figure 110

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 6 Oil - Steam Application
PHX-100 and PHX-125 Burners

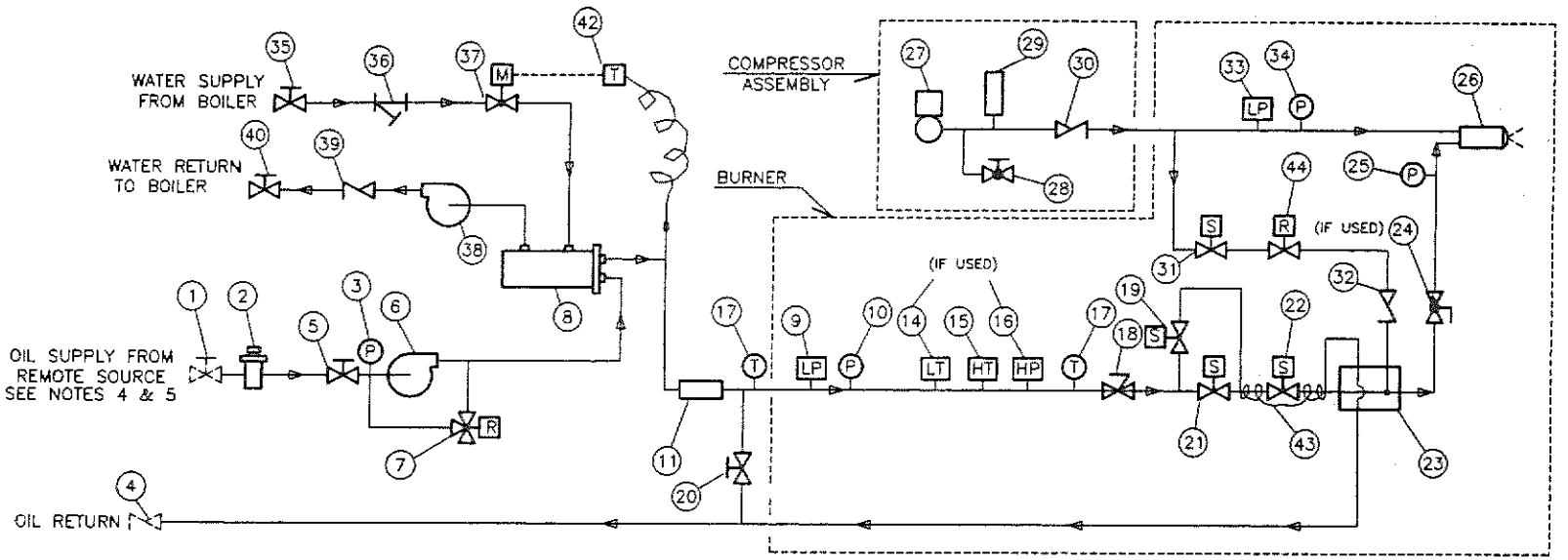


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
8. Steam Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Steam Supply Check Valve
36. Steam Supply Gate Valve
37. Steam Strainer
38 Steam Press. Regulator (High Press. Boilers Only)
39. Steam Safety Relief Valve (High Press. Boilers Only)
40. Temp. Regulating Valve
41. Steam Trap
42. 1/4" Heat Tracing Line
43. Air Purge Pressure Regulator

Figure 111

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 6 Oil - Water Application
PHX-100 and PHX-125 Burners

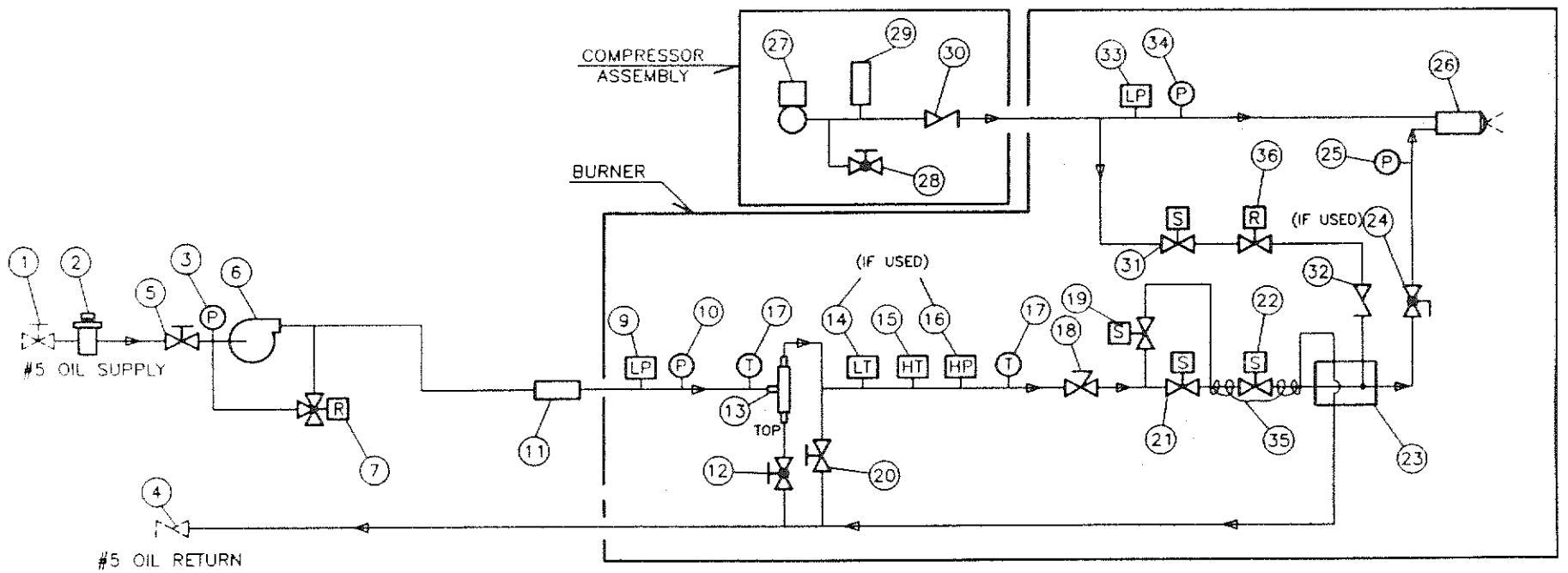


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Valve
8. Water Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Water Supply Gate Valve
36. Water Strainer
37. Temp. Regulating Valve
38. Water Circulating Pump
39. Water Return Check Valve
40. Water Return Gate Valve
41 Remote Oil Pump Set (Not Shown)
42. Temperature Controller
43. 1/4" Heat Tracing Line
44. Air Purge Pressure Regulator

Figure 112

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 5 Oil - Export Application

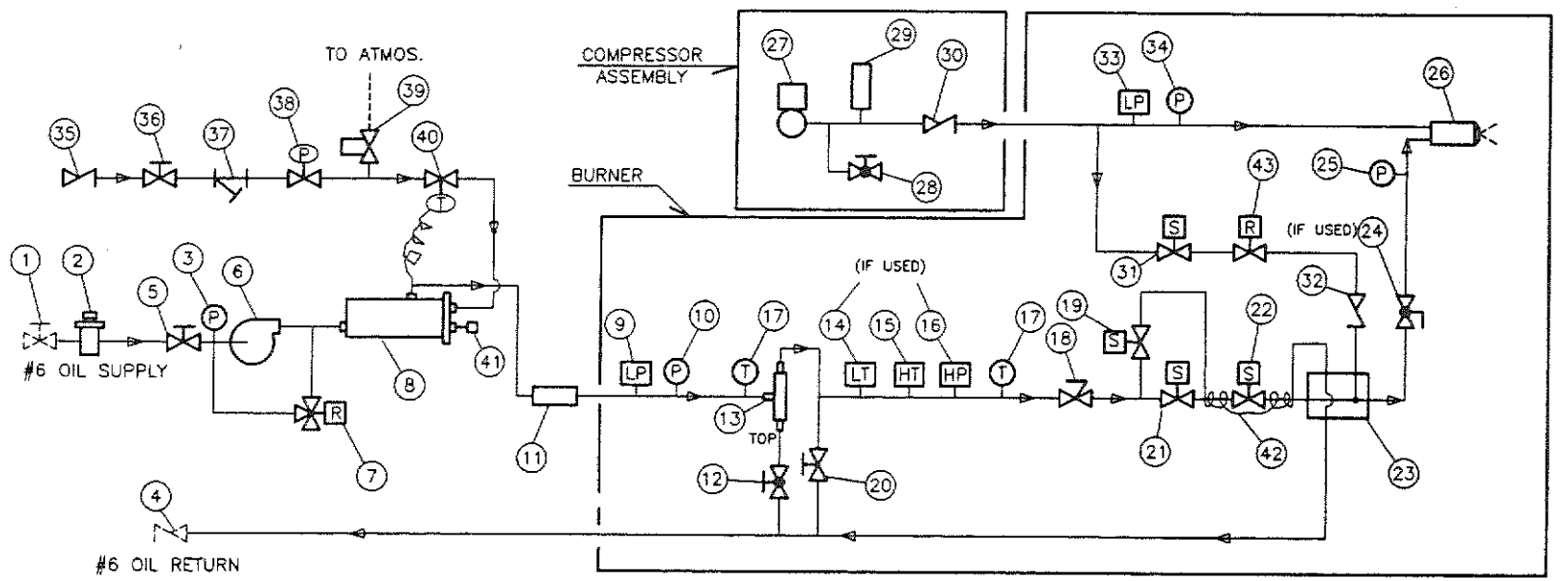


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Valve
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
12. Needle Valve
13. Vapor Separator
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. 1/4" Heat Tracing Line
36. Air Purge Pressure Regulator

Figure 113

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 6 Heavy Oil Export - Steam Application

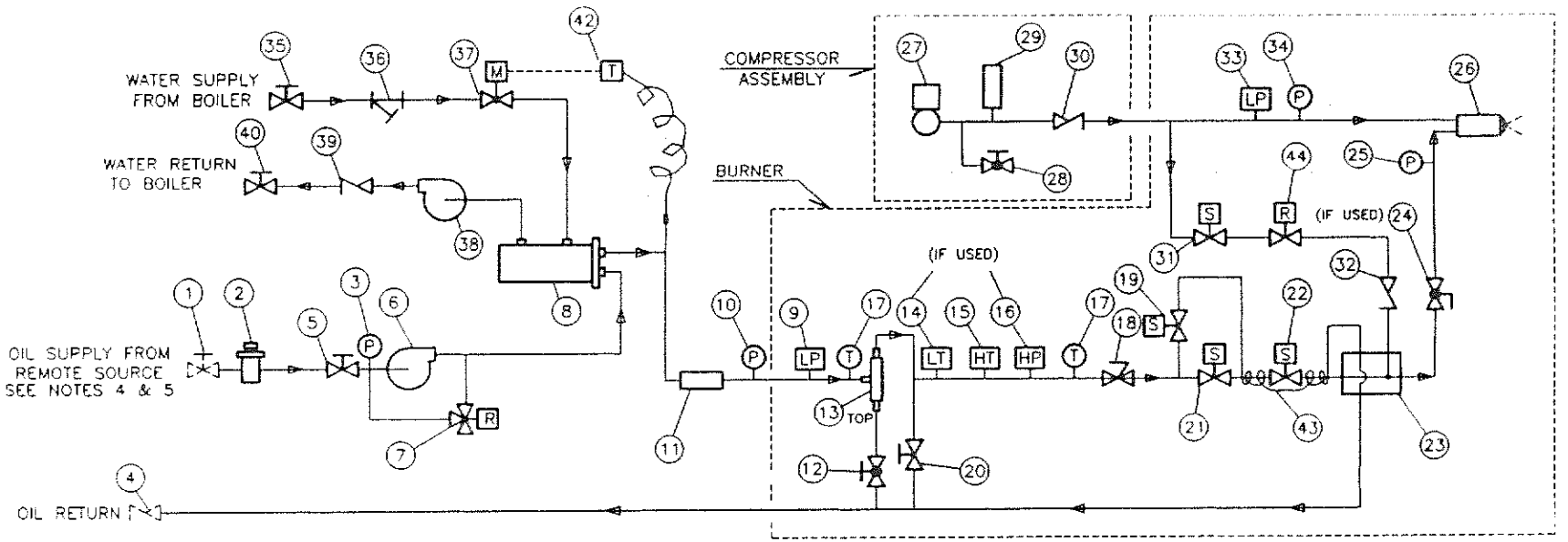


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
8. Steam Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Steam Supply Check Valve
36. Steam Supply Gate Valve
37. Steam Strainer
38 Steam Press. Regulator (High Press. Boilers Only)
39. Steam Safety Relief Valve (High Press. Boilers Only)
40. Temp. Regulating Valve
41. Steam Trap
42. 1/4" Heat Tracing Line
43. Air Purge Pressure Regulator

Figure 114

AIR ATOMIZING OIL NOZZLE SYSTEM

No. 6 Heavy Oil Export - Water Application



1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Valve
8. Water Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Water Supply Gate Valve
36. Water Strainer
37. Temp. Regulating Valve
38. Water Circulating Pump
39. Water Return Check Valve
40. Water Return Gate Valve
41 Remote Oil Pump Set (Not Shown)
42. Temperature Controller
43. 1/4" Heat Tracing Line
44. Air Purge Pressure Regulator

Figure 115

GENERAL ASSEMBLY DRAWING

PHX-150 through PHX-250 Burners

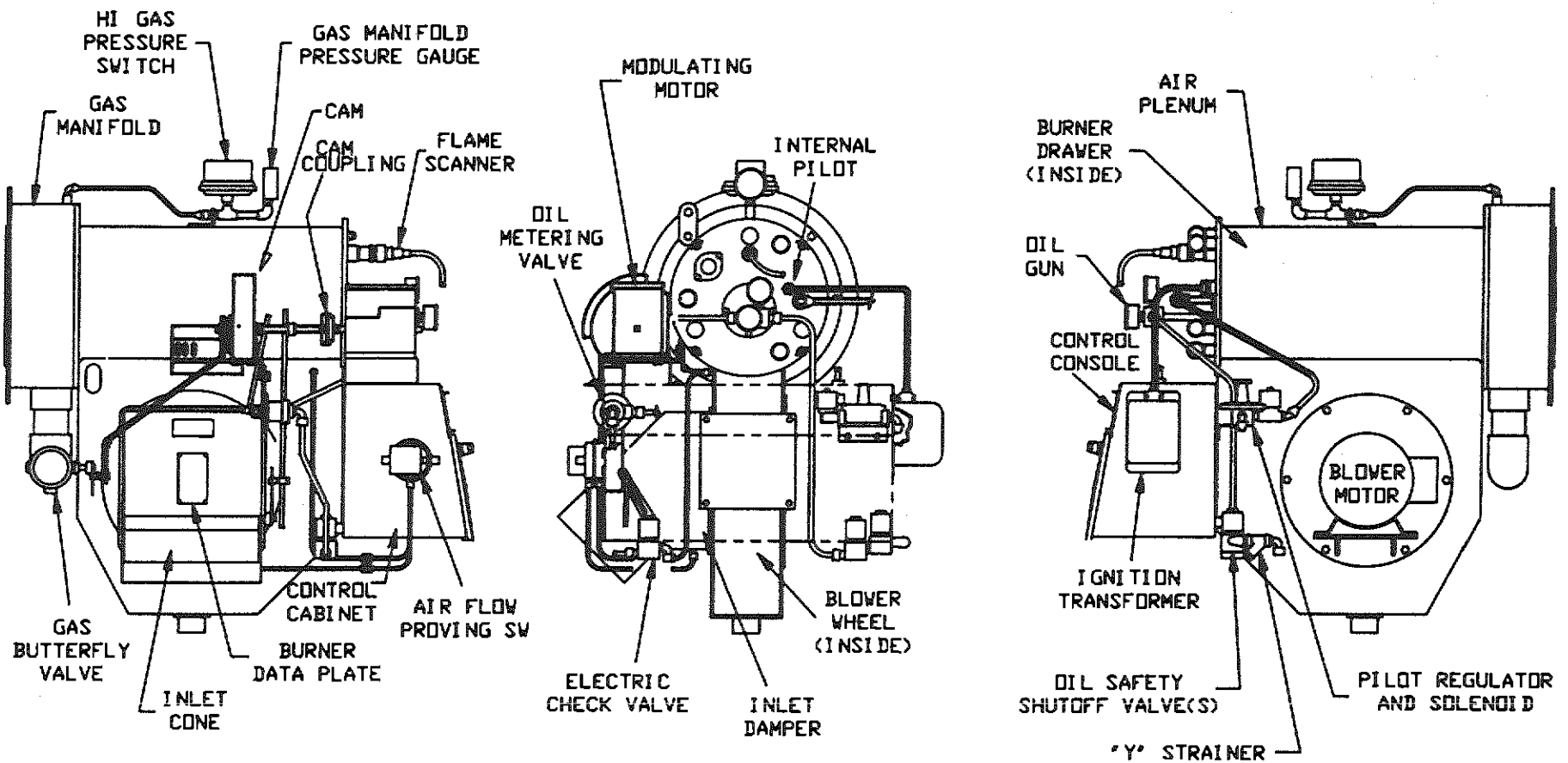


Figure 116

DATA SHEET

PHX-150 and PHX-250 Burners

	PHX-150	PHX-200	PHX-250
Nominal Air Flow CFM: (@ 20% Excess Air)	1294	1725	2156
Blower Wheel Type	Forward Curve	Forward Curve	Forward Curve
Blower Wheel:Diameter x Width	9.87 x 3.25	12.25 x 4.00	12.25 x 4.00
Blower Wheel: Static Pressure @ CFM	10.95" WC @ 1294	16.79" WC @ 1725	16.64" WC @ 2156
Blower Motor: HP	5 HP	7-1/2 HP	7-1/2 HP
Blower Motor: RPM	3600 RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	182T	184T	184T
Air Damper: (Number of Vanes)	(2)	(2)	(2)
Flow Area H x W	11.5 x 7.716	11.5 x 7.716	11.5 x 7.716
Burner Head Throat Diameter	11.50"	11.50"	11.50"
Nominal Air Velocity Thru Diffuser	154 Ft./Sec.	154 Ft./Sec.	154 Ft./Sec.
Burner Head Attachment to Plenum	Bolted	Bolted	Bolted
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	43.2	57.6	72.0
Oil Nozzle Type	Return Flow	Return Flow	Return Flow
Standard Make/Spray Pattern	Delavan Variflo	Delavan Variflo	Delavan Variflo
Approved Makes/Spray Patterns	Monarch BPS	Monarch BPS	Monarch BPS
Oil Nozzles:(Quantity)	(3)	(3)	(3)
GPH x Spray Angle	9.0 x 80°	12.0 x 80°	16.0 x 80°
Oil Pump Capacity: GPH @ PSI	50 @ 300	95 @ 300	95 @ 300
Oil Pump Mounting: On Burner/Remote	Remote	Remote	Remote
Oil Pressure Regulator: In Pump/Separate	Separate	Separate	Separate
Regulated Oil Pressure	300 PSI	300 PSI	300 PSI

	PHX-60	PHX-200	PHX-200
Gas Firing Rate (Nat. Gas @ 80% Eff.)	6,277	8,369	8,369
Gas Orifices: Body Size	3/8 - 18 NPT	3/8 - 18 NPT	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(21) .272	(15) .375	(15) .422
Nominal Gas Velocity Thru Orifices	203.5 Ft./Sec.	199.9 Ft./Sec.	197.3 Ft./Sec.
Butterfly Valve Pipe Size	2-1/2"	2-1/2"	2-1/2"
Gas Head Pressure (@ 0.0" Furnace Pressure)	8.39" WC	8.09" WC	7.88" WC
Standard Firing Rate Control System	Modulation	Modulation	Modulation
Standard Turndown Ratio Gas (Oil)	4 : 1 (3 : 1)	4 : 1 (3 : 1)	5 : 1 (3 : 1)
Standard Ignition System - Gas or Oil Firing	Gas Pilot	Gas Pilot	Gas Pilot
Standard Ignition System - Oil Firing Only	Oil Pilot	Oil Pilot	Oil Pilot
Standard Main Power Supply	230 / 3 / 60	230 / 3 / 60	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2-#6 Oil	Nat. Gas, LP, #2-#6 Oil	Nat. Gas, LP, #2-#6 Oil
Code Constructions Available	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI

Figure 117

INITIAL ADJUSTMENTS GAS SLEEVE AND DIFFUSER

PHX-150 through PHX-250 Burners

THESE ARE THE SETTINGS THAT SHOULD BE USED WHEN SETTING UP THE BURNER FOR INITIAL FIRING.

SIZE BURNER	H.P.	A DIM	V DIM	P DIM	D DIM
PHX-150	150	1/8	.188	.375	1.00
PHX-200	200	1/8	.250	.375	1.00
PHX-250	250	1/8	.375	.375	1.00

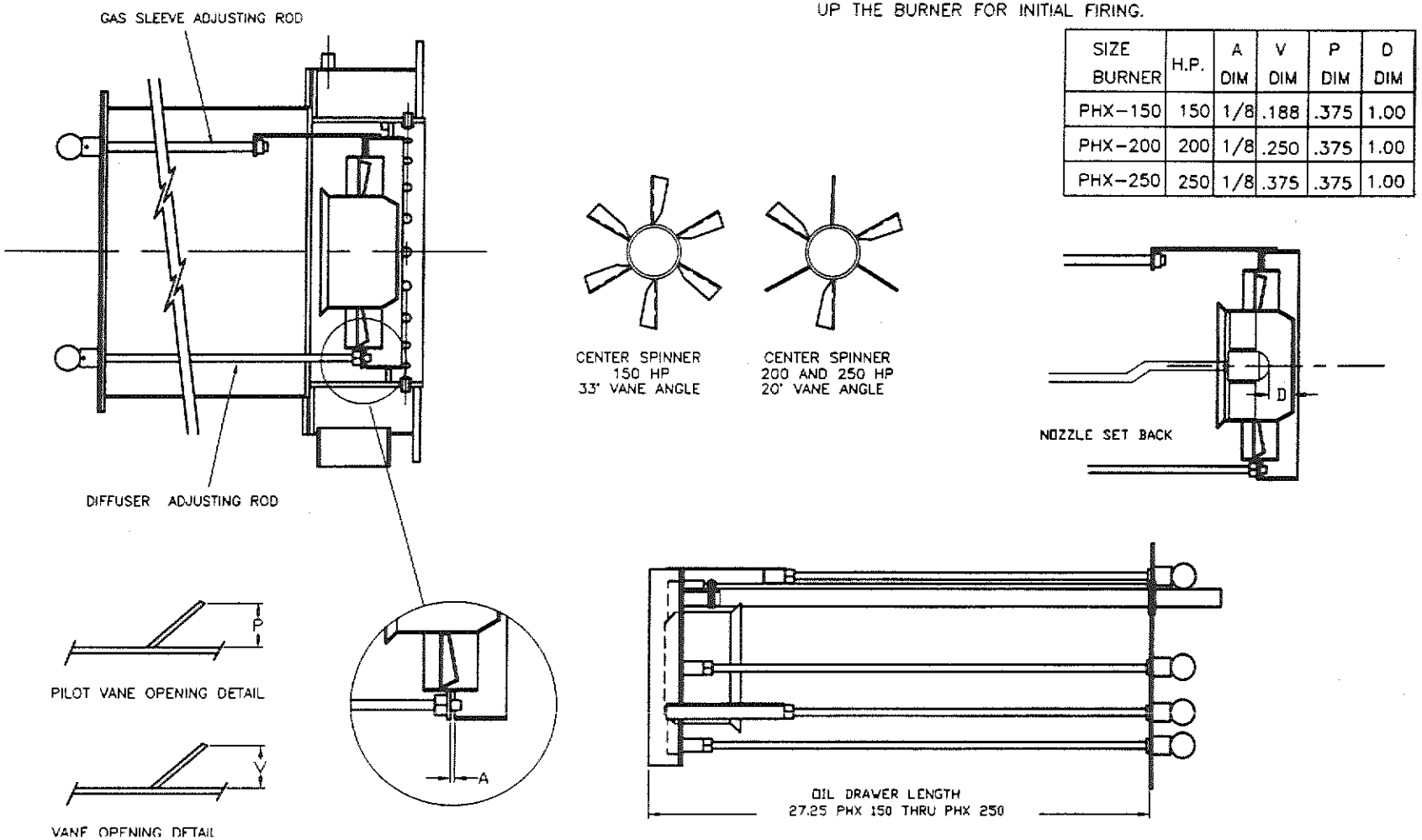
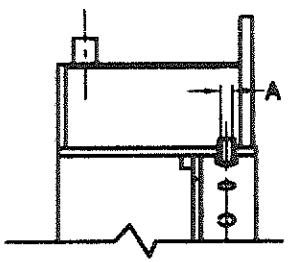


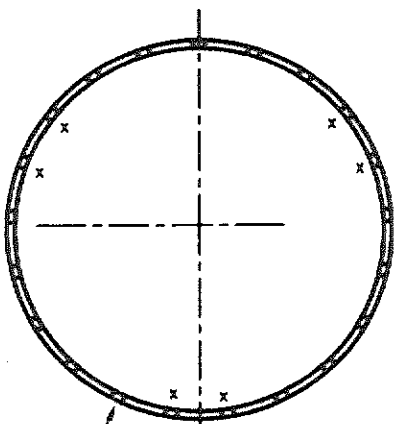
Figure 118

GAS HEAD ORIFICE INFORMATION

PHX-150 through PHX-250 Burners



21 GAS PORTS
SEE CHART
X NOTES PLUGGED PORTS



GAS ORIFICE SIZES APPLY TO NATURAL GAS AT ALTITUDES UP TO 2000 FT. ELEVATION.

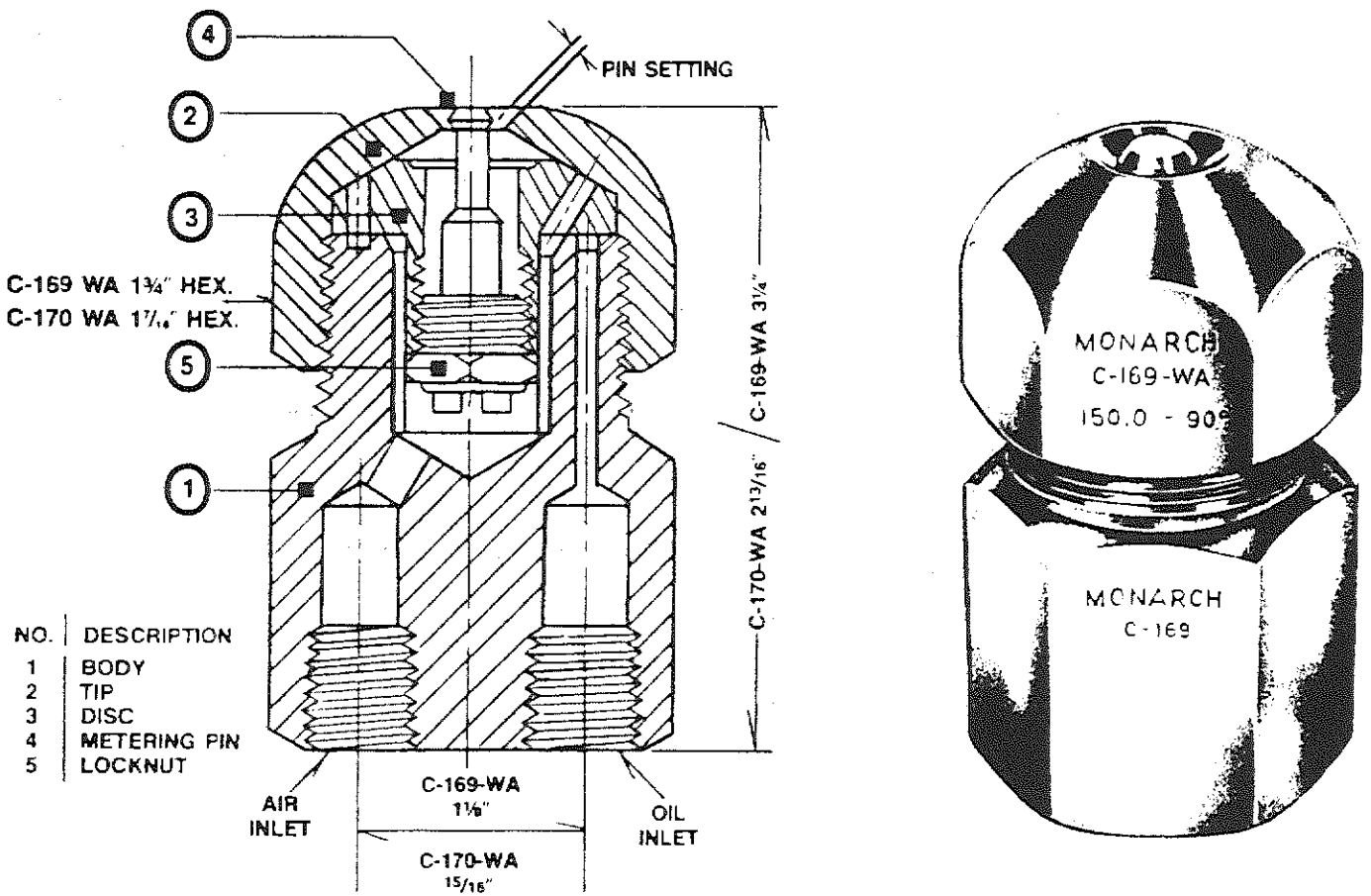
SIZE BURNER	H.P.	(A) SIZE ORIFICE	NO. ORIFICES	NO. PLUGS
PHX-150	150	.272	21	0
PHX-200	200	.375	15	6
PHX-250	250	.422	15	6

NOTE: ALL THREADED OPENINGS FOR THE GAS SPUDS ARE 3/8" NPT.

Figure 119

MONARCH AIR ATOMIZED NOZZLE ASSEMBLY

PHX-150 through PHX-250 Burners



NOTE: Application will vary with burner configuration and firing rate

Figure 120

MONARCH NOZZLE PIN SETTINGS

PHX-150 through PHX-250 Burners

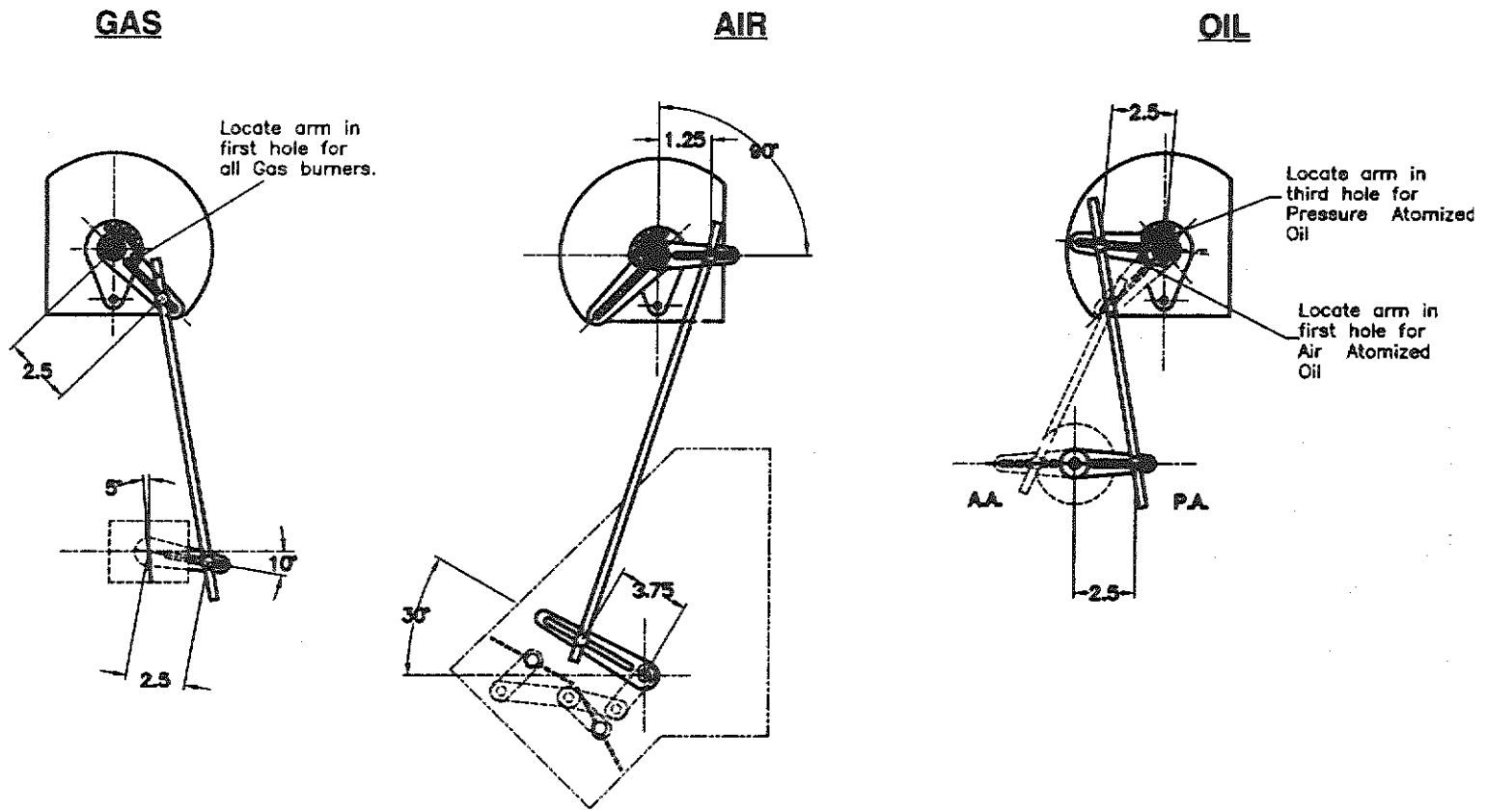
BURNER MODEL	FIGURE NUMBER	RATED GPH*	NPT CONNECTIONS		PIN SETTING
			AIR	OIL	
PHX-150	C-169-WA	50	1/4"	1/4"	.062"
PHX-200		60	1/4"	1/4"	.062"
PHX-250		80	1/4"	1/4"	.062"

* With air at 15 PSI and No. 2 oil at 26 PSI **OR** with air at 21 PSI and No. 2 oil at 31 PSI.

Figure 121

KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-150 and PHX-250 Burners



NOTE: on "Oil" drawing above, A.A. represents Air Atomized and P.A. represents Pressure Atomized

Figure 122

KEWANEE CAMCOMMAND

PHX-150 through PHX-250 Burners

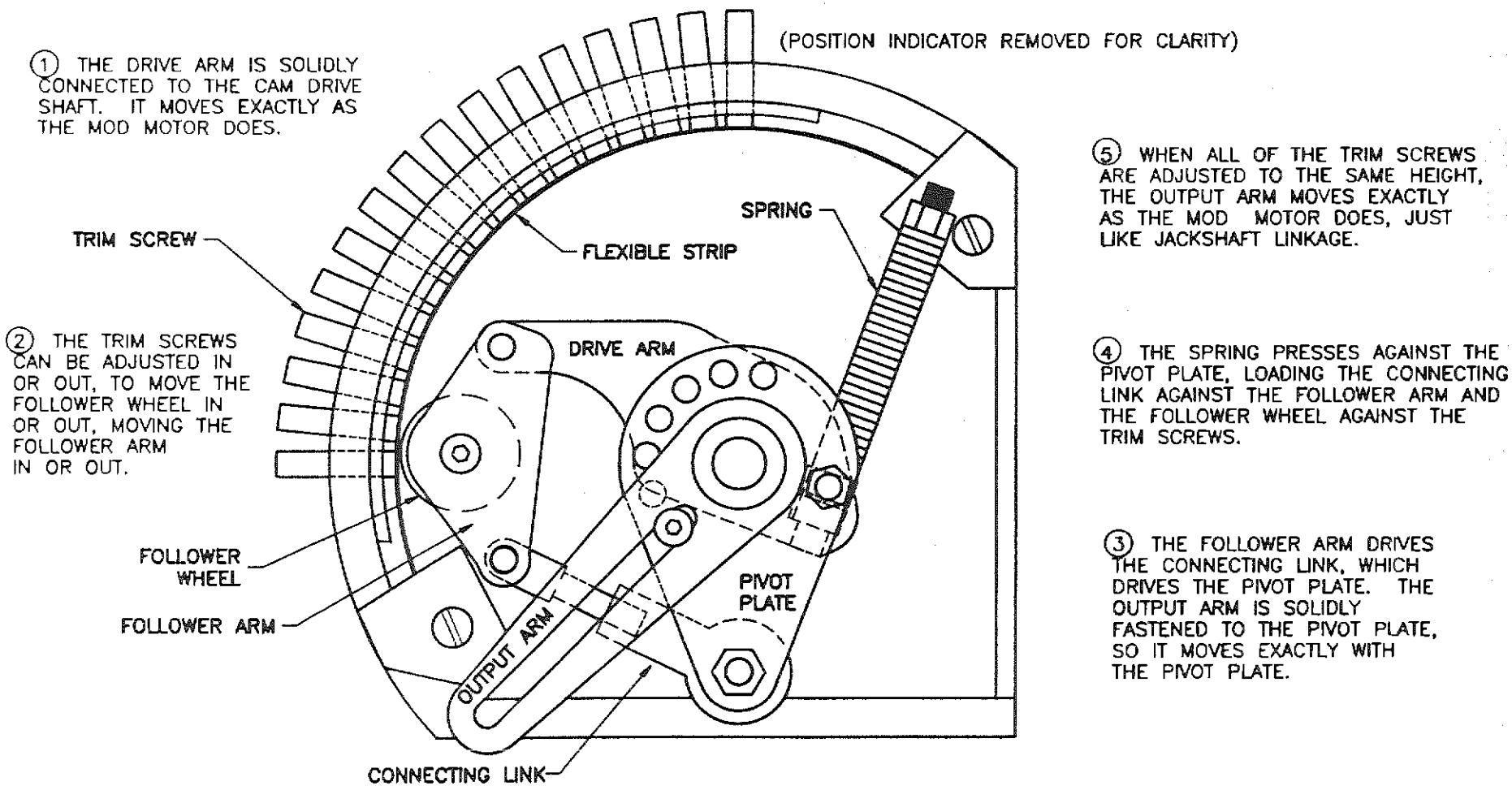
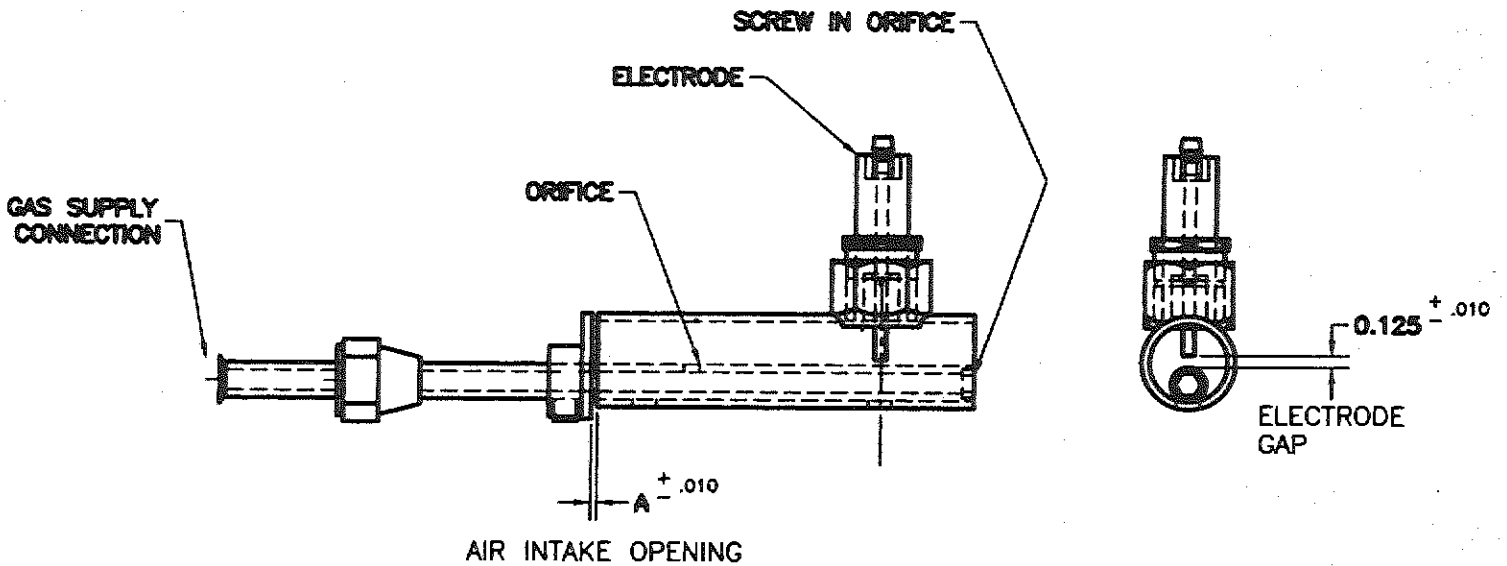


Figure 123

GAS PILOT SETTINGS

PHX-150 through PHX-250 Burners



DIMENSION A	BURNER SIZE
.063	PHX–40 Through PHX–400
.093	PHX–500 Through PHX–800

Figure 124

GAS TRAIN

UL and FM - (2,500,000 to 12,000,000 BTU)
60 to 250 HP

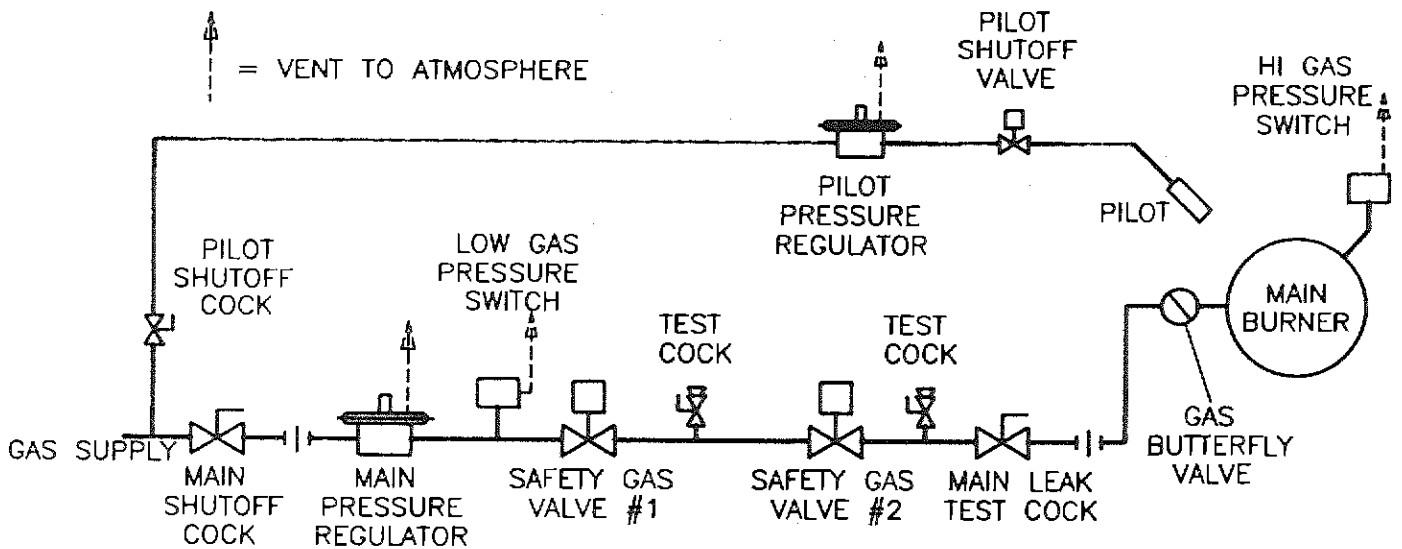


Figure 125

GAS TRAIN

IRI - (0 to 12,000,000 BTU)
10 to 250 HP

UL, FM and IRI - (12,000,000 and Over BTU)
300 HP and Over

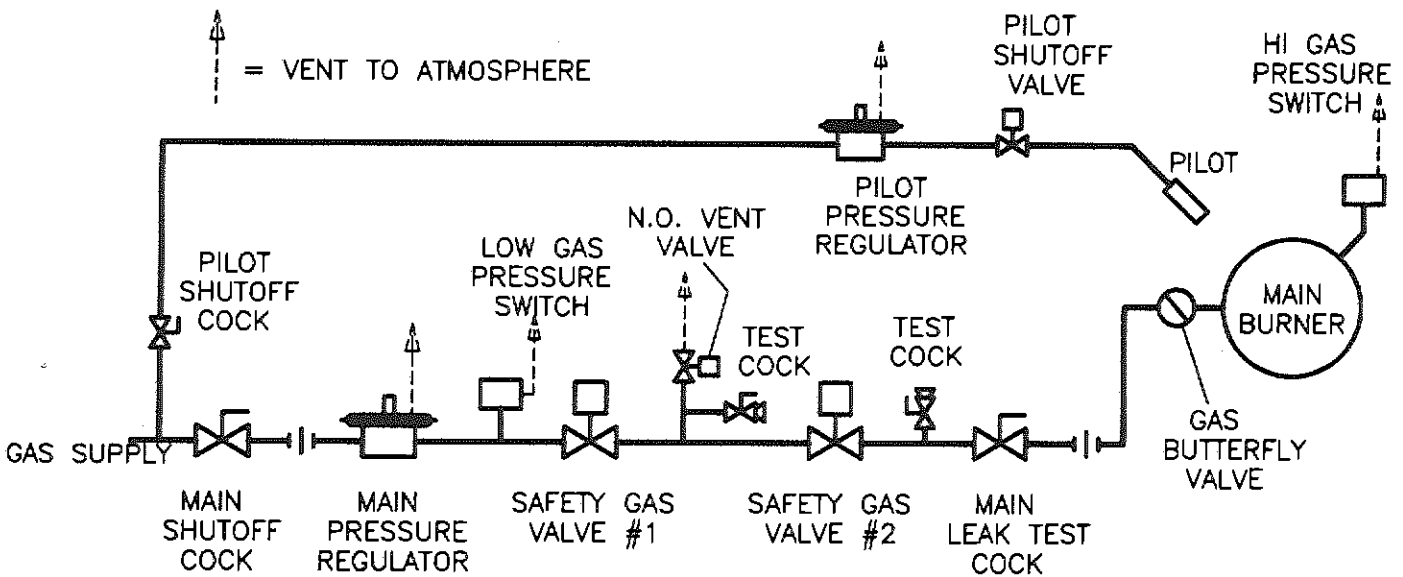


Figure 126

DUAL GAS TRAIN

UL, FM and IRI - (12,000,000 and Over BTU)
150 HP and Over

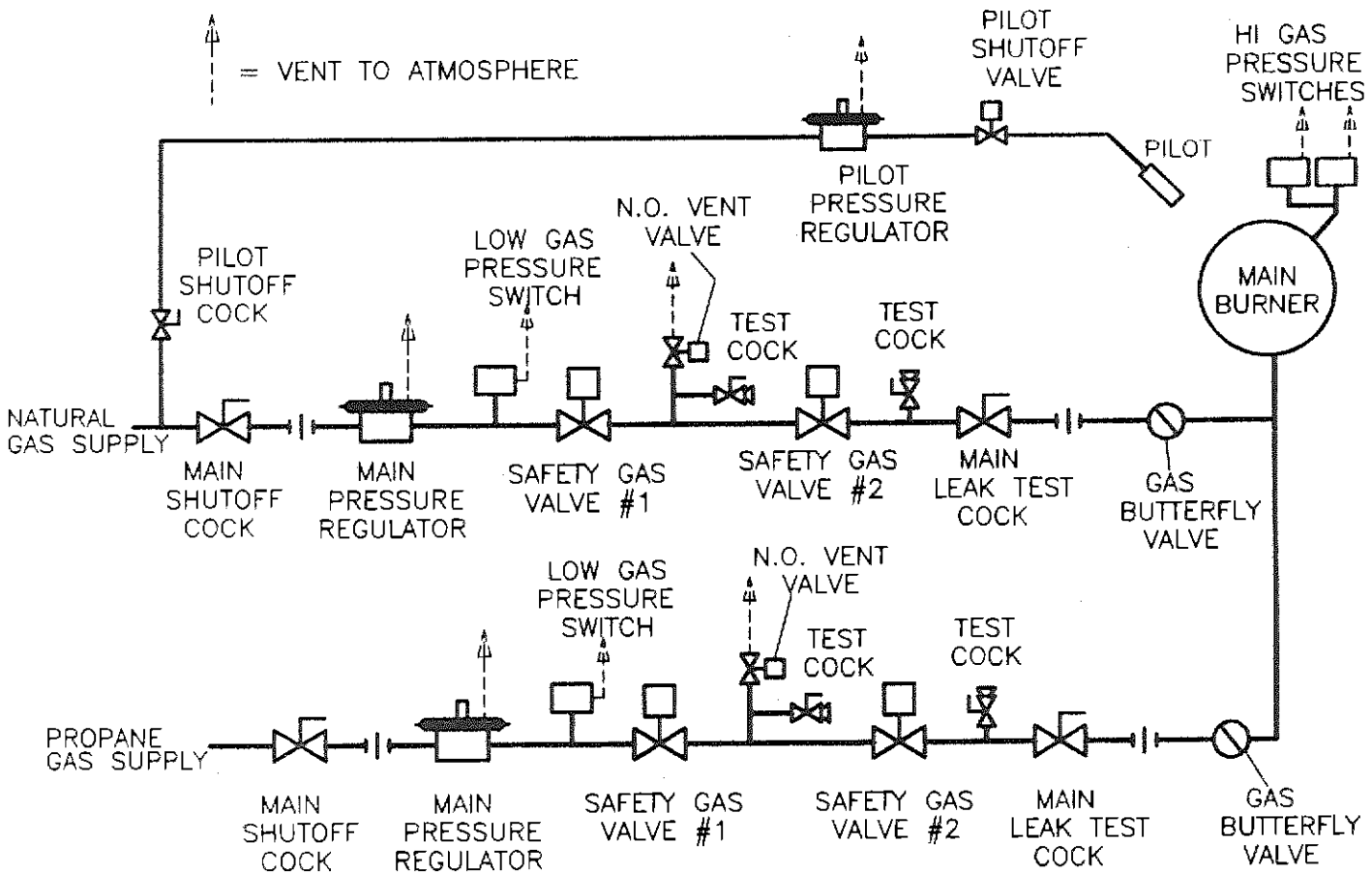


Figure 127

OIL PILOT SETTINGS

PHX-150 and PHX-250 Burners

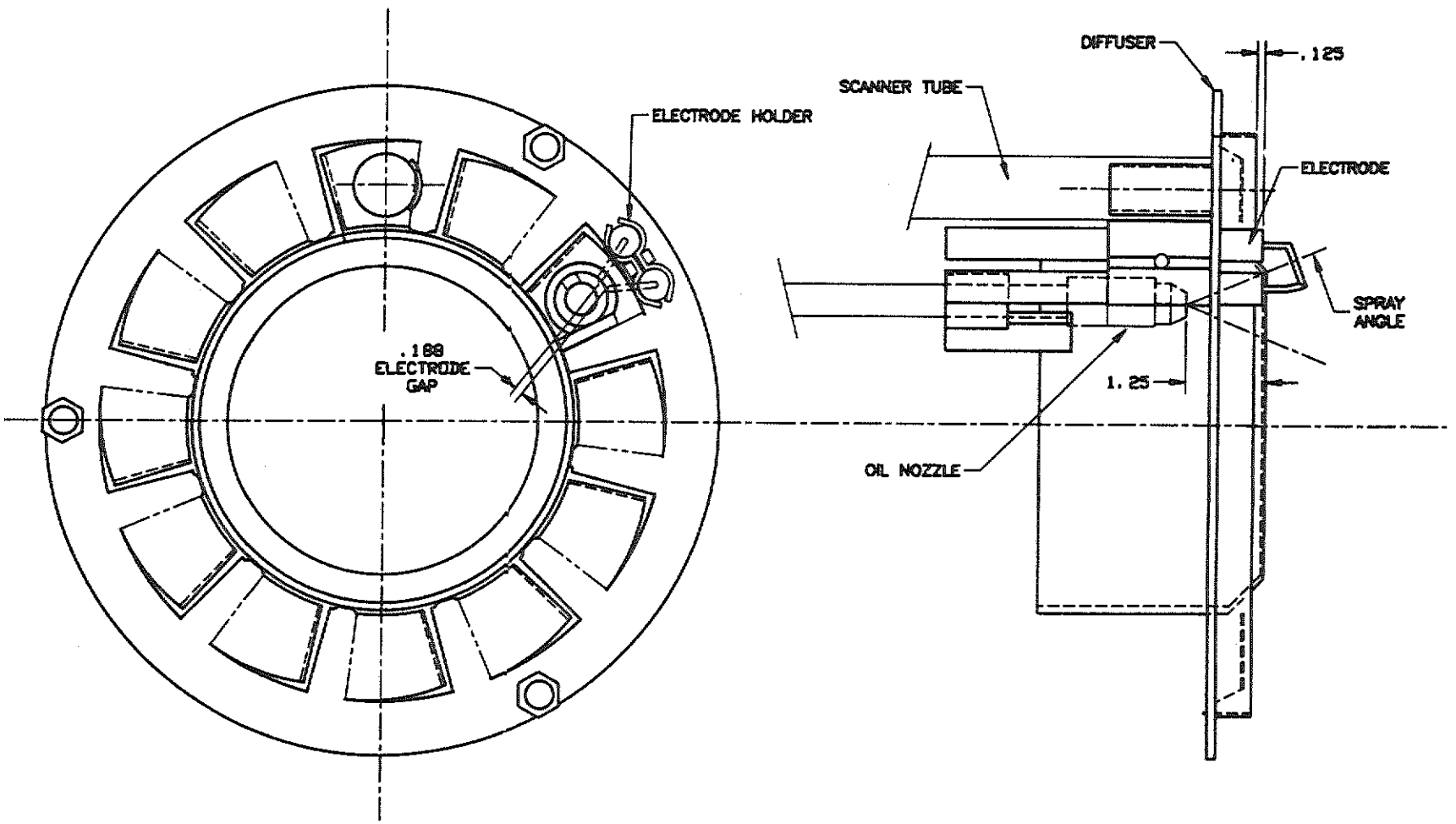
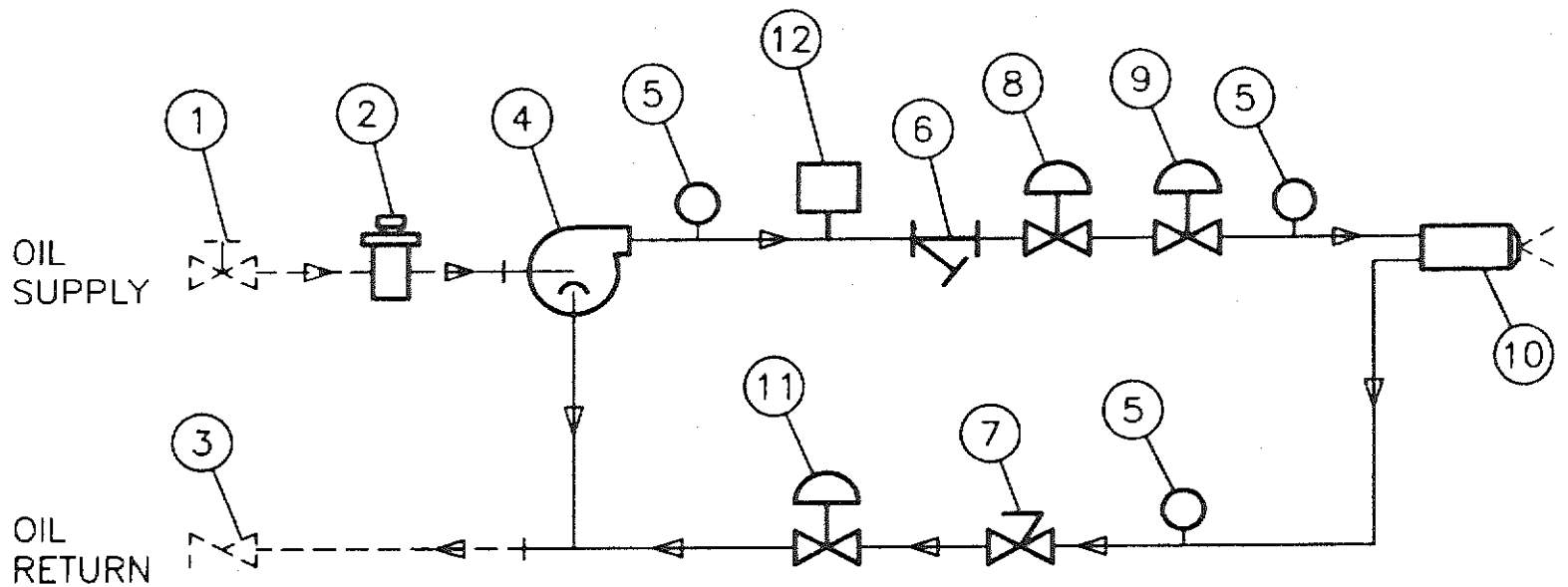


Figure 128

PRESSURE ATOMIZED OIL NOZZLE SYSTEM

Modulation
Pressure Atomized No. 2 Oil
PHX-150 and PHX-250 Burners

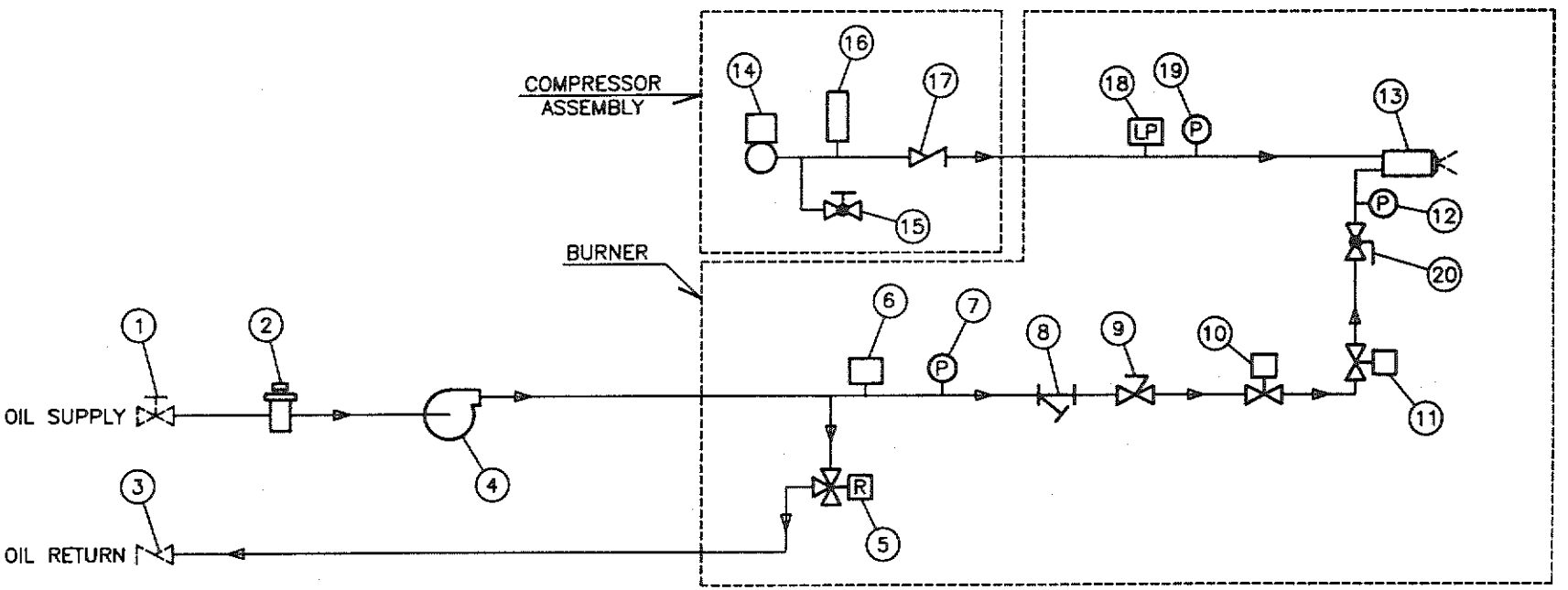


1. Oil Supply Gate Valve
2. Oil Strainer
3. Oil Return Check Valve
4. Oil Pump Assembly
5. Oil Pressure Gauge
6. Secondary Oil Strainer
7. Oil Metering Valve
8. Main Oil Valve, N.C.
9. Safety Oil Valve, N.C.
10. Pressure Atomizing Oil Nozzle
11. Oil Check Valve
12. Low Oil Pressure Switch

Figure 129

AIR ATOMIZING OIL NOZZLE SYSTEM

Modulation
Air Atomized No. 2 Oil
PHX-150 through PHX-250 Burners

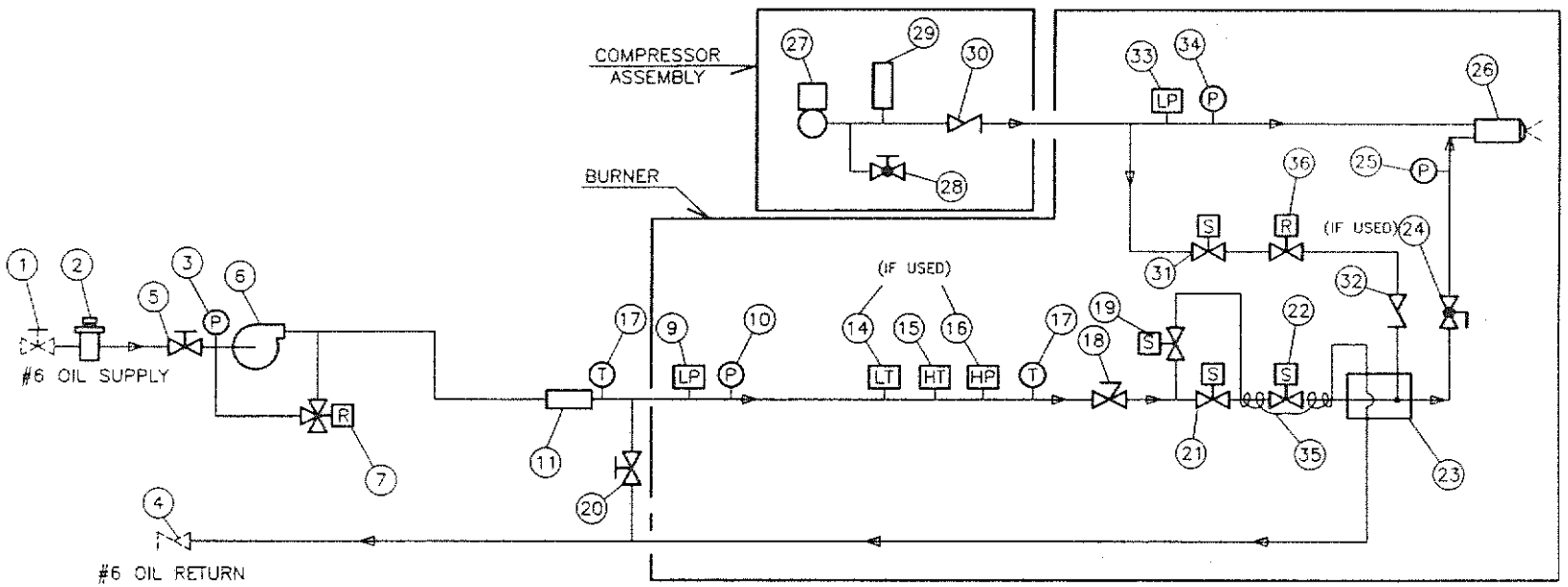


1. Oil Supply Gate Valve (By Others)
2. Oil Strainer
3. Oil Return Check Valve (By Others)
4. Oil Pump
5. Oil Pressure Regulating Valve
6. Low Oil Pressure Switch
7. Oil Pressure Gauge
8. Secondary Oil Strainer
9. Oil Metering Valve
10. Main Oil Valve, N.C.
11. Safety Oil Valve, N.C.
12. Nozzle Oil Pressure Gauge
13. Air Atomizing Oil Nozzle
14. Air Compressor
15. Air Bleed Needle Valve (If Used)
16. Compressor Dampening Tank
17. Air Check Valve
18. Low Atomizing Air Switch
19. Nozzle Air Pressure Gauge
20. Oil Shutoff Valve (If Used)

Figure 130

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 4 and No. 5 Oil
PHX-150 through PHX-250 Burners

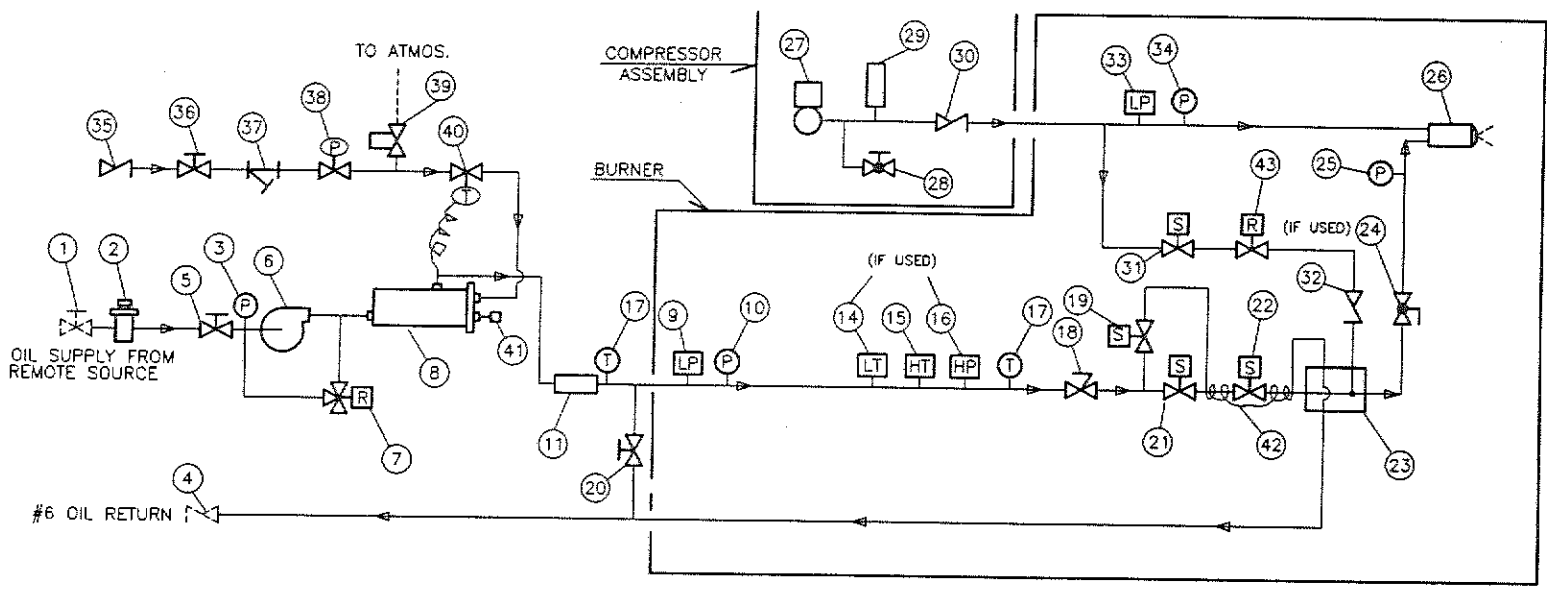


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. 1/4" Heat Tracing Line
36. Air Purge Pressure Regulator

Figure 131

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 6 Oil - Steam Application
PHX-150 and PHX-250 Burners

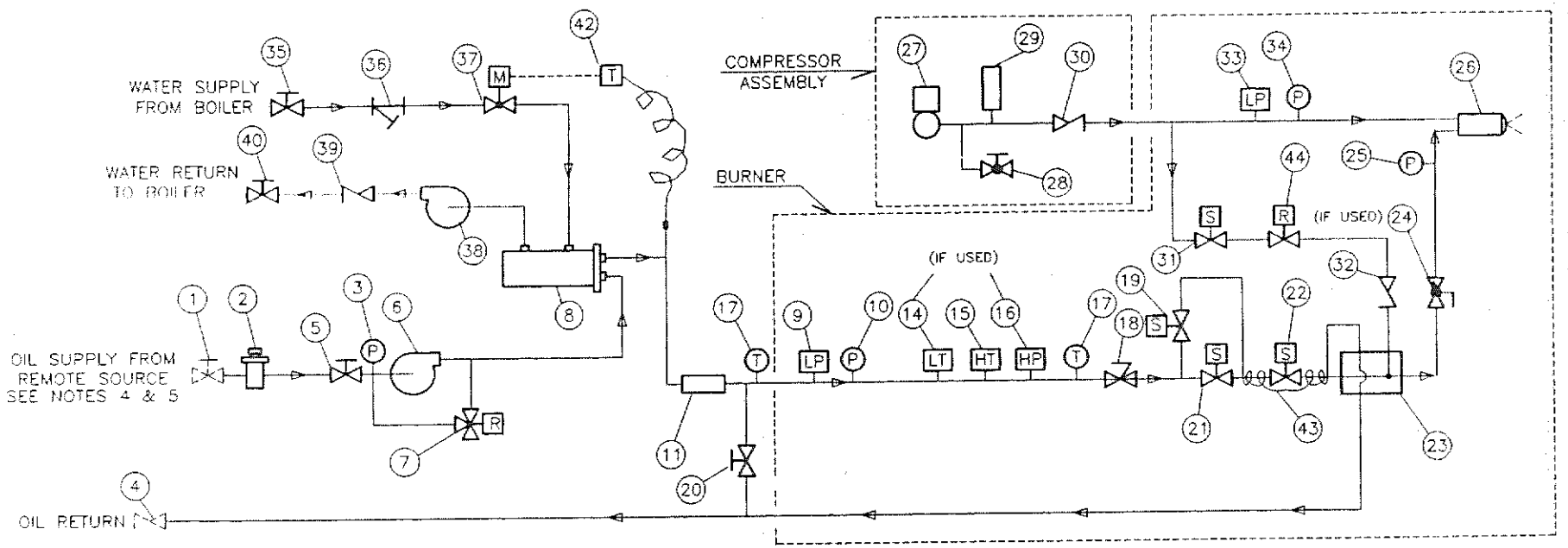


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
8. Steam Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Steam Supply Check Valve
36. Steam Supply Gate Valve
37. Steam Strainer
38 Steam Press. Regulator (High Press. Boilers Only)
39. Steam Safety Relief Valve (High Press. Boilers Only)
40. Temp. Regulating Valve
41. Steam Trap
42. 1/4" Heat Tracing Line
43. Air Purge Pressure Regulator

Figure 132

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 - No. 6 Oil Water Application
PHX-150 through PHX-250 Burners

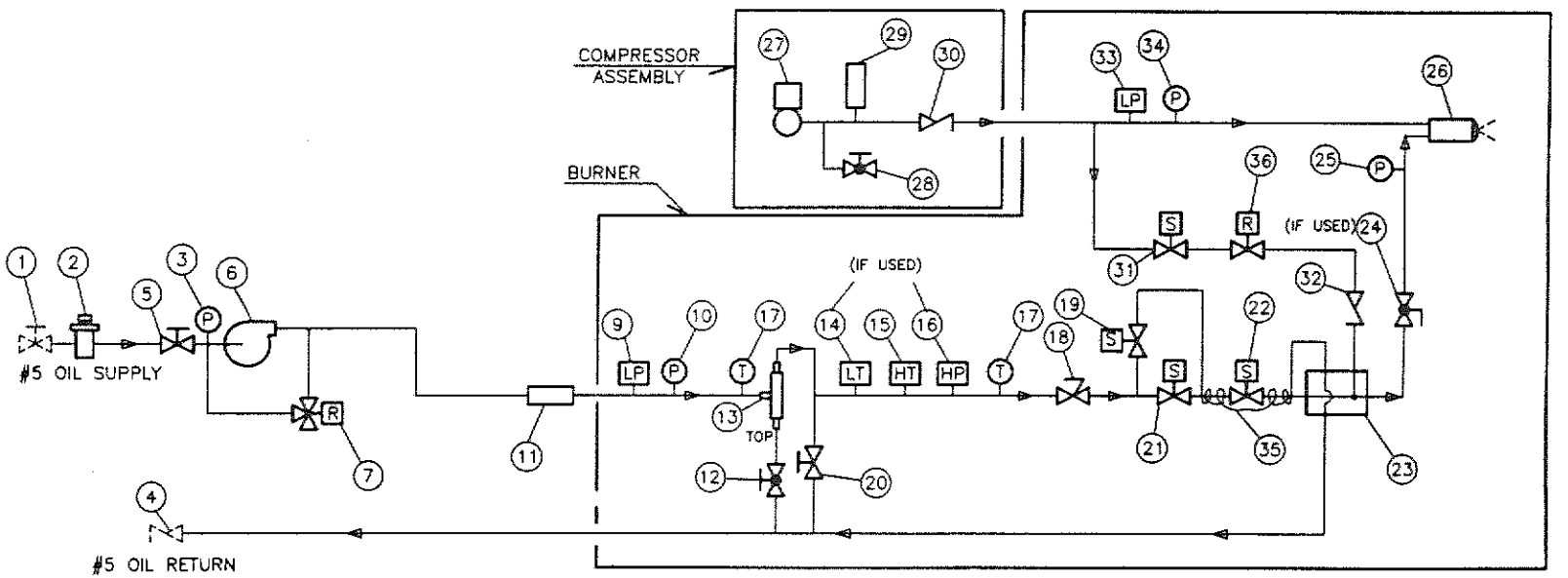


1. Oil Supply Gate Valve (By Others)
2. Oil Strainer
3. Oil Return Check Valve (By Others)
4. Oil Pump
5. Oil Pressure Regulating Valve
6. Low Oil Pressure Switch
7. Oil Pressure Gauge
8. Secondary Oil Strainer
9. Oil Metering Valve
10. Main Oil Valve, N.C.
11. Safety Oil Valve, N.C.
12. Nozzle Oil Pressure Gauge
13. Air Atomizing Oil Nozzle
14. Air Compressor
15. Air Bleed Needle Valve (If Used)
16. Compressor Dampening Tank
17. Air Check Valve
18. Low Atomizing Air Switch
19. Nozzle Air Pressure Gauge
20. Oil Shutoff Valve (If Used)

Figure 133

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 5 Oil Export
PHX-150 and PHX-250 Burners

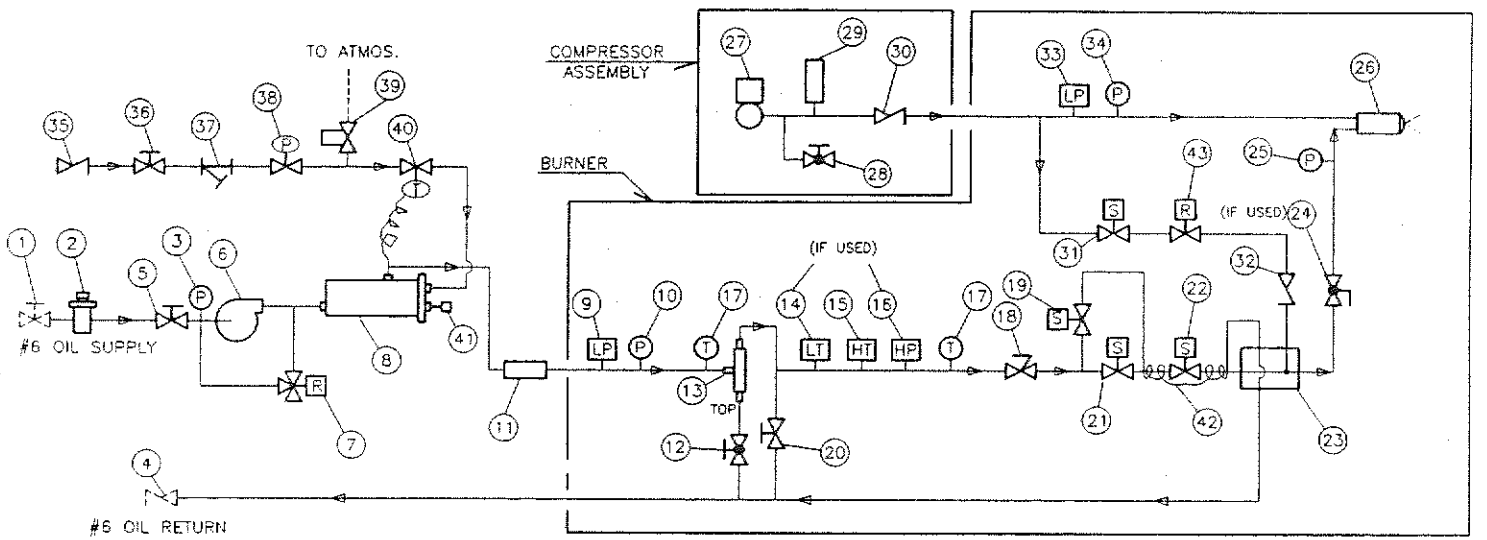


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. 1/4" Heat Tracing Line
36. Air Purge Pressure Regulator

Figure 134

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 6 Oil Export - Steam Application
PHX-150 and PHX-250 Burners

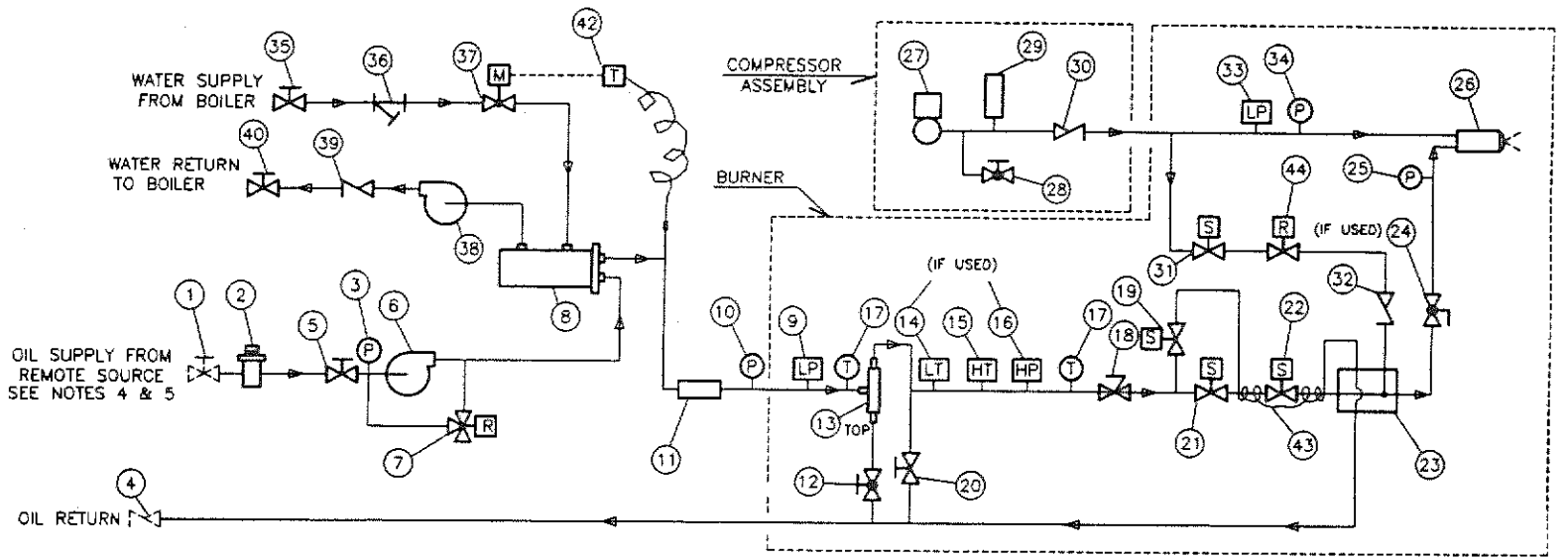


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
8. Steam Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Steam Supply Check Valve
36. Steam Supply Gate Valve
37. Steam Strainer
38. Steam Press. Regulator (High Press. Boilers Only)
39. Steam Safety Relief Valve (High Press. Boilers Only)
40. Temp. Regulating Valve
41. Steam Trap
42. 1/4" Heat Tracing Line
43. Air Purge Pressure Regulator

Figure 135

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 6 Oil Export - Water Application
PHX-150 and PHX-250 Burners



1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Valve
8. Water Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Water Supply Gate Valve
36. Water Strainer
37. Temp. Regulating Valve
38. Water Circulating Pump
39. Water Return Check Valve
40. Water Return Gate Valve
41 Remote Oil Pump Set (Not Shown)
42. Temperature Controller
43. 1/4" Heat Tracing Line
44. Air Purge Pressure Regulator

Figure 136

GENERAL ASSEMBLY DRAWING

PHX-300 through PHX-800 Burners

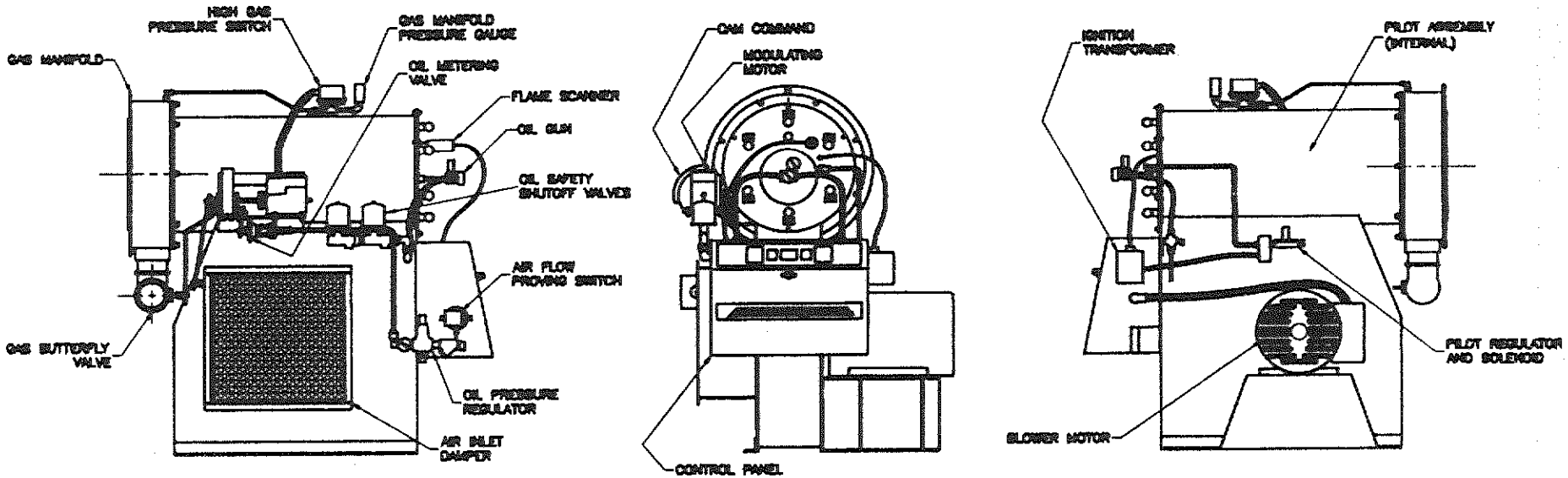


Figure 137

DATA SHEET

PHX-300 through PHX-400 Burners

	PHX-300	PHX-350	PHX-400
Nominal Air Flow CFM:			
(@ 20% Excess Air)	2588	3019	3450
Blower Wheel Type	Forward Curve	Forward Curve	Forward Curve
Blower Wheel:Diameter x Width	11.62 x 6.00	13.00 x 6.00	13.00 x 6.00
Blower Wheel: Static Pressure	14.93" WC	17.19" WC	17.56" WC
@ CFM	@ 2588	@ 3019	@ 3450
Blower Motor: HP	10 HP -	15 HP -	15 HP -
Blower Motor: RPM	3600 RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	213T	215T	215T
Air Damper: (Number of Vanes)	(4)	(4)	(4)
Flow Area H x W	13.00 x 13.00	13.00 x 13.00	13.00 x 13.00
Burner Head Throat Diameter	14.125"	14.125"	14.125"
Nominal Air Velocity Thru Diffuser	200 Ft./Sec.	200 Ft./Sec.	200 Ft./Sec.
Burner Head Attachment to Plenum	Bolted	Bolted	Bolted
Oil Firing Rate (No. 2 Oil @			
83% Eff.)	86.4	100.8	115.2
Oil Nozzle Type	Air Atomized	Air Atomized	Air Atomized
Standard Make/Spray Pattern	Monarch	Monarch	Monarch
	C-169-WA	C-169-WA	C-169-WA
Oil Nozzles:(Quantity)	(1)	(1)	(1)
GPH x Spray Angle	100 x 100°	100 x 100°	125 x 90°
Oil Pump Capacity: GPH @ PSI	174 @ 100	174 @ 100	174 @ 100
Oil Pump Mounting:			
On Burner/Remote	Remote	Remote	Remote
Oil Pressure Regulator:			
In Pump/Separate	Separate	Separate	Separate
Regulated Oil Pressure	45 PSI	45 PSI	45 PSI

	PHX-300	PHX-350	PHX-400
Atomizing Air Compressor	Atlas Copco,	Atlas Copco,	Atlas Copco,
Make, Model	LE22	LE22	LE22
Rating, SCFM @ 50 PSI	14.2	14.2	25.4
Gas Firing Rate (Nat. Gas @			
80% Eff.)	12,553	14,645	16,738
Gas Orifices: Body Size	3/8 - 18 NPT	3/8 - 18 NPT	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(18) .422	(18) .453	(18) .500
Nominal Gas Velocity Thru Orifices	197.3 Ft./Sec.	199.7 Ft./Sec.	187.4 Ft./Sec.
Butterfly Valve Pipe Size	3"	3"	3"
Gas Head Pressure (@ 0.0"			
Furnace Pressure)	7.88" WC	8.08" WC	7.11" WC
Standard Firing Rate Control System	Modulation	Modulation	Modulation
Standard Turndown Ratio	5 : 1	5 : 1	5 : 1
Standard Ignition System -			
Gas or Oil Firing	Gas Pilot	Gas Pilot	Gas Pilot
Standard Ignition System -			
Oil Firing Only	Oil Pilot	Oil Pilot	Oil Pilot
Standard Main Power Supply	230 / 3 / 60	230 / 3 / 60	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP,	Nat. Gas, LP,	Nat. Gas, LP,
	#2-#6 Oil	#2-#6 Oil	#2-#6 Oil
Code Constructions Available	UL, CSD-1,	UL, CSD-1,	UL, CSD-1,
	FM, IRI	FM, IRI	FM, IRI

Figure 138

DATA SHEET

PHX-500 Burner

	PHX-500
Nominal Air Flow CFM: (@ 20% Excess Air)	4312
Blower Wheel Type	Backward Inclined
Blower Wheel:Diameter x Width	18.25 x 7.218
Blower Wheel: Static Pressure @ CFM	15.9" WC @ 4312
Blower Motor: HP - RPM	20 HP - 3600 RPM
Blower Motor: Frame Size	254T
Air Damper: (Number of Vanes) Area H x W	(4) 16.00 x 16.00
Burner Head Throat Diameter	14.125"
Nominal Air Velocity Thru Diffuser	200 Ft./Sec.
Burner Head Attachment to Plenum	Bolted
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	144
Oil Nozzle Type	Air Atomized
Standard Make/Spray Pattern	Monarch C-169-WA
Oil Nozzles:(Quantity) GPH x Spray Angle	(1) 150.00 x 100°
Oil Pump Capacity: GPH @ PSI	174 @ 100
Oil Pump Mounting: On Burner/Remote	Remote
Oil Pressure Regulator: In Pump/Separate	Separate
Regulated Oil Pressure	50 PSI

	PHX-500
Atomizing Air Compressor Make, Model	Atlas Copco, LE40
Rating, SCFM @ 50 PSI	25.4
Gas Firing Rate (Nat. Gas @ 80% Eff.)	20,922
Gas Orifices: Body Size	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(18) .500
Nominal Gas VelocityThru Orifices	234.2 Ft./Sec.
Butterfly Valve Pipe Size	3"
Gas Head Pressure (@ 0.0" Furnace Pressure)	11.11" WC
Standard Firing Rate Control System	Modulation
Standard Turndown Ratio	5 : 1
Standard Ignition System - Gas or Oil Firing	Gas Pilot
Optional Ignition System - Oil Firing Only	Oil Pilot
Standard Power Supply	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2-#6 Oil
Code Constructions Available	UL, CSD-1, FM, IRI

Figure 139

DATA SHEET

PHX-600 through PHX-800 Burners

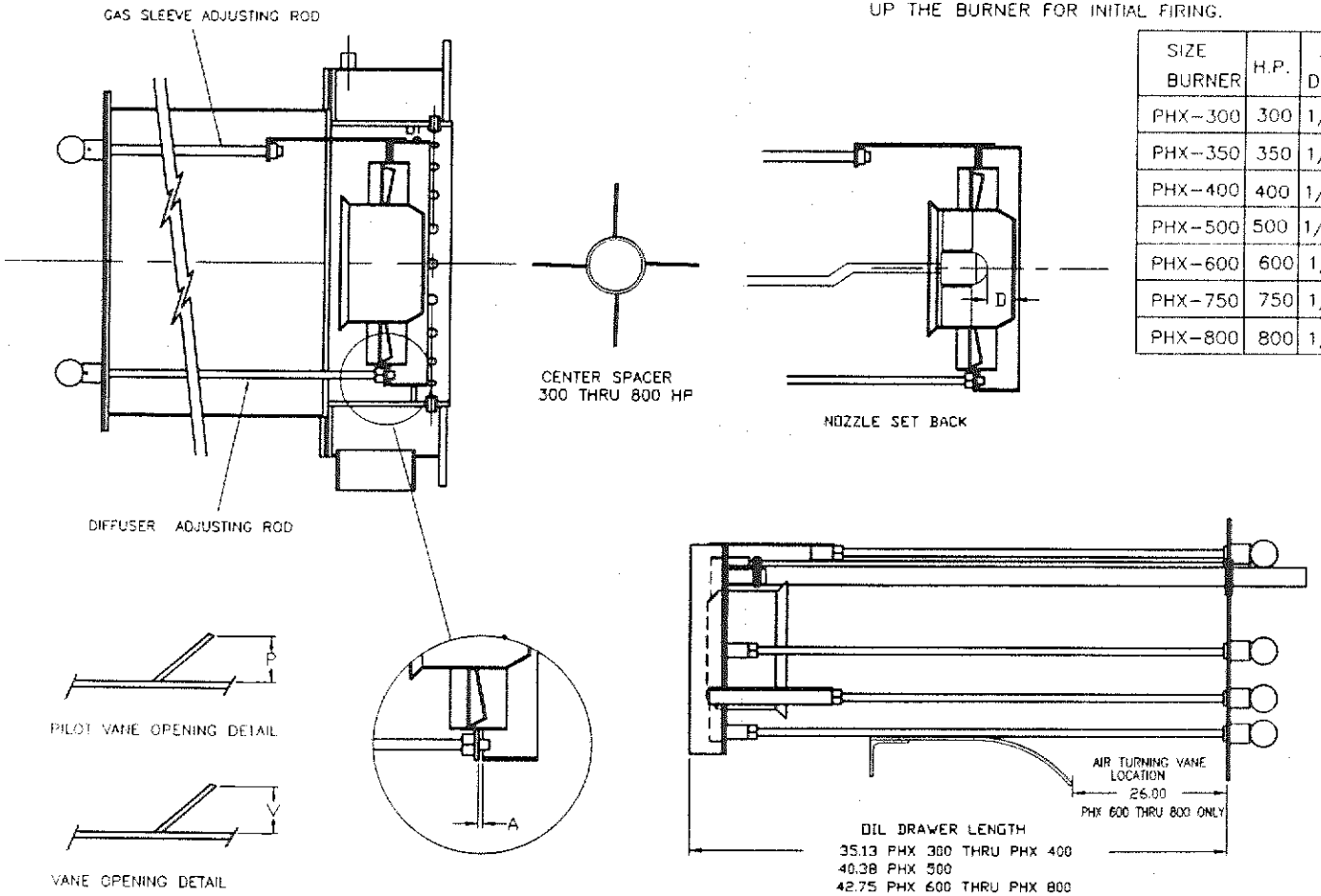
	PHX-600	PHX-750	PHX-800
Nominal Air Flow CFM: (@ 20% Excess Air)	5175	6469	6900
Blower Wheel Type	Backward Incline	Backward Incline	Backward Incline
Blower Wheel:Diameter x Width	20 x 6.75	22.25 x 6.31	22.25 x 6.31
Blower Wheel: Static Pressure @ CFM	18.38" WC @ 5175	22.60" WC @ 6469	22.32" WC @ 6900
Blower Motor: HP	25 HP	30 HP	40 HP
Blower Motor: RPM	3600 RPM	3600 RPM	3600 RPM
Blower Motor: Frame Size	256T	284TS	286TS
Air Damper: (Number of Vanes)	(6)	(6)	(6)
Flow Area H x W	20.12 x 20.12	20.12 x 20.12	20.12 x 20.12
Burner Head Throat Diameter	17.27"	17.27"	17.27"
Nominal Air Velocity Thru Diffuser	206 Ft./Sec.	206 Ft./Sec.	206 Ft./Sec.
Burner Head Attachment to Plenum	Bolted	Bolted	Bolted
Oil Firing Rate (No. 2 Oil @ 83% Eff.)	172.8	216.1	230.5
Oil Nozzle Type	Air Atomized	Air Atomized	Air Atomized
Standard Make/Spray Pattern	Monarch C-169-WA	Monarch C-169-WA	Monarch C-169-WA
Oil Nozzles:(Quantity) GPH x Spray Angle	(1) 150 x 100°	(1) 200 x 100°	(1) 200 x 100°
Oil Pump Capacity: GPH @ PSI	313 @ 100	313 @ 100	313 @ 100
Oil Pump Mounting: On Burner/Remote	Remote	Remote	Remote
Oil Pressure Regulator: In Pump/Separate	Separate	Separate	Separate
Regulated Oil Pressure	60 PSI	65 PSI	70 PSI

	PHX-600	PHX-750	PHX-800
Atomizing Air Compressor Make, Model	Atlas Copco, LE40	Atlas Copco, LE40	Atlas Copco, LE40
Rating, SCFM @ 50 PSI	25.4	25.4	25.4
Gas Firing Rate (Nat. Gas @ 80% Eff.)	25,106	31,383	33,475
Gas Orifices: Body Size	3/8 - 18 NPT	3/8 - 18 NPT	3/8 - 18 NPT
Gas Orifices: (Quantity) Drill Size	(45) .375	(45) .422	(45) .438
Nominal Gas VelocityThru Orifices	199.9 Ft./Sec.	197.3 Ft./Sec.	195.3 Ft./Sec.
Butterfly Valve Pipe Size	4"	4"	4"
Gas Head Pressure (@ 0.0" Furnace Pressure)	8.09" WC	7.88" WC	7.73" WC
Standard Firing Rate Control System	Modulation	Modulation	Modulation
Standard Turndown Ratio	5 : 1	5 : 1	5 : 1
Standard Ignition System - Gas or Oil Firing	Gas Pilot	Gas Pilot	Gas Pilot
Standard Ignition System - Oil Firing Only	Oil Pilot	Oil Pilot	Oil Pilot
Standard Main Power Supply	230 / 3 / 60	230 / 3 / 60	230 / 3 / 60
Control Circuit Power Supply	115 / 1 / 60	115 / 1 / 60	115 / 1 / 60
Standard Fuels Available	Nat. Gas, LP, #2-#6 Oil	Nat. Gas, LP, #2-#6 Oil	Nat. Gas, LP, #2-#6 Oil
Code Constructions Available	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI	UL, CSD-1, FM, IRI

Figure 140

INITIAL ADJUSTMENTS GAS SLEEVE AND DIFFUSER

PHX-300 through PHX-800 Burners



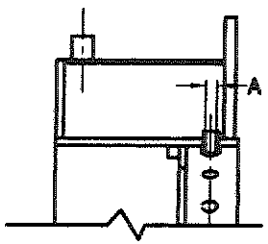
THESE ARE THE SETTINGS THAT SHOULD BE USED WHEN SETTING UP THE BURNER FOR INITIAL FIRING.

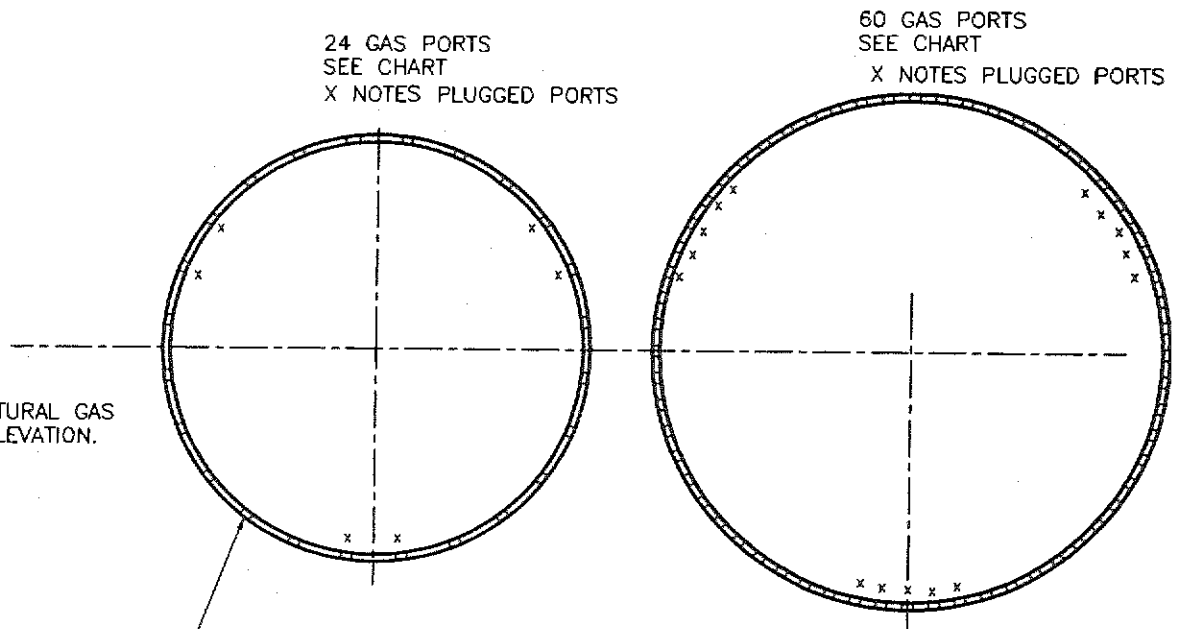
SIZE BURNER	H.P.	A DIM	V DIM	P DIM	D DIM
PHX-300	300	1/8	.625	.625	1.50
PHX-350	350	1/8	.625	.625	1.50
PHX-400	400	1/8	.750	.625	1.50
PHX-500	500	1/8	.750	.625	1.50
PHX-600	600	1/8	.750	.750	1.50
PHX-750	750	1/4	.875	.750	1.50
PHX-800	800	1/4	.875	.750	1.50

Figure 141

GAS HEAD ORIFICE INFORMATION

PHX-300 through PHX-800 Burners





GAS ORIFICE SIZES APPLY TO NATURAL GAS AT ALTITUDES UP TO 2000 FT. ELEVATION.

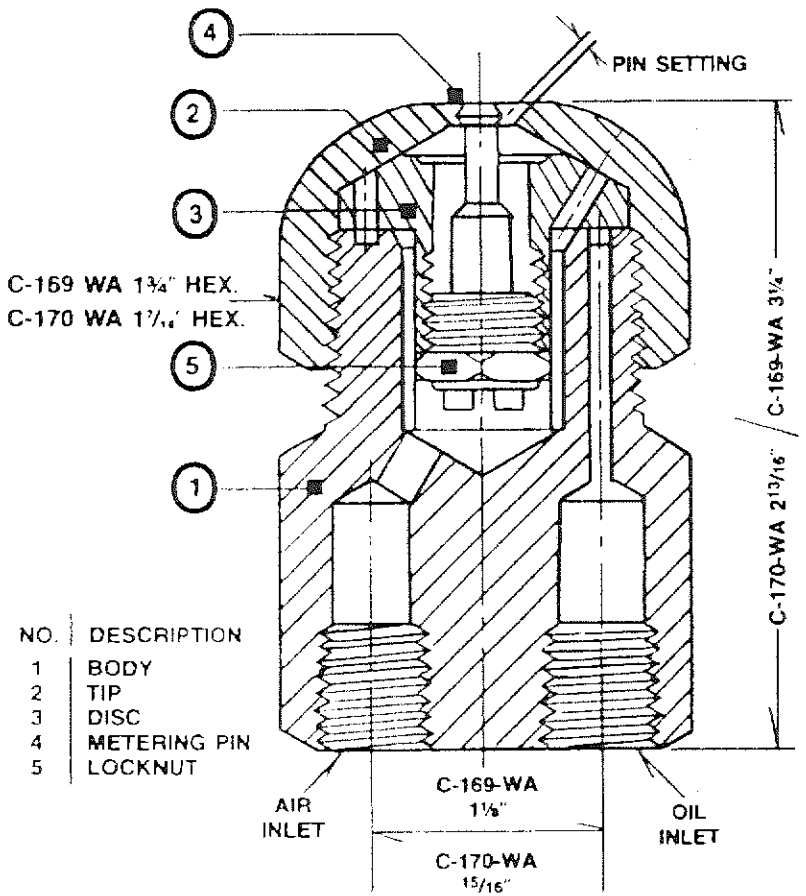
NOTE: ALL THREADED OPENINGS FOR THE GAS SPUDS ARE 3/8" NPT.

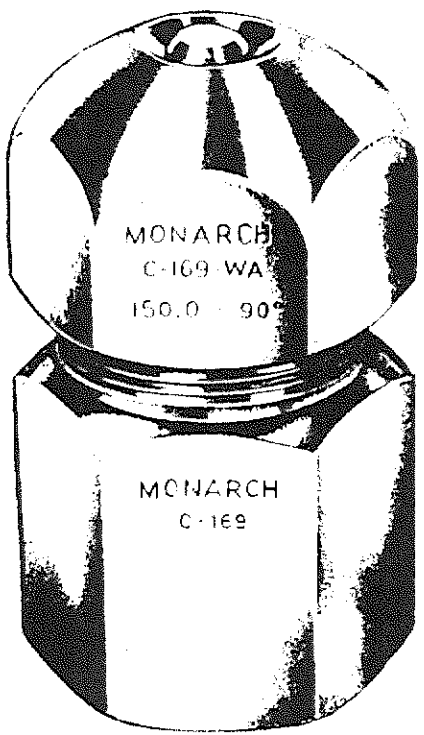
SIZE BURNER	H.P.	(A) SIZE ORIFICE	NO. ORIFICES	NO. PLUGS
PHX-300	300	.422	18	6
PHX-350	350	.453	18	6
PHX-400	400	.500	18	6
PHX-500	500	.500	18	6
PHX-600	600	.375	45	15
PHX-750	750	.422	45	15
PHX-800	800	.438	45	15

Figure 142

MONARCH AIR ATOMIZED NOZZLE ASSEMBLY

PHX-300 through PHX-800 Burners





NOTE: Application will vary with burner configuration and firing rate

Figure 143

MONARCH NOZZLE PIN SETTINGS

PHX-300 through PHX-800 Burners

BURNER MODEL	FIGURE NUMBER	RATED GPH*	NPT CONNECTIONS		PIN SETTING
			AIR	OIL	
PHX–300	C–169–WA	100	1/4"	1/4"	.062"
PHX–350		100	1/4"	1/4"	.062"
PHX–400		125	3/8"	1/4"	.062"
PHX–500		150	3/8"	1/4"	.062"
PHX–600		150	3/8"	1/4"	.062"
PHX–750		200	3/8"	3/8"	.062"
PHX–800		200	3/8"	3/8"	.062"

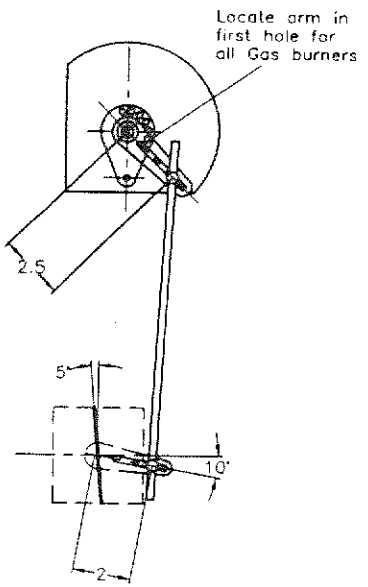
* With air at 15 PSI and No. 2 oil at 26 PSI **OR** with air at 21 PSI and No. 2 oil at 31 PSI.

Figure 144

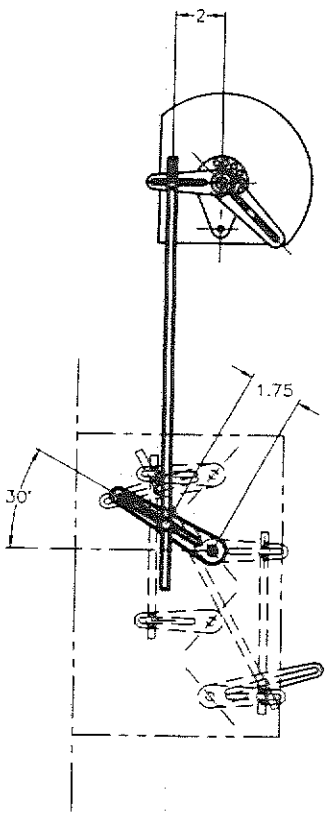
KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-300 and PHX-500 Burners

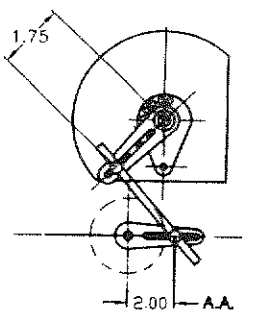
GAS



AIR



OIL

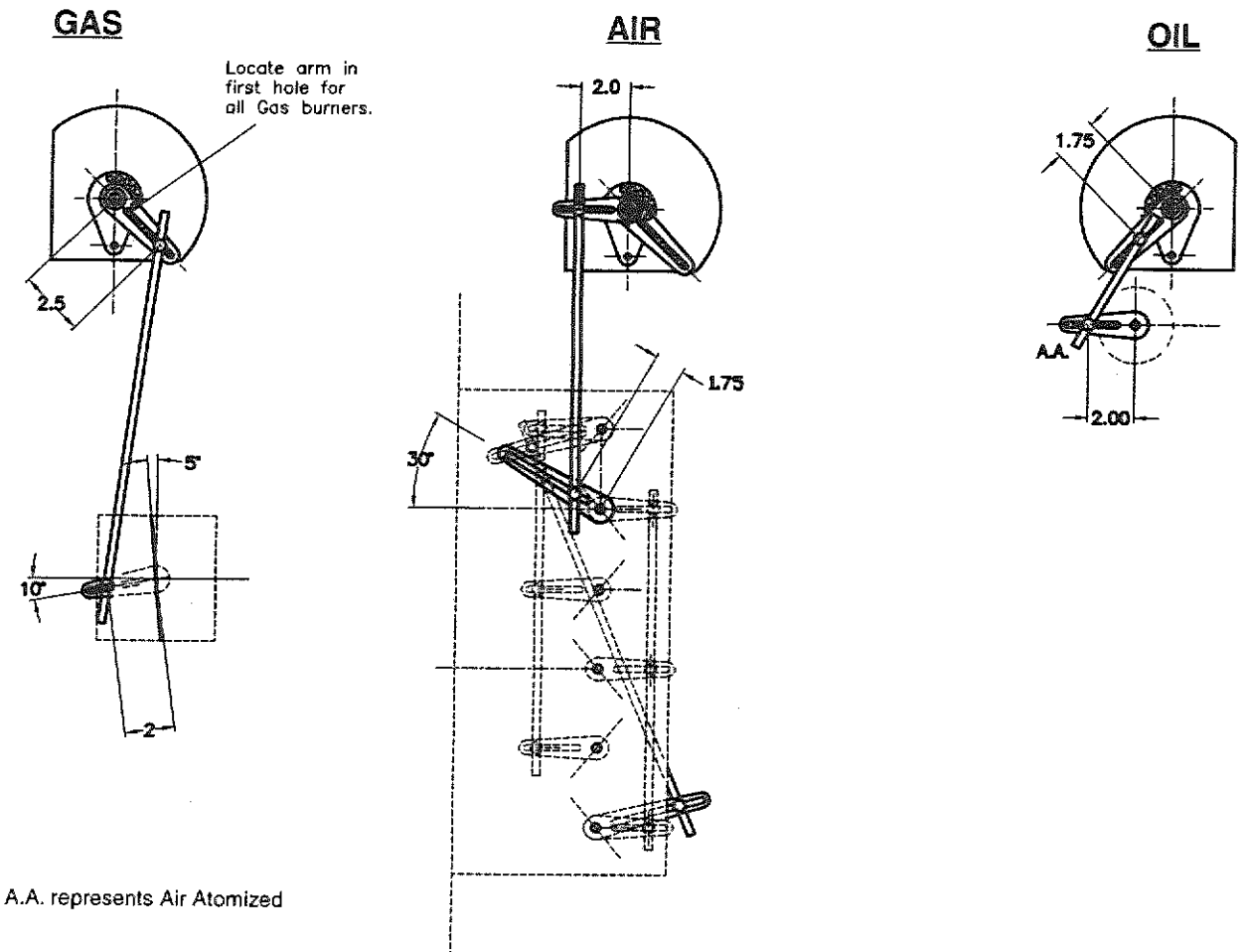


NOTE: on "Oil" drawing above, A.A. represents Air Atomized

Figure 145

KEWANEE CAMCOMMAND

Initial Linkage Settings
PHX-600 and PHX-800 Burners



NOTE: on "Oil" drawing above, A.A. represents Air Atomized

Figure 146

KEWANEE CAMCOMMAND

PHX-300 through PHX-800 Burners

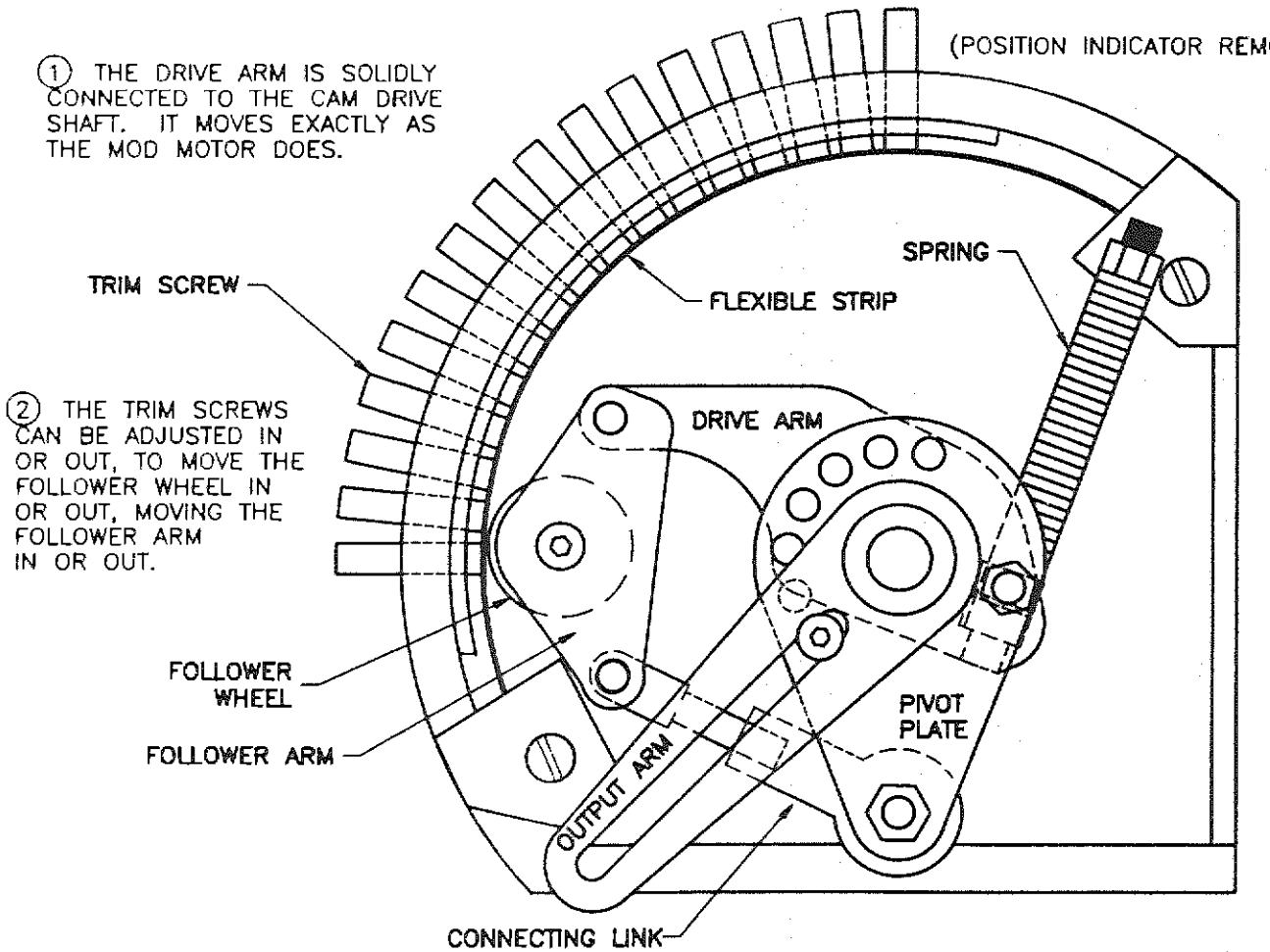
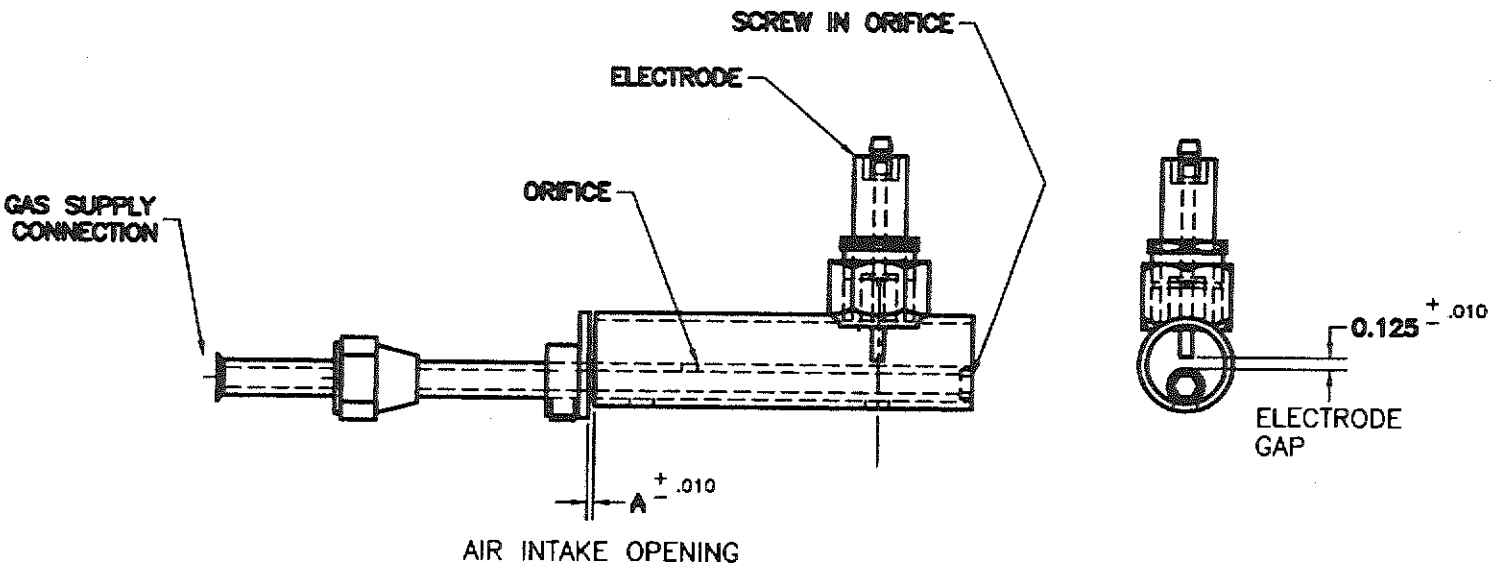


Figure 147

GAS PILOT SETTINGS

PHX-300 through PHX-800 Burners



DIMENSION A	BURNER SIZE
.063	PHX–40 Through PHX–400
.093	PHX–500 Through PHX–800

Figure 148

GAS TRAIN

IRI - (0 to 12,000,000 BTU)
10 to 250 HP

UL, FM and IRI - (12,000,000 and Over BTU)
300 HP and Over

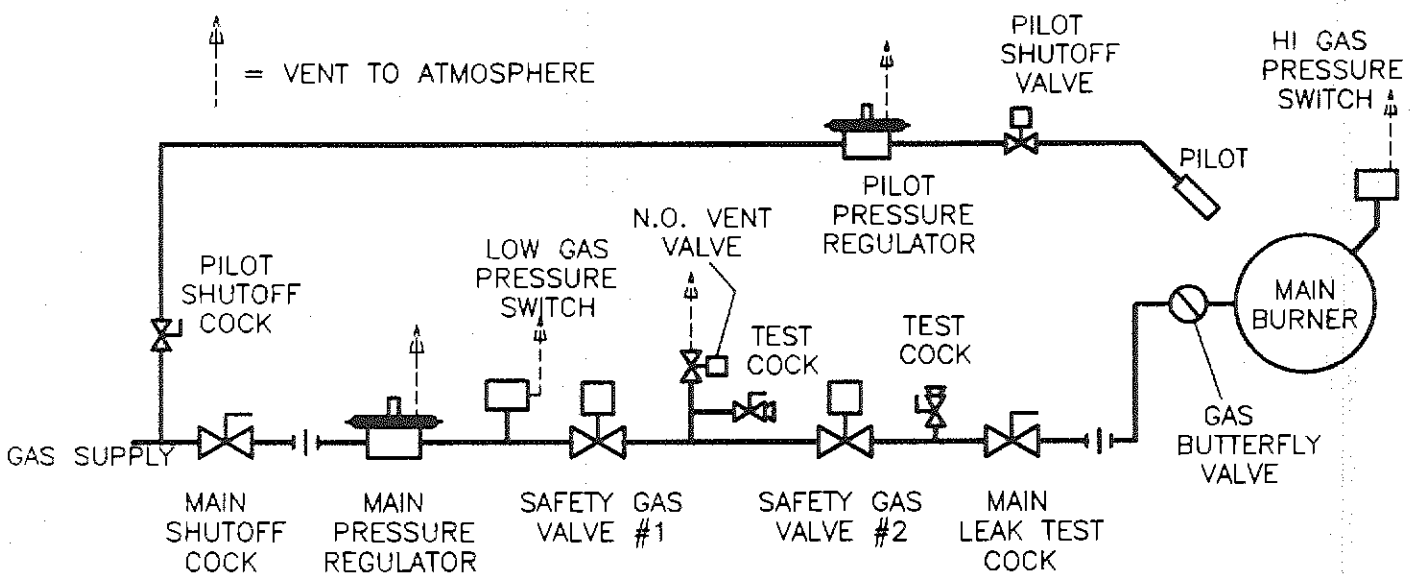


Figure 149

DUAL GAS TRAIN

UL, FM and IRI - (12,000,000 and Over BTU)
150 HP and Over

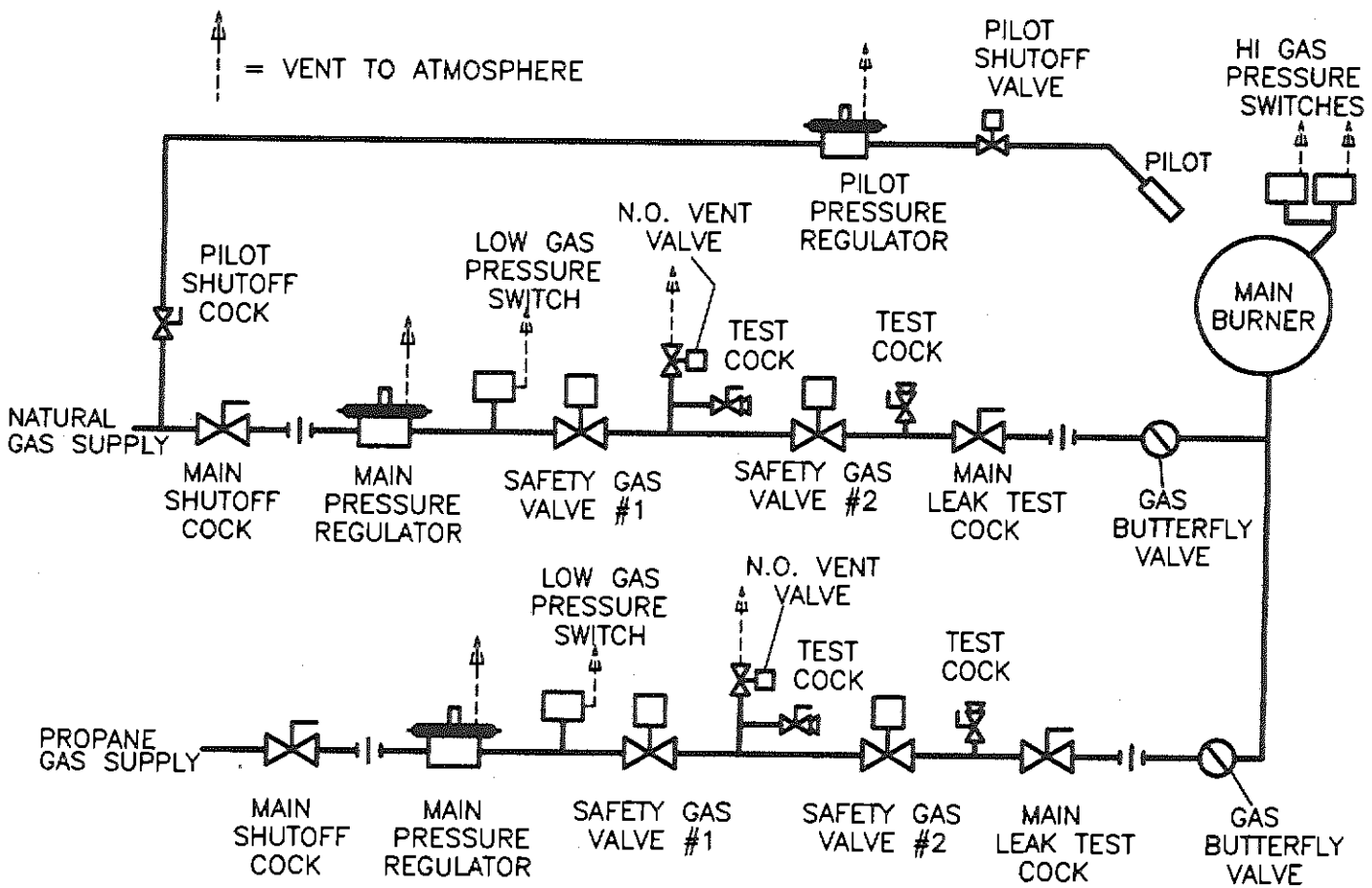


Figure 150

OIL PILOT SETTINGS

PHX-300 and PHX-800 Burners

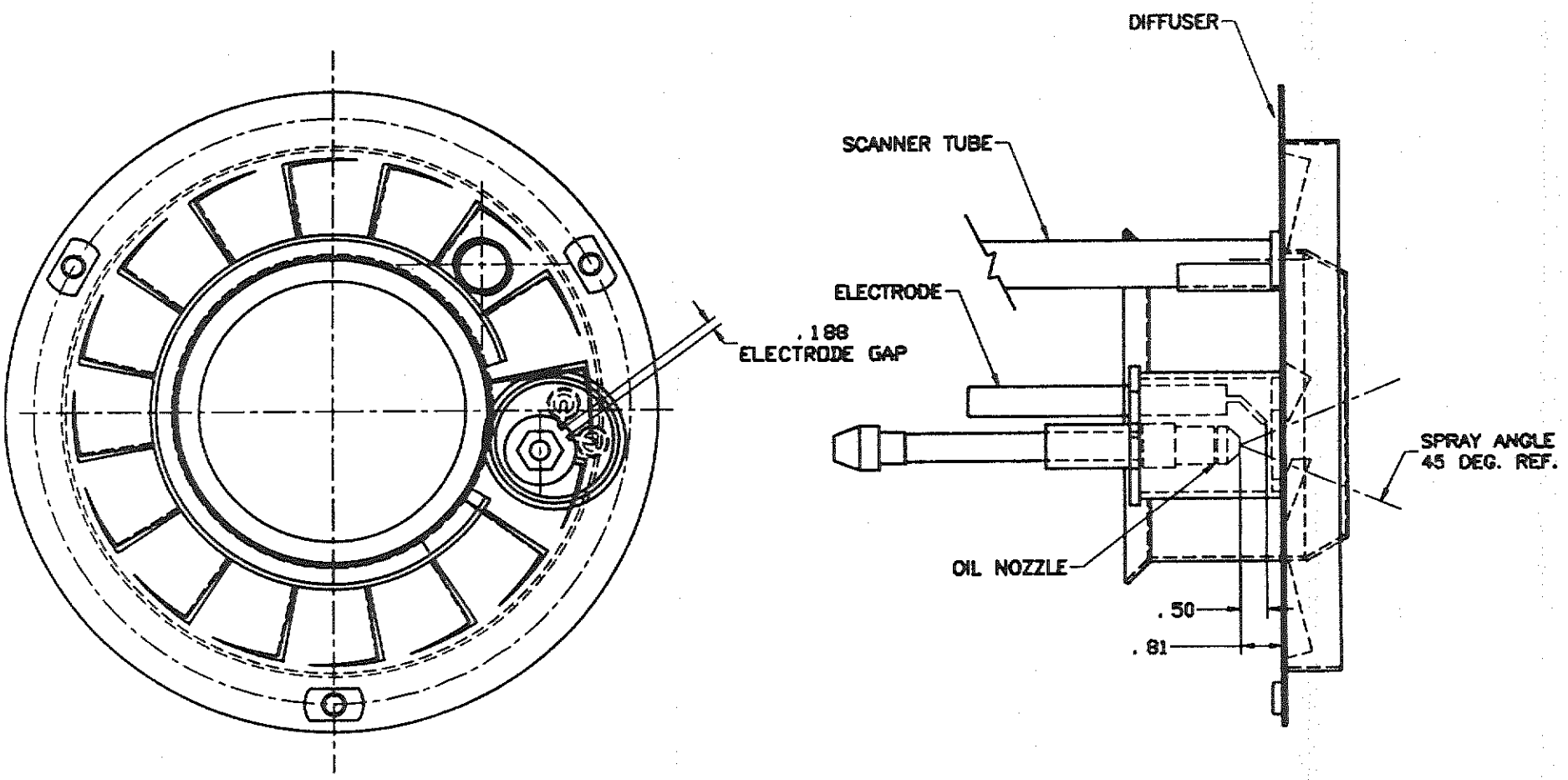
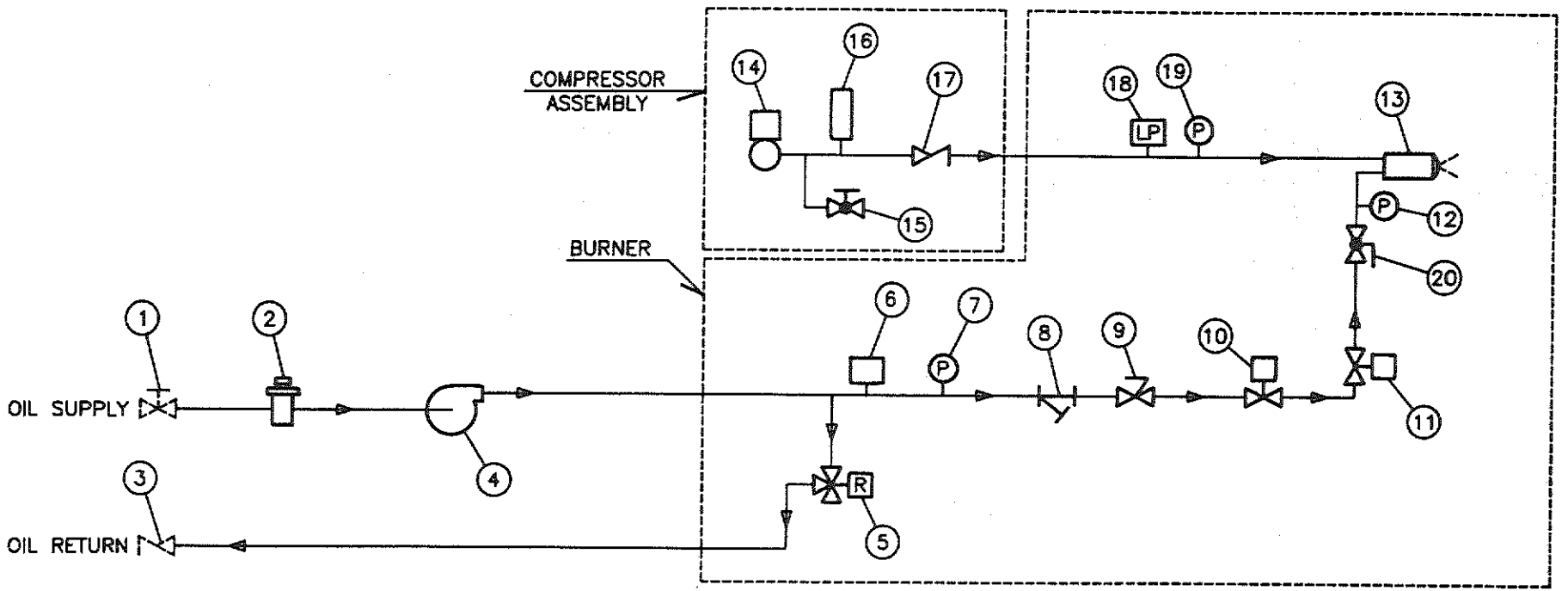


Figure 151

AIR ATOMIZING OIL NOZZLE SYSTEM

Modulation
Air Atomized No. 2 Oil
PHX-300 through PHX-800 Burners

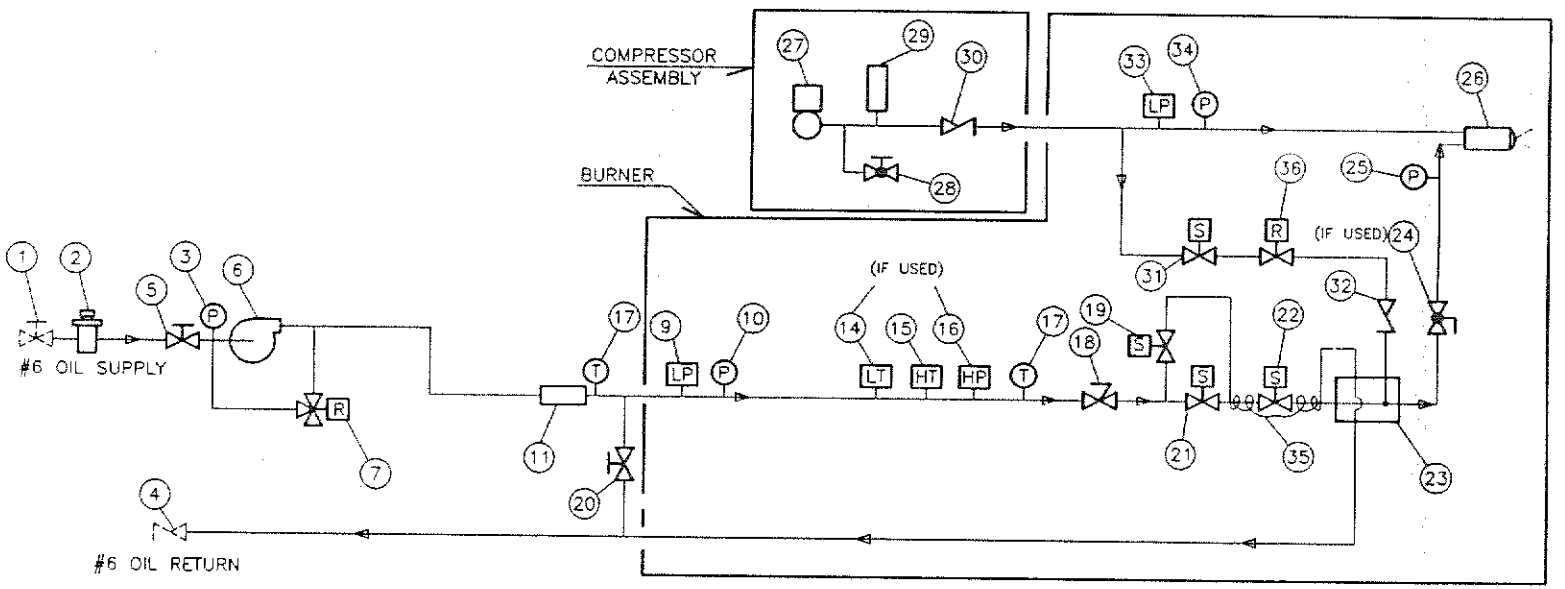


1. Oil Supply Gate Valve (By Others)
2. Oil Strainer
3. Oil Return Check Valve (By Others)
4. Oil Pump
5. Oil Pressure Regulating Valve
6. Low Oil Pressure Switch
7. Oil Pressure Gauge
8. Secondary Oil Strainer
9. Oil Metering Valve
10. Main Oil Valve, N.C.
11. Safety Oil Valve, N.C.
12. Nozzle Oil Pressure Gauge
13. Air Atomizing Oil Nozzle
14. Air Compressor
15. Air Bleed Needle Valve (If Used)
16. Compressor Dampening Tank
17. Air Check Valve
18. Low Atomizing Air Switch
19. Nozzle Air Pressure Gauge
20. Oil Shutoff Valve (If Used)

Figure 152

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 4 and No. 5 Oil
PHX-300 through PHX-800 Burners

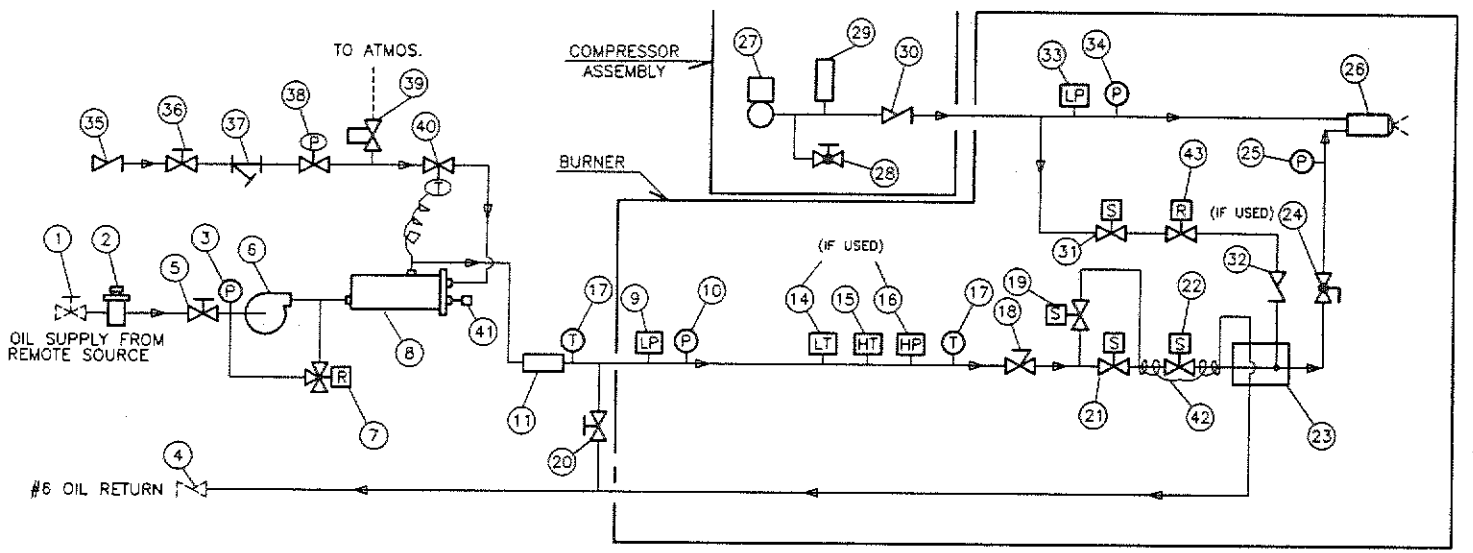


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. 1/4" Heat Tracing Line
36. Air Purge Pressure Regulator

Figure 153

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 6 Oil - Steam Application
PHX-300 and PHX-800 Burners

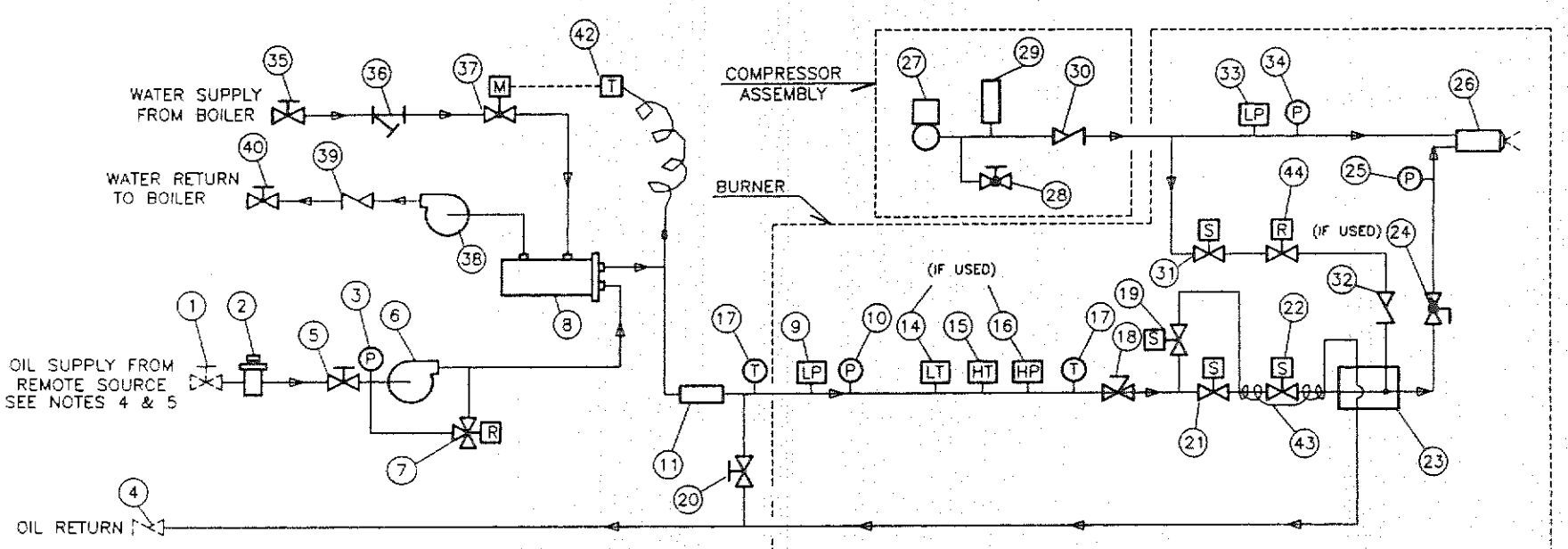


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
8. Steam Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Steam Supply Check Valve
36. Steam Supply Gate Valve
37. Steam Strainer
38. Steam Press. Regulator (High Press. Boilers Only)
39. Steam Safety Relief Valve (High Press. Boilers Only)
40. Temp. Regulating Valve
41. Steam Trap
42. 1/4" Heat Tracing Line
43. Air Purge Pressure Regulator

Figure 154

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized ASTM D396 No. 6 Oil - Water Application
PHX-300 through PHX-800 Burners

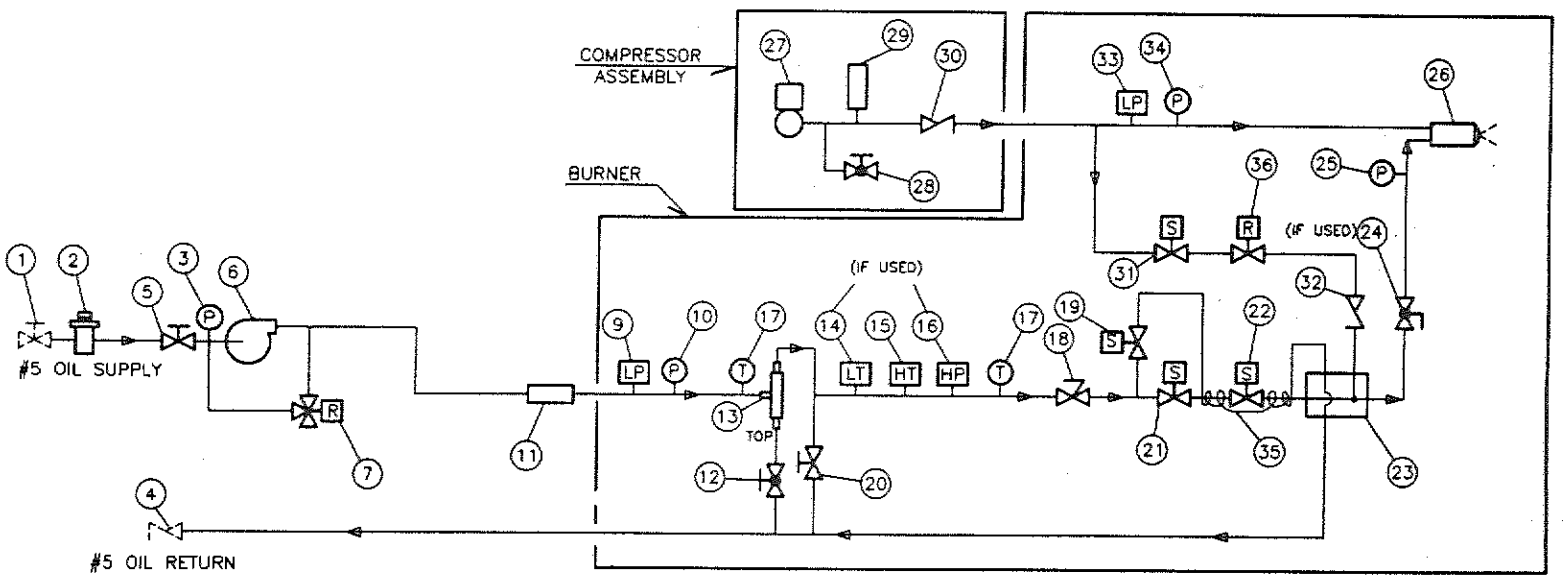


1. Oil Supply Gate Valve (By Others)
2. Oil Strainer
3. Oil Return Check Valve (By Others)
4. Oil Pump
5. Oil Pressure Regulating Valve
6. Low Oil Pressure Switch
7. Oil Pressure Gauge
8. Secondary Oil Strainer
9. Oil Metering Valve
10. Main Oil Valve, N.C.
11. Safety Oil Valve, N.C.
12. Nozzle Oil Pressure Gauge
13. Air Atomizing Oil Nozzle
14. Air Compressor
15. Air Bleed Needle Valve (If Used)
16. Compressor Dampening Tank
17. Air Check Valve
18. Low Atomizing Air Switch
19. Nozzle Air Pressure Gauge
20. Oil Shutoff Valve (If Used)

Figure 155

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 5 Oil Export
PHX-300 and PHX-800 Burners

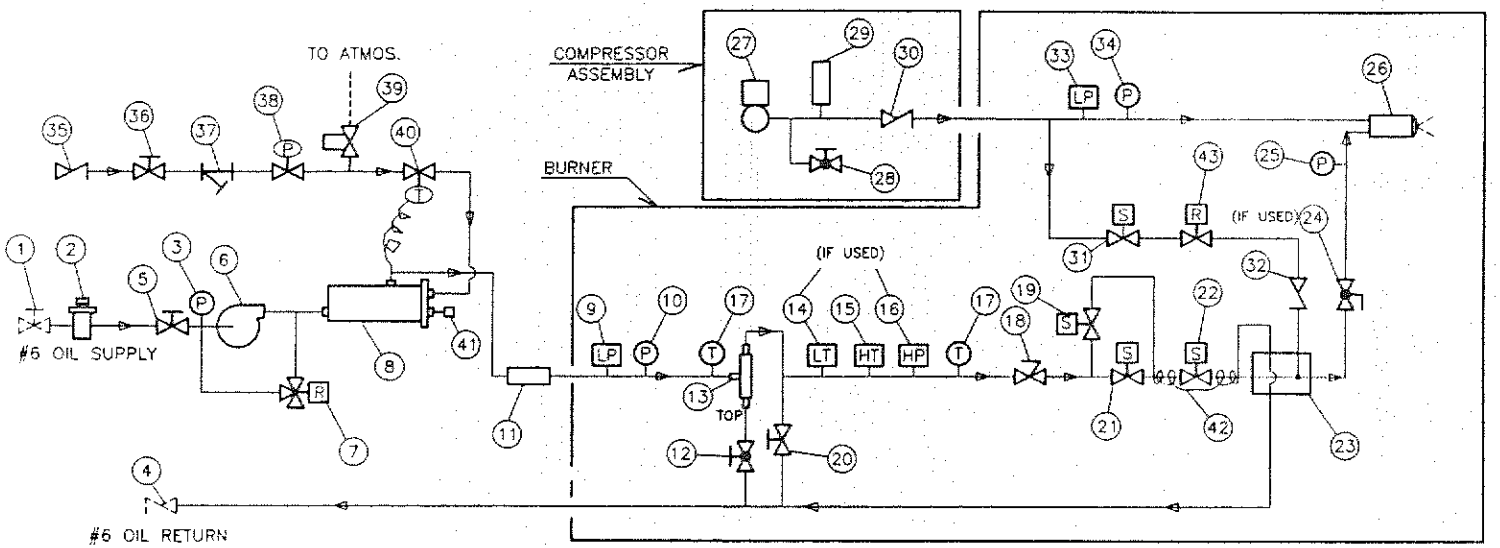


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. 1/4" Heat Tracing Line
36. Air Purge Pressure Regulator

Figure 156

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 6 Oil Export - Steam Application
PHX-300 and PHX-800 Burners

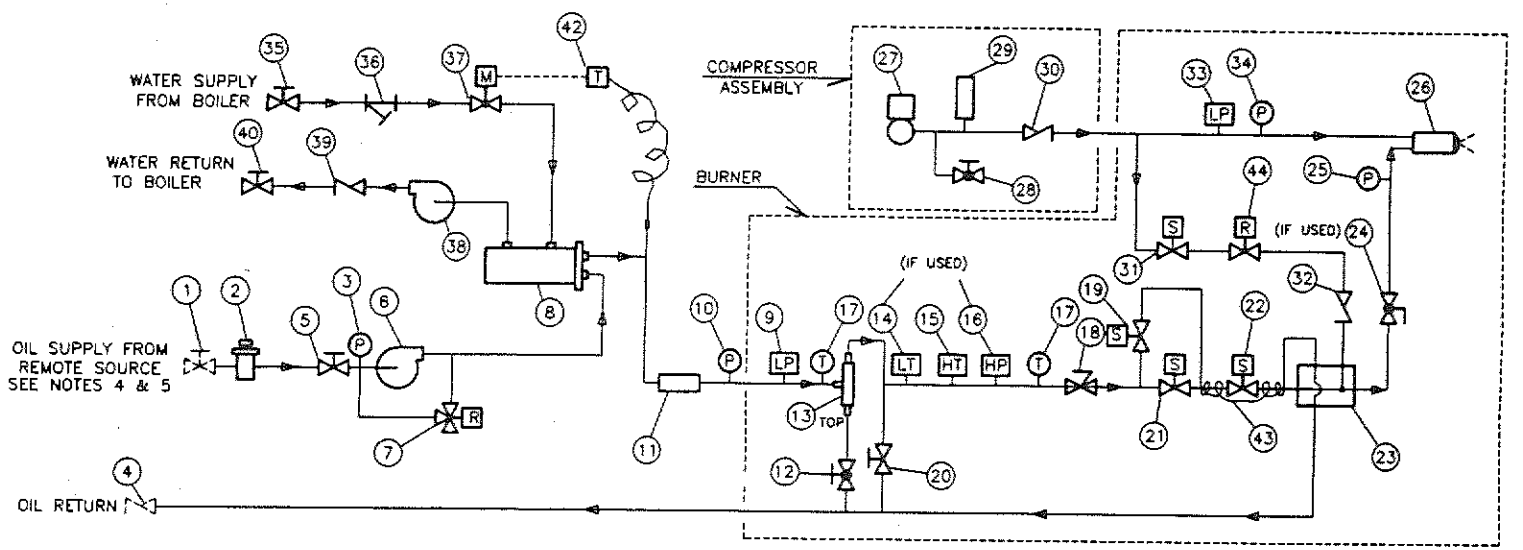


1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Vavle
8. Steam Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Steam Supply Check Valve
36. Steam Supply Gate Valve
37. Steam Strainer
38 Steam Press. Regulator (High Press. Boilers Only)
39. Steam Safety Relief Valve (High Press. Boilers Only)
40. Temp. Regulating Valve
41. Steam Trap
42. 1/4" Heat Tracing Line
43. Air Purge Pressure Regulator

Figure 157

AIR ATOMIZING OIL NOZZLE SYSTEM

Air Atomized No. 6 Oil Export - Water Application
PHX-300 and PHX-800 Burners



1. Oil Supply Gate Valve
2. Oil Strainer
3. Compound Pressure/Suction Gauge
4. Oil Return Check Valve
5. Gate Valve at Pump Inlet
6. Oil Pump
7. Oil pressure Regulating Valve
8. Water Oil Heater
9. Low Oil Pressure Switch
10. Oil Pressure Gauge
11. Electric Oil Heater
14. Low Oil Temp. Sw. (If Used)
15. High Oil Temp. Sw.
16. High Oil Press. Sw. (If Used)
17. Oil Temp. Gauge
18. Oil Metering Valve
19. Circulating Oil Valve, N.O.
20. Cold Start Gate Valve
21. Main Oil Valve, Normally Closed
22. Safety Oil Valve, Normally Closed
23. Nozzle Line Purge Block
24. Oil Shutoff Valve (If Used)
25. Nozzle Oil Pressure Gauge
26. Air Atomizing Oil Nozzle
27. Air Compressor
28. Air Bleed Needle Valve
29. Compressor Dampening Tank
30. Air Check Valve
31. Air Purge Solenoid Valve, N.O.
32. Air Purge Check Valve
33. Low Atomizing Air Switch
34. Nozzle Air Pressure Gauge
35. Water Supply Gate Valve
36. Water Strainer
37. Temp. Regulating Valve
38. Water Circulating Pump
39. Water Return Check Valve
40. Water Return Gate Valve
41 Remote Oil Pump Set (Not Shown)
42. Temperature Controller
43. 1/4" Heat Tracing Line
44. Air Purge Pressure Regulator

Figure 158

Section 8

START-UP - GAS FIRING

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

CAUTION: Fuel air ratio adjustments must only be made using a flue gas analyzer whose calibration and accuracy are proven. "Visual" estimations of combustion performance are inadequate for safety or efficiency.

1. The gas piping, controls and valves should be checked for compliance with all local utility and insurance requirements.

CAUTION: Vent valves, relief valves and vent tappings from all pressure regulators and pressure switches shall be piped to outside atmosphere by the installing contractor.

2. Check all linkages. The linkage and damper should be visually checked for opening and free

operation throughout full range to make sure that they were not damaged in shipment or installation. Ensure burner control switch is in manual with firing rate potentiometer in "Low".

3. Check the operation of the gas pilot as outlined in the General Instructions in Section 4 and Section 7.

4. With the manual shut-off valve closed and the pilot ignited, begin the process of lighting off the main burner. At this time the operating gas valve and the safety gas valve will open. Slowly open the manual gas shut-off valve. If the gas line has been properly purged of air, the main flame will be established almost immediately. If it is not established in a few seconds, shut off the manual gas valve. Check the operating and safety gas valves to be sure that they are open. Check the firing (butterfly) valve to be sure it is open for a proper low fire. Check the main gas pressure and the pressure downstream from the gas train pressure regulator. If all valves open properly, and if the proper gas pressure has been established, the main flame should light.

   With the main flame lit for the first time, watch the flame through the burner's observation port while you turn the burner off. The flame should extinguish almost immediately. This indicates proper function of the safety shutoff valves. If it is not extinguished in a few seconds, shut off the manual gas valve. Check the operating and safety gas valves to determine whether they have closed properly.

DANGER: Safety shutoff valves must be tested for proof of function at the first light off of the burner, using the method given in Item 4. Defective or improperly wired safety shutoff valves present a hazard of serious personal injury or death of boiler room personnel and severe damage to boiler room equipment if this procedure is not followed.

5. Restart the burner several times to check for smooth light-off. If light-off is not smooth, refer to the Troubleshooting Section in this manual.

6. Operate the burner at low fire until the water in the boiler is warm (above 150° F).

CAUTION: Attempts to fire boiler at high fire rate before boiler water is warm, will cause thermal shock and could cause permanent damage to the boiler.

7. Bring the burner to high fire by slowly advancing the manual potentiometer.

8. With the burner in high fire position, check the input at the gas meter, making due allowance for any pressure or temperature correction factors. Changes in the maximum firing rate may be affected by increasing or reducing the outlet gas pressure at the pressure regulator on the gas train. For details on calculating fuel input, see the information on Gas Rate Calculations below.

Gas Rate Calculations

To calculate the fuel rate input for natural gas, "clock" the gas meter provided by the gas company. Be sure that the burner that is being checked is the only unit running off this meter. The gas meter measures gas flow volume in cubic feet. The time interval can be up to the person timing , but it should be noted that the longer the time interval the more accurate your calculation will be. Use the following equation to calculate the rate.

$$Q = \frac{V \times Cp \times Ct \times Cc \times Hv \times 3600}{t}$$

Q = Cubic Feet per Hour
V = Gas Flow Volume ($Ft.^3$)
Cp = Gas Pressure Correction Factor
Ct = Gas Temperature Correction Factor
Cc = Gas Compressibility Correction Factor
Hv = Heating Value
t = Time (seconds)

The correction factors, Cp, Ct and Cc, are used to compensate for variation in base conditions. The base conditions are used to set gas meters. These are set according to the gas company to meet standard conditions for the area where the gas meter is located. Compressibility is generally a small factor, unless at high gas pressure conditions and can be ignored. For information on the correction factors and the heating value for the gas, contact the utility company supplying the gas.

9. High firing rate should be set at published input rating. The operator may reduce the high fire rate by adjusting the manual potentiometer setting toward the low fire position.

   On water boilers, condensed gases may damage boiler, breeching, and stack if the low firing rate or boiler water temperature is too low.

   Flue gas dew point temperatures for various fuels are provided in Figure 64. The operating water temperature of the boiler should be set at least 20° F above the dew point temperature.

Fuels	Dew Point Temperature
Gas	135°F
Light Oils*	115°F
Heavy Oils*	140°F

* For each percentage point of sulfur content, add 30°F

Figure 64 - Table of Dew Point Temperatures for Flue Gases of Various Fuels

The low fire boiler operating temperature not only affects the threat of condensation in the boiler, but also the potential for thermal shock. Thermal stresses in the boiler can lead to leaks in the fluetube joints. With the cycling of the boiler, fatigue can cause cracking around stay bolt connections and in the tube sheets. The operating temperature of a water boiler should be kept within 100° F of the saturation temperature corresponding to the design operating pressure of the boiler.

10. Adjust the fuel-air ratio to achieve a combustion rating as specified in the Performance Standards listed on the next page. Check gas pressures and combustion efficiencies for both high and low firing rates.

Performance Standards

The following performance standards for Oxygen (O_2) and Carbon Dioxide (CO_2) in the flue gases of boilers are given below as a guideline only for boiler start-up. Oxygen and Carbon Dioxide will differ according to the application and specifications of individual installations. (All % values given as a percentage by volume of dry flue gases.)

A. Oxygen (O_2) in flue gas

Firing Rate	Gas & #2 Oil $\%O_2$	#4,#5,#6 Oils $\%O_2$
High Fire	3.5 ± 0.5%	4.0 ± 0.5%
Mid Fire	4.5 ± 0.5%	5.0 ± 0.5%
Low Fire	7.0 ± 0.5%	8.0 ± 0.5%

B. Carbon Dioxide (CO_2) - in flue gas by fuel

Fuel	% CO2 (Dry Base)		
	High Fire	Mid Fire	Low Fire
Natural Gas	10.1 ± 0.3%	9.5 ± 0.3%	8.1 ± 0.3%
Propane	11.3 ± 0.3%	10.7 ± 0.3%	9.1 ± 0.3%
#2 and #4 Fuel Oil	12.6 ± 0.4%	11.9 ± 0.4%	10.1 ± 0.4%
#5 and #6 Fuel Oil	13.0 ± 0.4%	12.2 ± 0.4%	9.9 ± 0.4%

C. Carbon Monoxide (CO) in the flue gas of gas fired burners, should not exceed 50 ppm at any firing rate.

D. Smoke readings should be taken at high, mid and low firing rates for all oil firing burners. Smoke spot numbers (Bacharach Scale) should not exceed the following values:

Fuel	Smoke Spot		
	High Fire	Mid Fire	Low Fire
#2 Fuel Oil	1	1	2
#4,#5 and #6 Fuel Oil	2	2	3

11. Check safety limit controls (see Section 12 for details).

12. After completion of the above adjustments and checks, the burner may be released to automatic operation by turning the auto/manual switch to auto. Cycle the burner several times under full automatic operation. Check the flame response signal during the pilot proving and main flame period to be certain there is a steady signal present. Refer to the Troubleshooting section if steady signal is not present.

    If it becomes necessary to limit the firing rate in automatic operation, simply turn the manual potentiometer down to desired input. The manual potentiometer will limit the burner's maximum firing rate in either the manual or automatic setting.

Section 9

START-UP PRESSURE ATOMIZED OIL GAS PILOT

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: Fuel air ratio adjustments must only be made using a flue gas analyzer whose calibration and accuracy are proven. "Visual" estimations of combustion performance are inadequate for safety or efficiency.

CAUTION: Extreme care should be taken to insure fuel oil pumps are never allowed to run dry. If pumps are allowed to run continuously, the fuel oil system must be left in service at all times. Fuel oil is required to cool and lubricate the fuel oil pump when it is operating.

1. Pressure atomized oil firing is offered on PHX-40 through PHX-250 burners. High/low firing sequence with low fire start is standard on the PHX-40 through PHX-80 burners.

   PHX-100 through PHX-250 burners offer a fully modulating oil firing system with gas electric ignition as standard equipment.

2. Oil piping, controls and valves should be checked for compliance with all local utility and insurance requirements.

3. Check all linkages. The linkage and damper should be checked for opening and free operation to make sure that they were not damaged in shipment or installation.

4. Remove the pipe plug from the gauge port of the oil pump to purge air from the oil piping. Connect a length of copper tubing to the port to drain the oil discharge into a can or bucket.

5. Turn on the control circuit switch and wait one minute for controls to warm up. Turn the control panel switch to "on", at which point the blower motor will start, assuming power is available and all limit switches are closed. The integrally mounted oil pump is driven by a V-belt or direct off blower wheel shaft extension through a flexible coupling. Some units utilize a separate oil pump set.

6. If pump does not pick up oil within a minute, prime the oil pump as follows:

   A. Turn burner switch to "off"

   B. Close gate valve in suction line to prevent vacuum loss

   C. Open the oil strainer and fill strainer with fuel oil

Do not allow pump to run more than a minute without additional lubrication. When replacing the oil strainer cap, be very careful to assure a vacuum-tight seal.

7. Operate the oil pump until oil is obtained from the tank and the oil runs clear into the can or bucket. A milky appearance of the oil indicates air in the suction line. The flame safeguard may trip out on safety while pumping oil. If necessary, push reset button to repeat operation after safety switch cools.

8. Turn burner switch to "off". Remove copper purging line and install oil pressure gauge with a high range of not less than 600 PSI.

9. Check the pilot operation.

10. With the pilot ignited, proceed to light-off the main burner. At this time the oil solenoid valve will open as indicated by the "main fuel" light. After a slight delay, oil will be delivered to the nozzle and the main flame will be established. If the oil flame is not established in

a few seconds, check to be certain that the pilot is ignited; then check for a closed manual valve in the oil circuit. Finally check the electrical circuit of the oil solenoid valve, including all interlocks. Refer to the unit wiring diagram in the Appendix section of this manual.

11. Set the oil pressure for proper firing at low fire. Oil pressure may vary according to quality of the oil, capacity desired, or need for matching oil flow to air supply required for gas firing of combination units. Use figures on factory firetest sheet as a reference.

12. Restart the burner several times to check for smooth light-off. If light off is not smooth, refer to the Troubleshooting Section.

13. Operate the burner at low fire until the water in the boiler is warm.

NOTE: Attempts to fire boiler at high fire rate before boiler water is warm, will cause thermal shock and could cause permanent damage to the boiler.

14. Bring the burner to high fire by slowly advancing the manual potentiometer. (On high/low burners, turn firing selector switch to "auto" position.)

15. High firing rate should be set at published input rating. The operator may reduce the high fire rate of the modulating burner by adjusting the manual potentiometer setting toward the low fire position.

16. On water boilers, condensed flue gases may damage boiler, breeching and stack if boiler water temperature is too low. Flue gas dew point temperatures for various fuels areprovided in Figure 65. The operating water temperature of the boiler should be set at least 20° F above the dew point temperature. The low fire boiler operating temperature not only affects the threat of condensation in the boiler, but thermalshock must also be considered. Thermal stresses in the boiler can lead to leaks in the flue tube joints. With the cycling of the boiler, fatigue can cause cracking around stay bolts connections and in the tube sheets. For a designed operating pressure of a water boiler, the operating temperature should be kept close to the saturation temperature. The temperature differential for medium sized boilers can then run about 100° F. Smaller differentials should be used for larger boilers.

Fuels	Dew Point Temperature
Gas	135°F
Light Oils*	115°F
Heavy Oils*	140°F

* For each percentage point of sulfur content, add 30°F

Figure 65 - Table of Dew Point Temperatures for Flue Gases of Various Fuels

17. Adjust the fuel-to-air ratio to achieve a combustion rating as specified below by flue gas analysis. Check oil pressures and combustion efficiencies for both high and low firing rates.

Performance Standards

The following performance standards for Oxygen (O_2) and Carbon Dioxide (CO_2) in the flue gases of boilers are

given below as a guideline only for boiler start-up. Oxygen and Carbon Dioxide will differ according to the application and specifications of individual installations. (All % values given as a percentage by volume of dry flue gases.)

A. Oxygen (O_2) in flue gas

Firing Rate	Gas & #2 Oil $\%O_2$	#4,#5,#6 Oils $\%O_2$
High Fire	3.5 ± 0.5%	4.0 ± 0.5%
Mid Fire	4.5 ± 0.5%	5.0 ± 0.5%
Low Fire	7.0 ± 0.5%	8.0 ± 0.5%

B. Carbon Dioxide (CO_2) - in flue gas by fuel

Fuel	% CO2 (Dry Base)		
	High Fire	Mid Fire	Low Fire
Natural Gas	10.1 ± 0.3%	9.5 ± 0.3%	8.1 ± 0.3%
Propane	11.3 ± 0.3%	10.7 ± 0.3%	9.1 ± 0.3%
#2 and #4 Fuel Oil	12.6 ± 0.4%	11.9 ± 0.4%	10.1 ± 0.4%
#5 and #6 Fuel Oil	13.0 ± 0.4%	12.2 ± 0.4%	9.9 ± 0.4%

C. Carbon Monoxide (CO) in the flue gas of gas fired burners, should not exceed 50 ppm at any firing rate.

D. Smoke readings should be taken at high, mid and low firing rates for all oil firing burners. Smoke spot numbers (Bacharach Scale) should not exceed the following values:

Fuel	Smoke Spot		
	High Fire	Mid Fire	Low Fire
#2 Fuel Oil	1	1	2
#4,#5 and #6 Fuel Oil	2	2	3

18. If fuel-air ratio adjustments do not produce satisfactory performance, burner head adjustments may be incorrect. Refer to Section 26 for gas sleeve and diffuser adjustments. Any corrections made to the gas sleeve or diffuser will, in most cases, require readjustment of the oil nozzle position. Test work indicates that best oil firing performance is producedwith the oil nozzle positioned as far as possible "upstream"into the head without producing impingement of the oil spray on the front cone of the diffuser.

19. Check safety limit controls.

20. After completion of the above adjustments and checks, return the burner to automatic operation. Cycle the burner several times under full automatic operation. Check the flame response signal during the pilot proving and main flame period to be certain there is a steady signal present. Refer to the Troubleshooting Section if steady signal is not present.

Section 10

START-UP PRESSURE ATOMIZED OIL DIRECT SPARK

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: Fuel air ratio adjustments must only be made using a flue gas analyzer whose calibration and accuracy are proven. "Visual" estimations of combustion performance are inadequate for safety or efficiency.

CAUTION: Extreme care should be taken to insure fuel oil pumps are never allowed to run dry. If pumps are allowed to run continuously, the fuel oil system must be left in service at all times. Fuel oil is required to cool and lubricate the fuel oil pump when it is operating.

1. Kewanee PhoenX burner units, equipped for firing Pressure Atomized No. 2 oil only, have direct spark ignition of the main oil flame. Direct spark ignition is standard on PHX-40 through PHX-125 which fire oil as their only fuel.

2. Oil piping, controls and valves should be checked for compliance with all local utility and insurance requirements.

3. Check all linkages. The linkage and damper should be checked for opening and free operation to make sure that they were not damaged in shipment or installation.

4. Remove the pipe plug from the gauge port of the oil pump to purge air from the oil piping. Connect a length of copper tubing to the port to drain the oil discharge into a can or bucket.

5. Turn on the control circuit switch and wait one minute for controls to warm up. Turn the control panel switch to "on", at which point the blower motor will start, assuming power is available and all limit switches are closed. The integrally mounted oil pump is driven by a V-belt or direct off blower wheel shaft extension through a flexible coupling. Some units utilize a separate oil pump set.

6. If pump does not pick up oil within a minute, prime the oil pump as follows:

   A. Turn burner switch to "off"

   B. Close gate valve in suction line to prevent vacuum loss

   C. Open the oil strainer and fill strainer with fuel oil

   Do not allow pump to run more than a minute without additional lubrication. When replacing the oil strainer cap, be very careful to assure a vacuum-tight seal.

7. Operate the oil pump until oil is obtained from the tank and the oil runs clear into the can or bucket. A milky appearance of the oil indicates air in the suction line. The flame safeguard may trip out on safety while pumping oil. If necessary, push reset button to repeat operation after safety switch cools.

8. Turn burner switch to "off". Remove copper purging line and install oil pressure gauge with a high range of not less than 600 PSI.

9. Turn the burner switch to "on". On completion of a predetermined prepurge timing, the spark ignition should come on, and the oil valves open. The main flame should be ignited almost immediately. For smooth light-off, ignition should occur in 1 to 2 seconds. If light-off does not take place immediately, check the ignition transformer, ignition electrodes, spark gap and location of gap in relation to oil spray. Also check whether there is immediate delivery of oil to the nozzle.

NOTE: With flame safeguard control, the trial for ignition is 10 seconds. If flame is not established in this period, the control will lock out in the flame failure position.

10. Set the oil pressure for proper firing at low fire. Oil pressure may vary according the quality of the oil, capacity desired, or need for matching oil flow to air supply required or gas firing of combination units. Use figures on factory firetest sheet as a reference.

11. Restart the burner several times to check for smooth light-off. If light-off is not smooth, refer to the Troubleshooting Section.

12. Operate the burner at low fire until the water in the boiler is warm.

CAUTION: Attempts to fire boiler at high fire rate before boiler water is warm, will cause thermal shock and could cause permanent damage to the boiler.

13. Bring the burner to high fire by slowly advancing the manual potentiometer. (On high/lowburners, turn firing selector switch to "auto" position.)

14. High firing rate should be set at published input rating.

15. On water boilers, condensed flue gases may damage boiler, breeching and stack if boiler water temperature is too low. Flue gas dew point temperatures for various fuels are provided in Figure 66. The operating water temperature of the boiler should be set at least 20° F above the dew point temperature. The low fire boiler operating temperature not only affects the threat of condensation in the boiler, but thermal shock must also be considered. Thermal stresses in the boiler can lead to leaks in the flue tube joints. With the cycling of the boiler, fatigue can cause cracking around stay bolts connections and in the tube sheets. For a designed operating pressure of a water boiler, the operating temperature should be kept close to thesaturation temperature. The temperature differential for medium sized boilers can then run about 100° F. Smaller differentials should be used for larger boilers.

Fuels	Dew Point Temperature
Gas	135°F
Light Oils*	115°F
Heavy Oils*	140°F

* For each percentage point of sulfur content, add 30°F

Figure 66 - Table of Dew Point Temperatures for Flue Gases of Various Fuels

16. Adjust the fuel-to-air ratio to achieve a combustion rating as specified below by flue gas analysis. Check oil pressures and combustion efficiencies for both high and low firing rates.

Performance Standards

The following performance standards for Oxygen (O_2) and Carbon Dioxide (CO_2) in the flue gases of boilers are given below as a guideline only for boiler start-up. Oxygen and Carbon Dioxide will differ according to the application and specifications of individual installations. (All % values given as a percentage by volume of dry flue gases.)

A. Oxygen (O_2) in flue gas (all fuels)

Firing Rate	Gas & #2 Oil $\%O_2$	#4,#5,#6 Oils $\%O_2$
High Fire	3.5 ± 0.5%	4.0 ± 0.5%
Mid Fire	4.5 ± 0.5%	5.0 ± 0.5%
Low Fire	7.0 ± 0.5%	8.0 ± 0.5%

B. Carbon Dioxide (CO_2) - in flue gas by fuel

Fuel	% CO2 (Dry Base)		
	High Fire	Mid Fire	Low Fire
Natural Gas	10.1 ± 0.3%	9.5 ± 0.3%	8.1 ± 0.3%
Propane	11.3 ± 0.3%	10.7 ± 0.3%	9.1 ± 0.3%
#2 and #4 Fuel Oil	12.6 ± 0.4%	11.9 ± 0.4%	10.1 ± 0.4%
#5 and #6 Fuel Oil	13.0 ± 0.4%	12.2 ± 0.4%	9.9 ± 0.4%

C. Carbon Monoxide (CO) in the flue gas of gas fired burners, should not exceed 50 ppm at any firing rate.

D. Smoke readings should be taken at high, mid and low firing rates for all oil firing burners. Smoke spot numbers (Bacharach Scale) should not exceed the following values:

Fuel	Smoke Spot		
	High Fire	Mid Fire	Low Fire
#2 Fuel Oil	1	1	2
#4,#5 and #6 Fuel Oil	2	2	3

17. If fuel-air ratio adjustments do not produce satisfactory performance, burner head adjustments may be incorrect. Refer to Section 26 for gas sleeve and diffuser adjustments. Any corrections made to the gas sleeve or diffuser will, in most cases, require readjustment of the oil nozzle position. Test work indicates that best oil firing performance is produced with the oil nozzle positioned as far as possible "upstream" into the head without producing impingement of the oil spray on the front cone of the diffuser.

18. Check safety limit controls.

19. After completion of the above adjustments and checks, return the burner to automatic operation. Cycle the burner several times under full automatic operation. Check the flame response signal during the pilot proving and main flame period to be certain there is a steady signal present. Refer to the Troubleshooting Section if steady signal is not present.

20. After running for an extended amount of time, the direct spark electrodes should be checked for carbon and soot build-up. If upon inspection there is build-up, clean the electrodes and adjust them back off the spray pattern. A simple template made at the oil nozzle spray pattern angle is a useful tool for this job.

Section 11

START-UP - AIR ATOMIZED OIL

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

CAUTION: Extreme care should be taken to ensure fuel oil pumps are never allowed to run dry. If pumps are allowed to run continuously, the fuel oil system must be left in service at all times. Fuel oil is required to cool and lubricate the fuel oil pump when it is operating.

1. Oil piping, gas piping, controls and valves should be checked for compliance with all local utility and insurance requirements.

2. Check all linkages. The linkage and damper should be checked for opening and free operation to make sure that they were not damaged in shipment or installation.

3. Check the oil level in the compressor. Maintain the oil level midway in the bulls eye sight glass.

Do not fill above the full mark.

4. Air atomized burners with No. 2 oil do not have an electric heater. The oil pump motor is interlocked with the control system and will run only when the burner is operated in the oil firing mode.

5. To assure that the oil heater is filled, and to purge the oil piping of all air, proceed as follows:

   A. On units with no electric heater (No. 2 oil), removethe pipe plug from the tee on the pump discharge.

   B. Connect a length of copper tubing to the opening to drain the oil discharge into a can or bucket.

   C. On No. 2 oil units, manually operate the oil pump starter to run the pump.

6. If pump does not pick up oil within a minute, prime the oil pump. Turn off oil pump motor, close gate valve in suction line to prevent vacuum loss, open the oil strainer and fill strainer with fuel oil. Do not allow pump to run more than a minute without additional lubrication. When replacing the oil strainer cap be very careful to assure a vacuum-tight seal.

7. Operate the oil pump until air-free oil is obtained

from the tank. In the case of No. 2 oil, the oil should run clear when run into a can or bucket. A milky appearance of oil indicates an air leak in the suction line.

8. Turn off the oil pump motor. Remove the copper purging line and replug the openings.

9. Oil pressure adjustments should be made per your oil schematic. Pressure relief valve upstream of the burner oil pump should be set at a maximum of 5 PSIG to protect the pump seals from excessive pressure supplied by the remote oil pump.

10. The pressure regulating valve upstream of the metering valve should be set at the necessary pressure to supply the desired input of oil with the metering valve in high fire position. Normally, this will range from 30 - 80 PSIG. The metering valve will regulate the flow to the nozzle at reduced firing rates.

11. Atomizing air pressure normally will require no adjustment since the air pressure varies automatically with the oil pressure. Bleed valve on air compressors permit a reduction in the volume of atomizing air if desired.

12. Air atomized oil burners are normally equipped with gas pilot ignition, check its operation at this time.

13. With the pilot ignited, proceed to light-off the main burner. At this time the main oil solenoid valve will open, provided the compressor air proving switch indicates adequate atomizing air pressure. The "Main Fuel" light will go on. After a slight delay to fill the nozzle line with oil, oil will be delivered to the nozzle, and the main flame will be established.

14. If the oil flame is not established within a few seconds on the initial light-off, it may be due to cold oil in the nozzle line. To correct, shut the burner off and remove the oil nozzle assembly from the burner and also the oil line from the solenoid valve to the nozzle assembly. Blow out with air and replace. Proceed to establish the main oil flame as outlined, after the electric heater has heated the oil to proper burning temperature.

15. Operate the burner at low fire until the water in the boiler is warm.

16. Oil pressure and atomizing air pressure may vary depending on the quality of the oil, the oil temperature or the capacity desired.

17. Proper oil temperatures must be maintained to insure good combustion of all grades of fuel oil.

    With reference to Figures 67 and 68, the thermostat on the electric oil heater should be set to maintain the oiltemperature high enough to equal 90 to 100 SSU viscosity oil. The auxiliary (cold oil lockout) switch should be set approximately 20° F below the thermostat setting.

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	Air Pressure - PSI		Oil Pressure to Nozzle - PSI	
HP	Low Fire	High Fire	Low Fire	High Fire
100	28-32	44-48	24-28	46-50
125	30-34	48-52	28-32	50-54
150	17-21	24-28	14-16	26-30
200	14-28	22-26	11-13	25-29
250	14-18	24-28	13-15	25-29
300	17-21	26-30	14-18	28-32
350	13-17	21-25	8-12	26-30
400	15-19	21-25	10-14	24-28
500	18-22	15-29	11-15	31-35
600	17-21	28-32	15-19	44-48
750	14-18	32-36	14-18	46-50

Figure 67 - Typical Air and Oil Pressure Monarch Nozzles Air Atomizing Oil

Grade of Oil	Temperature (Degree F)
No. 2 Oil	No Heat
No. 4 Oil	80-120
No. 5 Oil - Light (Under 300 SSU)	120-150
No. 5 Oil - Heavy (Over 300 SSU)	150-175
No. 6 Oil - Light (Under 3000 SSU)	180-225
No. 6 Oil - Heavy (Over 3000 SSU)	225-260

NOTE: All SSU ratings at 100°F

Figure 68 - Typical Oil Temperatures

18. Bring the burner to high fire.
19. High firing rate should be set at published input rating. The operator may reduce the high fire rate by the manual potentiometer setting on "Auto" position during low load demand periods.
20. On water boilers, condensed flue gases may damage boiler, breeching and stack if the low firing rate or boiler water temperature is too low. Flue gas dew point temperatures for various fuels are provided in Figure 69. The operating water temperature of the boiler should be set at least 20° F above the dew point temperature. Setting the low fire boiler operating temperature not only affects the threat of condensation in the boiler, but thermal shock must also be considered. Thermal stresses in the boiler can lead to leaks in the flue tube joints. With the cycling of the boiler, fatigue can cause cracking around stay bolts connections and in the tube sheets. For a designed operating pressure of a water boiler, the operating temperature should be kept close to the saturation temperature. The temperature differential for medium sized boilers can then run about 100° F. Smaller differentialsshould be used for larger boilers.

Fuels	Dew Point Temperature
Gas	135°F
Light Oils*	115°F
Heavy Oils*	140°F

* For each percentage point of sulfur content, add 30°F

Figure 69 - Table of Dew Point Temperatures for Flue Gases of Various Fuels

21. Adjust the fuel-air ratio to achieve a combustion rating as specified in the following Performance Standards. Check oil pressures and combustion efficiencies for both high and lowfiring rates.

Performance Standards

The following performance standards for Oxygen (O_2) and Carbon Dioxide (CO_2) in the flue gases of boilers are given below as a guideline only for boiler start-up. Oxygen and Carbon Dioxide will differ according to the application and specifications of individual installations. (All % values given as a percentage by volume of dry flue gases.)

A. Oxygen (O_2) in flue gas (all fuels)

Firing Rate	Gas & #2 Oil $\%O_2$	#4,#5,#6 Oils $\%O_2$
High Fire	3.5 ± 0.5%	4.0 ± 0.5%
Mid Fire	4.5 ± 0.5%	5.0 ± 0.5%
Low Fire	7.0 ± 0.5%	8.0 ± 0.5%

B. Carbon Dioxide (CO_2) - in flue gas by fuel

Fuel	% CO2 (Dry Base)		
	High Fire	Mid Fire	Low Fire
Natural Gas	10.1 ± 0.3%	9.5 ± 0.3%	8.1 ± 0.3%
Propane	11.3 ± 0.3%	10.7 ± 0.3%	9.1 ± 0.3%
#2 and #4 Fuel Oil	12.6 ± 0.4%	11.9 ± 0.4%	10.1 ± 0.4%
#5 and #6 Fuel Oil	13.0 ± 0.4%	12.2 ± 0.4%	9.9 ± 0.4%

C. Carbon Monoxide (CO) in the flue gas of gas fired burners, should not exceed 50 ppm at any firing rate.

D. Smoke readings should be taken at high, mid and lowfiring rates for all oil firing burners. Smoke spot numbers (Bacharach Scale) should not exceed the following values:

Fuel	Smoke Spot		
	High Fire	Mid Fire	Low Fire
#2 Fuel Oil	1	1	2
#4,#5 and #6 Fuel Oil	2	2	3

22. If fuel-air ratio adjustments do not produce satisfactory performance, burner head adjustments may be incorrect. Refer to Section 26 for gas sleeve and diffuser adjustments. Any corrections made to the gas sleeve or diffuser will, in most cases, require readjustment of the oil nozzle position. Test work indicates that best oil firing performance is produced with the oil nozzle positioned as far as possible"upstream" into the head without producing impingement of the oil spray on the front cone of the diffuser.

23. Check safety limit controls.

24. After completion of the above adjustments and checks, the burner may be released to automatic operation by turning the auto/manual switch to auto. Cycle the burner several times

under full automatic operation. Check the flame response signal during the pilot proving and main flame period to be certain there is a steady signal present. Refer to the Troubleshooting Section in this manual if steady signal is not present. If it becomes necessary to limit the firing rate in automatic operation, simply turn the manual potentiometer down to desired input. The manual potentiometer will limit the burner's maximum firing rate in either the manual or automatic setting.

Section 12

START-UP - OPERATING/LIMIT/ SAFETY CONTROLS

Boilers will normally be equipped with the following controls and safety devices.

1. A firing rate (modulating or high fire) control to adjust fuel and air input to match load demand.

2. A limit (operating) control to turn off the burner when temperature or pressure reaches normal limits.

3. A second limit (safety) control to back up the first limit control for added safety from excess temperature or pressure.

NOTE: The second limit (safety) control is a manual reset device.

These controls must be properly set to maintain a stable temperature or pressure output from the boiler without excessive on-off cycling which may increase internal boiler stresses. Figure 70 shows recommended settings of the controls for normal operation.

To check the control settings:

a. Set controls as described in Figure 70.

b. Permit the unit to run through a complete cycle. Note pressure (or temperature) at which the modulating motor reaches high fire and low fire and at which the limit control shuts off the burner. Occasionally, there will be a slight difference between limit control settings and readings on the pressure (or temperature) gage. Controls should be reset to achieve desired gage readings.

c. After a differential pressure (or temperature) drop, the burner should restart automatically. The firing rate should remain at low fire until increased by load demand. If the firing rate goes directly from low to high fire, the limit (operating) control setting should be raised slightly (or firing rate control reduced slightly) to maintain a proper difference between the limit control and firing rate control.

d. Check the high limit switch setting by raising the operating control set point slightly above the set point of the high limit control. Cycle the burner while carefully monitoring boiler pressures. The high limit switch should turn the burner off when its set point is reached and require manual reset to restart the burner. Return operating control settings to their original values, cycle the system and verify correct operation.

BOILER TEMPERATURE, PRESSURE AND LEVEL CONTROLS

High Pressure Steam Boiler

Control Description	Control Differential	Control Setting
Firing Rate (Modulation)	10 psi	To meet system design requirements
First Limit (Operating)	5 psi	10 psi higher than firing rate in modulating control setting
Second Limit (Safety)	5 psi	15 psi higher than firing rate in modulating control setting

No Settings to Exceed Boiler Relief Valve Settings

Control Description	Control Differential	Control Setting
Low Water Cut-Off	Fixed	Preset by manufacturer - height determines trip point
Low Gas Pressure	Fixed	15% below high fire pressure
High Gas Pressure	Fixed	15% above high fire pressure
Combustion Air Flow	Fixed	"Go" - "no-go" - "mid scale"
Low Oil Pressure	Variable	10% below high fire oil pressure
Low Oil Temperature	Fixed	15° F below optimum oil temperature
High Oil Pressure	Variable	10% above high fire oil pressure
High Oil Temperature	Fixed	15° F above optimum oil temperature
Low Atomizing Air Pressure	Variable	10% below "free air"

Figure 70

4. Low Water Cut-Off - On a steam unit, open the blow-down valve on the low water cut-off while the burner is in operation. The burner should shut down and recycle automatically when the proper water level in the low water cut-off is re-established.

NOTE: This device may have manual reset capability.

Testing the low water cutoff in hot water boilers becomes more complicated. On older units, boilers may have to be drained down. Float type devices may have Test-N-Check valves installed in place of crosses to accommodate checks. Probe type devices can be modified or replaced to allow electrical checks. Probes themselves should be removed from the boiler at least annually to inspect for contamination.

5. Low Gas Pressure Switch (If Used) - This device is located downstream of the main gas regulator on the gas train. It is a manual reset device. Its function is to insure adequate fuel pressure is available to support combustion. During the initial setup of the burner, gas pressure at the low gas pressure switch should be recorded at high fire. The low gas pressure switch should then be set at 15% below this pressure. Cycle the burner several times to insure switch integrity. Slight adjustments may have to be made to compensate for surges and to insure switch stability. To test, install gauge or manometer adjacent to switch. Close manual gas valve and vent switch until switch trips. Record trip point and verify settings. Open gas valve to resume operation.

6. High Gas Pressure Switch (If Used) - This device is located on the top of the burner plenum and senses burner head (gas ring pressure). It is a manual reset device. Its function is to prevent over firing of the burner. During the initial setup of the burner the gas manifold pressure should be recorded at high fire. The high gas pressure switch should be set at 15% above this pressure. Cycle the burner several times to ensure switch integrity. Slight adjustments may have to be made to compensate for surges and to ensure switch stability. To test, reduce setting on setpoint screw until burner trips. Return setpoint to required setting and reset.

7. Combustion Air Flow Proving Switch - This device is mounted on the control cabinet and senses the differential pressure across the combustion air fan (blower wheel). The switch has been selected based on the static pressure generated by the blower wheel. It is preset at the factory so that its set point is near the maximum static pressure capacity of the blower wheel. This adjustment should be verified at the job site after the burner has been installed and initial adjustments have been made. The following procedure must be followed: Install a switch in the electrical circuit which powers the blower motor startercoil. Jumper out the blower motor starter auxiliary switch. Operate the burner to the open damper pre purge condition. Turn off the blower motor by interrupting the coil signal to

its starter using the switch you installed. Time the interval from turning off the blower to flame safeguard lockout. That interval should be between 1 and 4 seconds. If the timed interval is too long, increase the pressure setting of the switch by turning the adjusting screw clockwise. Setting the switch pressure too high can cause nuisance lockouts. When adjustment is complete make absolutely certain that your jumper and switch is removed, and that the electrical circuit is returned to its original condition.

DANGER: The combustion air flow proving switch is a vital part of the burner's safety control system. Its adjustment should be verified at the job site after the burner has been installed and initial adjustments have been made. Operation of the burner with the air flow proving switch "jumpered out" or set too low presents a hazard of severe injury or fatality to boiler room personnel and severe damage to boiler room equipment. If adjustment is thought to be necessary, this procedure must be followed exactly.

8. Low Oil Pressure Switch (If Used) - This device is mounted on the control cabinet of oil fired burners and senses the pressure available to the oil system for firing the burner through its entire range. This pressure is determined by the oil pump output or the pressure regulator output, whichever the case. The switch setting should be 10% below the pressure required to establish high fire input. To test, record system normal pressure and reduce system regulated outputpressure slowly until switch trips. Adjust switch to required pressure and return system to required regulated output pressure.

9. Low Oil Temperature Switch (If Used) - This device, for obvious reasons, is utilized on heated oil systems only. The switch is an integral part of the oil heater on UL and IRI installations. On FM installations the switch is a separate item in the oil system. Once the optimum oil temperature has been established for the proper burn characteristics, the switch should be set at 10% below that setpoint. To test,record system regulated output temperature and reduce regulated temperature by turning heater thermostat down. When proper setpoint has been verified, restore temperature to required setpoint.

10. High Oil Temperature Switch (If Used) - This device, for obvious reasons, is utilized on heated oil systems only. The switch is a separate item in the oil system. This device is installed to prevent overheating and possible vaporization or carbonization of the fuel oil. Once the optimum oil temperature has beenestablished for proper burn characteristics, the switch should be set at 10% above that setpoint. To test, record system regulated output temperature. Increase system regulated output temperature to verify setpoint by increasing thermostat on electric oil heat. Once proper setpoint has been verified, return thermostat to proper setting. Allow oil temperature to stabilize prior to operating burner.

11. High Oil Pressure Switch (If Used) - This device is utilized to prevent over-firing the burner. It is

mounted on the control cabinet and senses oil pump regulator discharge pressure. Once proper oil pressures have been established, this device should be set at 10% above optimum oil pressure. Testing in this case requires that caution be exercised. To test, with burner off and oil pump running, adjust regulator to increase oil pressure until switch trips. Record setting and return pressure to proper setting.

12. Low Atomizing Air Pressure Switch - This device is installed to prove availability of atomizing medium on air atomized oil burners. Loss of the atomizing air compressor seriously affects burner performance. This device is mounted on the control cabinet and senses atomizing air compressor discharge pressure. Once nozzle "free air" has been established, the switch should be set 10% below that point. To test, record "free air" pressure. Record compressor bleed valve position and open bleed valve and observe switch trip point. Set if required and return bleed valve to proper setting.

13. If an emergency shut-off switch is used, check to be certain it shuts down the burner when opened.

14. Pilot flame failure and main flame failure should be checked as outlined in the flame safeguard manual.

15. Remove any temporary electrical jumper wires, used in the control circuit. If the unit has a modulating firing sequence, set the "Man-Auto" toggle switch and potentiometer to match the heating requirements.

16. After the above procedures have been completed, the operator should be carefully instructed in the proper operation, maintenance, and service of the equipment.

Section 13

PHOENX BURNER ILLUSTRATIONS AND SCHEMATICS

NOTE: This section of the manual contains illustration and schematics of those systems and their intended adjustments for your Kewanee PhoenX burner. Study the portions of those sections which apply to your burner before proceeding with this section

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Section 14

MAINTENANCE - GENERAL

NOTE: All warranties are void if maintenance is neglected.

1. After the burner has been started and adjusted by your Kewanee service representative, linkage settings, fuel pressures and control settings 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. Keep a constant check on the fuel supply. Do not depend on "automatic delivery"-watch the supply yourself. Check fuel gages on the oil tank. Keep track of the supply and re-order before the tank is empty.

3. Keep the boiler, the burner and the entire boiler room clean. Do not allow fuel to leak anywhere-it is dangerous. A clean environment is essential to first class boiler operation.

4. Keep the burner control cabinet door closed. The electrical contacts in the cabinet are very sensitive to dust and dirt.

5. 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.

6. Repair all leaks promptly. All piping connections to the burner and accessories should be maintained leak-proof because even a minor leak, if neglected, may soon become serious.

7. Establish and maintain logs of operational parameters and maintenance requirements on the entire boiler room system. A conscientious review of these logs is a way of anticipating problems before they become serious.

Section 15

MAINTENANCE - DAILY

1. Record parameters on logs at prescribed interval.

2. Check water level.

3. Blow down low water cutoff and gauge glass.

4. Blow down boiler.

5. Check and record chemistry of boiler water.
6. Inspect burner linkages.

7. Inspect pumps (inspect belts, couplings, seals, etc.)

8. Inspect compressors (check oil level, couplings, etc.)

9. Check temperatures and record.

A. Fuel

B. Feedwater

C. Stack

D. Economizer

E. Air heater

10. Check pressures and record.

A. Boiler

B. Fuel

C. Feedwater

11. Inspect burner flame. Record any unusual sightings.

12. If the burner is equipped with an oxygen trim system, monitor and record stack oxygen levels.

Section 16

MAINTENANCE - WEEKLY

1. Check all burner linkages to be sure that there has been no change from its original marked position. Tighten if necessary. Check to ensure linkage not binding. Lubricate if necessary.

2. On low pressure steam boilers, open the blowdown valve of the low water cutoff while the burner is running. The burner should shut down when the water level drops in the glass, showing that the low water cutoff is operating properly and that the float bowl is clean.

3. On steam heating boilers, the gage cocks and blowdown valves on the water column and water glass should be operated to make sure the connections are open.

4. Note condition of belts or flexible couplings on oil pumps and air compressors. Have spare belts available (if used) and replace any cracked belts. Excessive side wear indicates need for realigning sheaves or correcting belt tension.

5. Check compressor oil pressure and maintain at 15 PSIG. Check oil level and maintain between high and low level marks. Do not overfill with oil. Use oil approved by compressor manufacturer.

6. Inspect the oil strainer and clean if necessary. The frequency of cleaning will depend upon the frequency of the burner operation, and the quality of oil in use. Be sure the cap gasket is in good order and mating surfaces are clean. A light coat of clean oil will help secure a vacuum-tight joint.

7. Check flame safeguard. Ensure proper shutdown and re-light sequence by simulating a flame failure and supervising a re-light.

8. Measure and record flame signal strength.

Section 17

MAINTENANCE - MONTHLY

1. Check ignition assembly and electrode. Clean if necessary.

2. Clean oil nozzle (if necessary). Never use a sharp instrument on the nozzle. If nozzle becomes damaged, replace it.

3. Clean flame detector lens with a soft, clean, lint free cloth. Check scanner cell.

4. Check air dampers and blower wheel. Remove any accumulation of lint or dirt.

5. Inspect condition of refractory.

6. Clean intake filter element on the air compressor with nonflammable solvent. The frequency of cleaning will depend on air supply conditions. The standard air filter is of sufficient size and design to meet normal conditions.
7. Operate safety valve by pulling the test link. Clean unit. Remove dust or dirt from cooling fins by compressed air.

NOTE: Close the gate valve ahead of the strainer before removing the cap to prevent loss of oil prime.

8. Lubricate motors in accordance with motor manufacturer's instructions. (May be annual requirement.)

9. Check safety valves by manually lifting with handle provided. Ensure they reseat.

10. Check and record flue gas analysis. Compare with previous readings to detect any trends. Make appropriate adjustments if required.

11. Lubricate all damper and drive arm bearing surfaces with a dry lubricant.

Section 18

MAINTENANCE - ANNUAL

1. Have unit inspected and checked by your local Kewanee Service Representative.

NOTE: Annual maintenance should be conducted in the spring to afford ample time to repair serious problems.

2. Check condition of oil tank. Clean and remove sludge, if necessary.
3. Drain and clean sediment and accumulated carbon from electric oil heater and boiler mounted oil heater.

4. If the burner is to be out of service for the summer, be sure to close all valves and break all power connections to the burner and auxiliaries.

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

5. Completely tear down boiler and thoroughly clean fire side and water side. Inspect for deterioration which could indicate an inadequate water treatment program.

NOTE: While boiler is torn down, it should be inspected by the authorized inspector heading local jurisdiction over the boiler installation.

6. Reassemble boiler using new gaskets. Perform hydrostatic test.

7. Clean and inspect low water cutoff. This includes float chamber, if applicable.

8. Clean and inspect all burner components. Perform tune up and record readings as a comparison base. Replace any defective components.

9. Check all operating and safety devices, including a test of safety/safety relief valves, flame safeguard checks and leak test of safety shutoff valves.

10. Check and clean all external systems including steam traps, combustion air inlets, etc.

11. The atomizing air compressor system should be serviced according to a running hours schedule as follows:

Running Hours	Operation
---	Test safety valve
350	Change air filter
1000	valve
1000	change strainer in unloaded or non-return valve assembly
2000	change oil
2000	change crankcase breather valve
2000	Remove and clean crankcase breathers and outlet silencers
2000/3000	Change unloaded or non-return valve assembly
5000	Change valves

Section 19

MAINTENANCE - SPECIAL

"SPECIAL" maintenance procedures are any inspections or checks that should be accomplished subsequent to other maintenance activities to ensure integrity of safety related devices. All tests should be performed by qualified burner technicians.

1. Pilot Turndown Test - (all installations using a pilot) - The purpose of this test is to ensure that the main burner can be lighted by the smallest pilot flame that will hold the flame safeguard in. Detailed procedures for conducting this test are in the applicable Flame Safeguard Bulletin.

2. Hot Refractory Hold In Test - (infrared detectors) - This test is to ensure that hot refractory will not cause the flame safeguard to detect a "flame signal" after the burner flame is extinguished. Detection of a signal during safe start checks can cause a nuisance shutdown. Detailed procedures for conducting this test are in the applicable Flame Safeguard literature.

3. Ignition Spark Response Test - (all ultraviolet detectors) - High energy spark in ignition systems is an excellent source of UV energy. To ensure the flame detection system is not responding to this energy source, a test must be performed to ensure this does not occur. Detailed procedures for conducting this test are in the applicable Flame Safeguard Bulletin.

4. Safety Shutoff Valve Leak Test - (gas) - The purpose of this test is to ensure the integrity of safety shutoff valves (SSOV). Test should be performed at startup and annually thereafter. In systems with "double block and bleed", each valve should be tested separately.

CAUTION: Procedure should be performed and supervised by a qualified burner service technician. In some cases, manual manipulation of components is necessary.

A. Turn off power to control system and SSOV's.

B. Shut manual gas cocks at inlet and outlet of fuel train.

C. In leak test, tap downstream of each SSOV, install a manual test petcock with ample 1/4" tubing on its outlet to be immersed 1/2" in a glass jar or beaker of water. Cut end of tubing at a 45° angle.

D. Manipulate SSOV (electrically) to the full open position and allow it to shut (de-energize).

E. Slowly open test petcock.

F. When rate of bubbles coming through waterstabilizes, count bubbles appearing during a 10 second period. Each bubble that appears during a 10 second period represents a flow rate of approximately .001 CFH. To meet requirements, leakage should not be more than 23 bubbles in a 10 second period (.023 CFH = 650 CC/HR). If leakage exceeds 23 bubbles, valve must be repair or replaced.

G. Repeat test for second valve (if applicable).

H. Remove test apparatus and soap bubble check test connections.

I. Restore system to normal operation.

J. Ensure any required jumper wires are removed, wiring restored and cycle burner several times to ensure proper operation.

5. Safety Shutoff Valve Leak Test - (oil) - The purpose of this test is to ensure the integrity of safety shutoff valves (SSOV). Test should be performed at startup and annually thereafter. Each valve should be tested independent of the other.

CAUTION: Test should be performed and supervised by a qualified burner service technician, as in most cases manual manipulation of system components is necessary.

A. Disconnect supply line and return line (if applicable) from the oil gun assembly. This is to negate accidental flooding of the boiler combustion chamber with raw oil.

B. Disconnect oil line immediately downstream of valve to be tested.

C. Wait until any residual oil has stopped dripping out of connection and start oil pump. (Manual manipulation will be required.)

D. Observe valve for leakage for 1-3 minutes. Any leakage at all is unacceptable.

E. Repeat testing of all valves in system.

F. Remove any jumpers or temporary connections and restore system to normal operation.

G. Cycle burner on several times to ensure integrity of system.

H. Check all connections for leaks.

Section 20

SERVICE PROCEDURES - GAS ELECTRIC IGNITER

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in the Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your Kewanee service representative for dependable service assistance. All warranties are void if maintenance is neglected.

1. The igniter assembly should be removed and inspected regularly. The pilot can be inspected by removing the entire pilot from the diffuser and inspecting internally through the open end of the pilot body.

Care must be taken to prevent breakage of the porcelain insulator when securing it with the gland assembly. The porcelain insulator should be clean and must be replaced if cracked.

2. Maintain a spark gap of 1/8" between the electrode and the igniter body.

3. The high tension wire between the transformer and the igniter electrode should be checked for deterioration.

4. The air intake opening should be set as specified to insure adequate pilot combustion air.

5. Care should be taken to ensure burner turndown is not reduced below published and nameplate valves. Excessive combustion air in the "Low Fire Start" inlet damper position can blow the pilot out.

6. Make sure the pilot is fully seated and properly aligned in its opening in the pilot box on the diffuser.

Section 21

SERVICE PROCEDURES - DIRECT SPARK IGNITER

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in the Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your Kewanee service representative for dependable service assistance. All warranties are void if maintenance is neglected.

1. The igniter assembly should be removed and cleaned regularly. The porcelain insulators should be kept clean and must be replaced if cracked.

2. The spark gap must be set as specified. Care should be taken to make sure the electrodes are kept at least 1/4" from the nozzle and nozzle adapter to prevent arcing.

3. The electrode should not extend closer than 1/8" to the spray angle of the nozzle to prevent carboning.

4. The high tension wires and clips between the transformer and igniter electrodes should be checked periodically for deterioration.

Section 22

SERVICE PROCEDURES - OIL PILOT SERVICE

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in the Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your Kewanee service representative for dependable service assistance. All warranties void if maintenance is neglected.

1. The oil pilot consists of two systems, a direct spark ignition system and a pressure atomized oil supply system. The direct spark ignition system includes a pair of direct spark igniters, their high tension wires and ignition transformer. The pressure atomized oil supply system contains a pressure atomized oil nozzle, its piping, valving and supply components.

2. Refer to Section 21, Service Procedures - Direct Spark Igniter for information regarding service of the direct spark ignition components in the system.

3. Refer to Section 23, Service Procedures - Pressure Atomized Oil Nozzles for information regarding service of the pressure atomized oil supply components in the system.

4. Adjustment the oil pilot consists of adjustment of oil nozzle and ignition electrode positions and spark gaps as specified, and adjustment of the oil pressure to the nozzle.

5. Nominal oil pressure to the nozzle is 100 PSI. This pressure can be increased if conditions require, however we do not recommend operation below 100 PSI. Pressure adjustment must consider two factors. First, pressure must be adjusted high enough to produce a reliable pilot for scanning and main flame ignition purposes. Second, it should be set low enough that the pilot does not produce a smoky appearance, or a soot trail in the furnace. Stack gas analysis can not be used for adjustment of the pilot since pilot air demand is small relative to the air supplied for main flame at low fire.

Section 23

SERVICE PROCEDURES - PRESSURE ATOMIZED OIL NOZZLES

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in the Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilledserviceman. Call your Kewanee service representative for dependable service assistance. All warranties are void if maintenance is neglected.

1. Oil atomizing nozzles should be removed and cleaned regularly.

2. The nozzles should be removed from the nozzle adapter by use of a socket or box end wrench. The nozzles should be disassembled and thoroughly cleaned with a liquid solvent (non-flammable preferred) and a brush. (Aerosol spray penetrating oils are convenient for this purpose.)

3. Do not use a screwdriver, wire brush or similar metallic objects to clean nozzles. Damage to orifices or spray slots results in off-center or "sparky" fires.

4. The nozzle should be seated firmly on the nozzle adapter to prevent leaks.

5. If a nozzle is damaged or burned, replace it.

6. On fully modulating burners, variable flow and simplex nozzles are used, depending on application. These nozzles are used with a constant supply pressure of approximately 300 PSIG.

NOTE: Rating stamped on the nozzle is the nominal delivery rate at 100 PSIG.

7. On fully modulating burners, nozzle delivery rate is varied by altering the opening of a metering valve situated in the nozzle return flow line. To reduce nozzle flow rate, the return flow metering valve must be opened and vice versa to increase input. Approximate high fire and low fire return line pressures are shown in Figure 147. On some applications (simplex nozzles), the oil metering valve is in the supply line. Consult your oil system schematic.

8. On burners utilizing "on-off" firing sequence, the nozzles are "simplex". Input to the burner is determined by the nozzle size, quantity and oil delivery pressure.

9. On burners utilizing "high-low" firing sequence, the nozzles can be either "simplex" or "by-pass", depending on firing rate.

10. The spray angle becomes wider as the discharge rate is reduced. Adjust nozzle position to avoid oil impingement on the air diffuser cone, pay special attention to the low fire rate.

11. Smoky fires with apparent large droplet size in the spray are generally caused by reduced supply pressure. Check the pump pressure. Also check the adapter and the nozzle strainer to be sure that they are not partially plugged.

12. Careless cleaning or handling of the nozzles may damage the orifice, causing heavy streaks in the oil spray. This will show up as large droplets and sparks in the fire.

13. Off-center fires, reduced by-pass line pressure and safety lockouts due to ignition failure may result from plugged slots in the distributor head or by one of the nozzles becoming plugged.

14. Excessive "after squirt" of oil may be caused by air in the oil, leaking main oil valve, overhead oil lines or fittings, or leaking check valve on the return line from nozzle.

15. The Teflon seal on by-pass nozzles stays attached to the screw pin. Should the seal become damaged, the resulting leak will cause an increase in by-pass flow at reduced firing rates, reducing nozzle oil delivery. In extreme cases that causes lean, harsh combustion or flame failure. A leak at the seal will not affect the nozzles fuel delivery at high fire, since the return line is closed then.

16. The variable flow nozzles are especially sensitive to accumulation of carbon and dirt within the nozzle. Keep the nozzle clean at all times.

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PRESSURE ATOMIZING OIL BURNER NOZZLES AND TYPICAL OPERATING PRESSURES

High - Low Burners

Burner Size BHP	Nozzle Size (GHP @ 100 PSIG)		Pump Pressure (PSIG)		Low Fire Regulator (Pressure Setting PSIG)	
	Delavan	Monarch	Delavan	Monarch	Delavan	Monarch
60	4.0	4.0	230	235	55	75
70	4.5	4.5	245	250	70	95
80	5.0	5.0	260	265	65	105

Modulation Burners

Burner Size BHP	Nozzle Size (GHP @ 100 PSIG)		Pump Pressure (PSIG)		By-Pass Pressure			
					Low Fire		High Fire	
	Delavan	Monarch	Delavan	Monarch	Delavan	Monarch	Delavan	Monarch
60	4.0	4.0	300	300	50	75	130	170
70	4.5	5.0	300	300	60	95	155	190
80	5.0	5.5	300	300	55	120	135	195
100	6.5	6.5	300	300	75	60	155	205
125	8.0	8.0	300	300	65	95	150	195
150	9.5	9.5	300	300	70	95	155	235
200	12.0	12.0	300	300	50	75	140	235
250	16.0	15.3	300	300	50	60	130	250

NOTES: 1. Nozzles may be Delavan or Monarch with 60o spray angle. Three (3) nozzles required per burner.
2. The above pressures are based on No. 2 oil having a viscosity of 35 SSU and will vary slightly depending upon the viscosity of the oil used. All pressures noted above are ± 5 PSIG.

Figure 159

Section 24

SERVICE PROCEDURES - AIR ATOMIZED OIL NOZZLES

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your Kewanee service representative for dependable service assistance. All warranties are void if maintenance is neglected.

1. The air atomizing nozzle is designed to handle No. 2, No. 4, No. 5 and No. 6 fuels. Air is supplied from the compressor to provide the energy for atomization. Oil supply to the nozzle is controlled by the oil metering valve.

2. The air atomizing nozzle is of the internal mixing type. Air and fuel are piped separately to the nozzle and are mixed in the swirl chamber so that a uniform spray is discharged through the orifice in a semi-solid cone spray pattern.

3. The spray angle becomes wider as the volume of secondary air is reduced. Adjust nozzle position to avoid oil impingement on the air diffuser cone.

4. Since the fuel and air passages in this type of nozzle are quite large, clogging is not a frequent problem. However, both the air and fuel are filtered to remove lint and large particles of foreign matter. Clogging of air passages or fuel passages will result in off-center fires. Be aware that chips and particles from pipe threading have occasionally worked into the nozzles and caused problems.

5. Damage to the orifice may result in a streaky fire or an off center fire or drooling.

Section 25

SERVICE PROCEDURES - AIR ATOMIZED HEAVY OIL NOZZLE LINE PURGE SYSTEM

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your Kewanee service representative for dependable service assistance. All warranties are void if maintenance is neglected.

1. GENERAL INFORMATION

Kewanee burners designed for firing heavy oil have as standard equipment, a nozzle line purge system. This system eliminates the problem of heavy oil solidifying and plugging

the cold parts of the burners oil piping. It is designed to remove any oil in the oil nozzle and in the piping from the nozzle to the air/oil check valve assembly from those areas during the burners post purge interval.

The nozzle line purge system consists of a normally open solenoid valve, a needle valve and the piping required to connect between the atomizing air line and the air/oil check valve assembly.

2. SYSTEM FUNCTION

Air flows through the nozzle line purge system only when the atomizing air compressor is operating and the purge system solenoid valve is open. (The purge system solenoid valve is open only when the main oil safety shut-off valves are closed.) This means that air is flowing through the nozzle line purge system only during the burners pre-purge and post purge intervals.

At the end of the burners run period, power is removed from the main oil safety shut-off valves closing them and stopping oil flow from the pump and oil metering valve. Since the purge system solenoid valve is a normally open valve wired in parallel with the main oil valves, it opens as they close. Air from the atomizing air compressor flows through the purge system maintaining the oil pressure to the oil nozzle. Oil in the line continues to flow through the nozzle maintaining main flame until all the oil in the line is burned. Normally that means that main flame is continued about 10 seconds into the post purge period. The remainder of the post purge interval is unaffected by the nozzle line purge system.

3. SYSTEM ADJUSTMENT

The only adjustment for the system is the needle valve. To adjust it, start the burner and operating it at low fire recording the oil pressure at the oil nozzle. Turn the burner off and watch the oil pressure at the nozzle during post purge. It should remain at the same pressure as recorded at low fire until all the oil in the line was burned. If the pressure is too high or too low, open or close the needle valve accordingly until the correct pressure is obtained.

Smoke produced during post purge is a good indicator that the pressure is set too high. Light-off problems caused by line or nozzle fouling is a good indicator that air pressure is set too low.

Section 26

SERVICE PROCEDURES - FIRING HEAD (DRAWER)

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in the Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your Kewanee service representative for dependable service assistance. All warranties are void if maintenance is neglected.

1. The combustion control adjustment surfaces available in the diffuser assembly are as follows: Position of the gas sleeve relative to the gas orifices, Position of the gas sleeve relative to the diffuser outer ring, Opening width of the diffuser vanes, Center spinner vane angle, and position of the oil nozzle(s) relative to the front edge of the diffuser front cone. Optimized values for these adjustments are given in Section 13. We recommend use of those published adjustments. They have been developed from lab testing and field experience, and should be the best settings for typical installations. If standard adjustments are not satisfactory for your specific application, the following notes describe the effects of changing each of those control surfaces, and the techniques to be used.

NOTE: The control surfaces are sensitive. Any adjustments should be made in small increments of about 1/16".

2. The position of the gas sleeve relative to the gas orifices affects stability of the combustion process. Moving the gas sleeve upstream beyond the recommended position can cause a low frequency resonance in the combustion process. Moving it downstream too far can do the same. The effect of this can be seen in the gas ring pressure. The resonance will be seen as fluctuation or bouncing in the pressure reading. The maximum observed fluctuation in the gas ring pressure should be ± 0.5" W.C. Also, if the gas sleeve covers the gas orifices, gas flow rates can be reduced while gas ring pressure increases. The flue gas O2 level will increase, and harsh combustion noises will be heard.

3. The diffuser and gas sleeve create three air flow regions in the burner's combustion zone. The center region passes through the center cone of the diffuser, and produces a high velocity, low swirl air flow. Encircling the center is the high swirl region produced by the diffuser vanes. The quantity of swirl air flow is controlled by the opening of the diffuser vanes. Surrounding the high swirl zone is an axial flow zone at the outer perimeter of the diffuser. The air flow in this zone can be controlled by adjusting the gap between the diffuser and the gas sleeve.

4. The position of the gas sleeve relative to the diffuser outer ring affects the overall air flow resistance of the diffuser assembly. Opening it too far drops mixing velocities through the diffuser, and increases the tendency to form smoke or CO. Closing it too far decreases air flow at the perimeter of the flame, and can cause smoke formation and sooting on the furnace wall.

5. The opening width of the diffuser vanes is the primary adjustment for air flow mixing velocity. The mixing velocity is an optimized velocity which is proportional to burner head size. We specify the optimized values for each firing rate of the burner. With reduced firing rate the vanes are closed off a bit to keep the air flow velocity at its best level. Increased tendencies for smoke and CO formation can come from either too high or too low mixing velocities.

6. The center spinner vane angle values shown are balanced values for combination gas and oil firing. In general, gas firing is best with the greatest center vane angles consistent with adequate combustion air flow. Conversely, oil firing prefers very moderate levels of center air spin.

7. The position of the oil nozzle(s) relative to the front edge of the diffuser front cone is based on the spray pattern of the nozzle(s) involved. Vaporization of the atomized oil is enhanced by the cross shear of air, through the oil spray pattern, created by the front cone of the diffuser. Keeping the spray pattern of oil close to the edge of the front cone maximizes the benefit of the cross shear. Moving the oil nozzle(s) upstream relative to the diffuser front cone moves the oil spray pattern closer to the front cone. If the nozzle(s) are moved too far upstream, oil spray can impinge on the front cone, allowing droplets of oil to form on the front cone, accumulate and collect in the bottom of the head as a liquid. This condition must be avoided.

8. **For PHX-40 through PHX-125** - To adjust the diffuser and gas sleeve, remove the drawer assembly from the burner and stand it upright on a flat surface, resting on the gas sleeve. The position of the gas sleeve relative to the diffuser should be adjusted first. Loosen the three screws securing the gas sleeve to the diffuser. Set the diffuser to gas sleeve gap using drill bits or feeler gauges of the appropriate size positioned

between the diffuser and gas sleeve adjacent to the gas sleeve mounting tabs. Lock the tabs securely in place with their clamping screws.

The position of the gas sleeve relative to the gas orifices should be set next. Insert a drill bit of the same diameter as the inside diameter of the gas orifice into a gas orifice. Measure from its upstream edge to the plenum flange against which the plenum cover seals. Now take that measurement back to the drawer assembly. The distance from the plenum cover to the downstream edge of the gas sleeve should be equal to your measurement less any gap dimension shown in the tables on the appropriate diffuser adjustment drawing. Loosen the two set screws on the three collars securing the control rods which establish the gas sleeve and diffuser assembly position. Set each of the rods to the dimension you have determined, and lock it securely in place with its set screws.

If diffuser vane adjustments are required, turn the drawer assembly over for access. Diffuser vane adjustments are made by bending the vanes. The vane openings are intended to be tapered, with their inner edges opened less than their outer edges. Specified opening dimensions are set at the midpoint of the width of the vane, and are meant to be the actual air flow opening of the vane (don't allow vane metal thickness to be deducted from the setting dimensions).

If the burner fires oil, the nozzle position will require adjustment if the diffuser has been moved. Standard measurements are tabulated with the other drawer adjustment values, or a cardboard template can be cut to the nozzle spray angle to help visualize the correct nozzle to diffuser cone position.

9. **For PHX-150 through PHX-800** - To adjust the diffuser and gas sleeve, remove the drawer assembly from the burner and stand it upright on a flat surface, resting on the gas sleeve.

The position of the gas sleeve relative to the gas orifices should be set first. Insert a drill bit of the same diameter as the inside diameter of the gas orifices into a gas orifice. Measure from its upstream edge to the plenum flange against which the plenum cover seals. Now take that measurement back to the drawer assembly. The distance from the plenum cover to the downstream edge of the gas sleeve should be equal to your measurement less any gap dimension shown in the tables on the appropriate diffuser adjustment drawing. Loosen the two set screws on the three collars securing the control rods which establish the gas sleeve position. Set each of the rods to the dimension you have determined, and lock it securely in place with its set screws. Once the gas sleeve position has been adjusted, the gap between the gas sleeve and diffuser can be adjusted. Loosen the two set screws on the three collars securing the control rods which establish the diffuser position. Set the diffuser to gas sleeve gap using drill bits or feeler gauges of the appropriate size positioned between the diffuser and gas sleeve and in line with the diffuser control rods. Lock the rods securely in place with their set screws.

If diffuser vane adjustments are required, turn the drawer assembly over for access. Diffuser vane adjustments are made by bending the vanes. The vane openings are intended to be tapered, with their inner edges opened less than their outer edges. Specified opening dimensions are set at the midpoint of the width of the vane, and are meant to be the actual air flow opening of the vane (don't allow vane metal thickness to be deducted from the setting dimensions).

If the burner fires oil, the nozzle position will require adjustment if the diffuser has been moved. Standard measurements are tabulated with the other drawer adjustment values, or a cardboard template can be cut to the nozzle spray angle to help visualize the correct nozzle to diffuser cone position.

Section 27

SERVICE PROCEDURES - OIL PUMPS

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in the Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your Kewanee service representative for dependable service assistance. All warranties are void if maintenance is neglected.

1. Oil pumps are internal gear type with rated capacity not less than 125 percent of the burner firing rate. Viking or Tuthill pumps rated at 100 PSIG or more are used on air atomizing burners. Webster pumps rated at 300 PSI are used on pressure atomizing burners. Figures 160 and 161s show belt tensioning and oil pressure adjustment provisions. More detail on pump operation is provided in the manufacturers cut sheet. Motor rotation direction is indicated by a label on the motor.

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. For pump service problems and possible causes see Figure 162.

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(WHEN PROVIDED)

OIL PUMP ADJUSTMENTS

PHX-60 and PHX-100 Burners

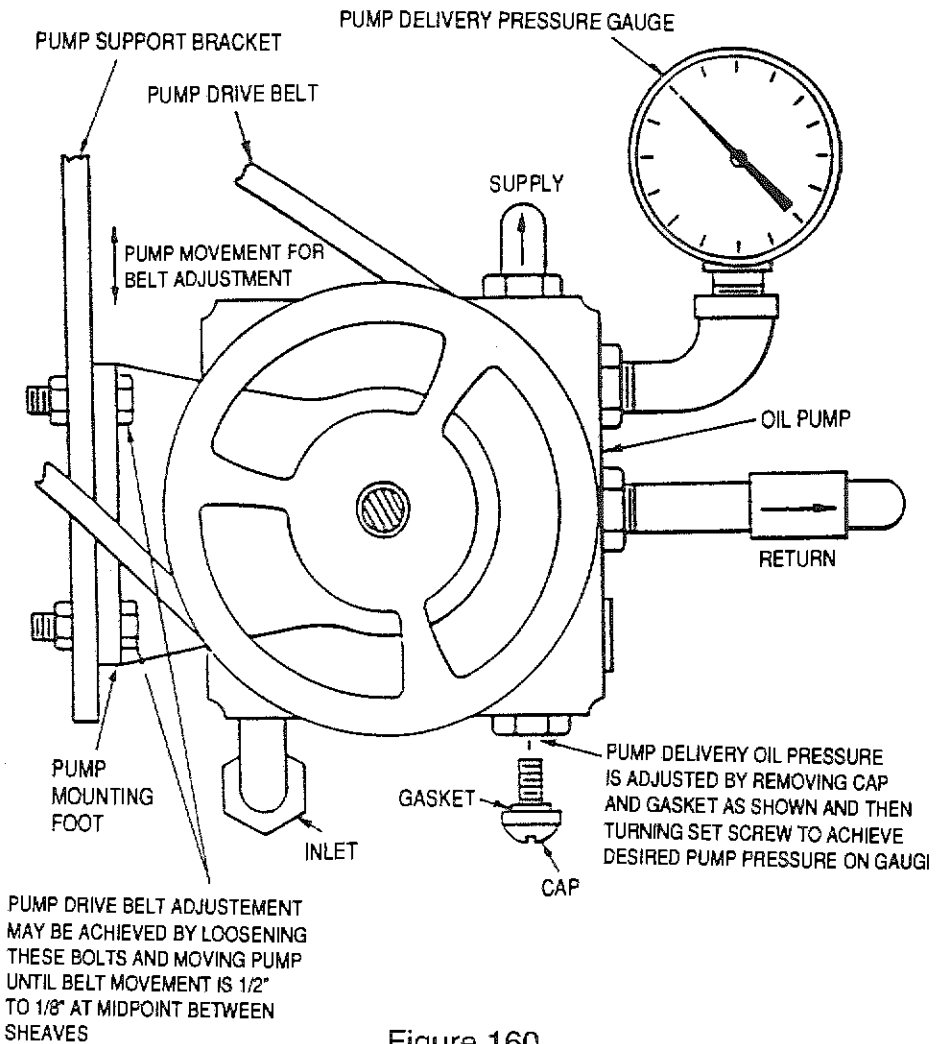

Figure 160

OIL PUMP ADJUSTMENTS

PHX-125 and PHX-800 Burners

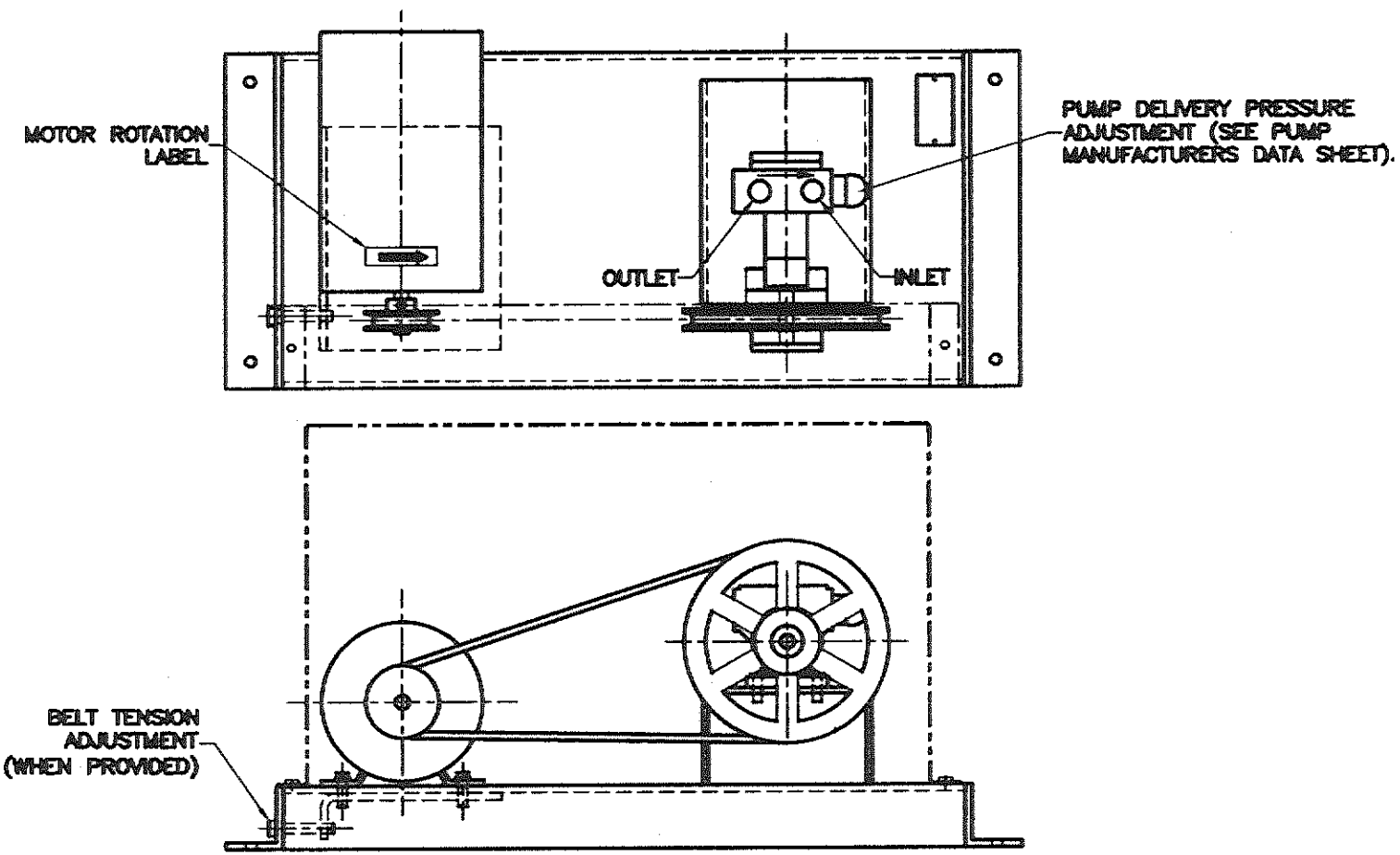

Figure 161

OIL PUMP TROUBLESHOOTING GUIDE

Problem	Possible Cause
No Oil Delivered	1. Oil tank empty 2. Pump not primed 3. Suction Lift too high 4. Air leak in suction line 5. Wrong direction of rotation 6. Pump coupling not installed properly 7. Pump gears worn 8. Pump seal leak 9. Broken V-belt 10. Loose sheaves 11. Supply valves closed
Capacity Too Low	1. Suction lift too high 2. Air leak in suction line 3. Suction line too small 4. Check vavle or strainer too small or obstructed 5. Mechanical defects: (a) pump badly worn; (b) seal defective 6. Pump coupling slipping on shaft 7. Belt slippage
Pump is Noisy	1. Pump not securely mounted 2. Vibration caused by bent shaft of misalignment 3. Pump overload 4. Air leak in suction line 5. Suction lift so high that vapor forms within liquid
Pump Leaks	1. Cover bolts need tightening; gasket is broken or defective 2. Mechanical seal may be scratched due to dirt 3. Pump bushings and other parts badly worn from abrasives in fuel oil 4. Oil line fittings not tight

Figure 162

Section 28

SERVICE PROCEDURES - OIL METERING VALVE

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in the Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your Kewanee service representative for dependable service assistance. All warranties are void if maintenance is neglected.

1. Pressure Atomizing Units - The metering valve indirectly controls the oil flow by controlling the nozzle return line pressure. When the metering valve is closed, the unit is at high fire. When the metering valve is open, the unit is at low fire. The valve will be modulated between the high and low fire positions, according to load demand. On burner shutdown, the valve always returns to the low fire position.

   On some simplex nozzle applications, the oil metering valve in the nozzle supply line is opened to increase input to the nozzles and closed to decrease flow.

   The metering valve itself is non-adjustable. All adjustments for low fire point, high fire point and rate of change from low to high fire are CAM controlled.

2. Air Atomizing Units - On air atomizing units the metering valve directly controls the flow of oil to the nozzle. When the metering valve is open, the unit is at high fire. When the metering valve is nearly closed, the unit is at low fire. Two distinct types of oil metering valves are utilized. On smaller units a non-adjustable oil metering valve is utilized (same as pressure atomized oil units). On larger units the oil metering valve has an adjustable orifice controlled by a characterizing knob.

3. The oil metering valve is directly connected to the modutrol motor cam operator.

Section 29

SERVICE PROCEDURES - FUEL AND AIR CONTROL LINKAGES

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in the Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your Kewanee service representative for dependable service assistance. All warranties are void if maintenance is neglected.

1. All linkage must move with no stress or binding.

2. Adjustment of the amount of travel of the air damper shutters is made by changing the position of the linkage rod on the slotted arm of the air shutter. The travel of the oil metering valve or the gas butterfly valve is adjusted by both linkage adjustments and CAM screw adjustments so that the fuel input at any point from low to high fire will match the air input. Linkage changes are made for coarse adjustment, CAM screws tune in fine adjustments. For actual details of setting the various linkages used, refer to Figures in Section 13.

3. Change in linkage to reduce valve or louver opening setting or speed is normally accomplished either by moving the ball-joint connector closer to the center of the driving arm; or by moving the ball-joint connector closer to the end of the driven arm.

4. Initial adjustment of control linkages is made to produce butterfly valve and oil metering valve travel that goes from about 1/8 open at low fire to about 7/8 open at high fire, and air damper travel that goes from nearly closed at low fire to about 3/4 open at high fire. The nominal adjustments shown in Section 13 will produce approximately those openings. The results of this adjustment can be observed while cycling the burner through its purge cycle.

5. After the burner has been started, low fire fuel and air flow adjustments are made to produce a safe, clean flame and the boiler is allowed to slowly warm up. When it is properly warmed, the burner is gradually brought to its high fire setting with initial adjustments being made through the range. At high fire, fuel pressure adjustments are made to produce the specified rated fuel flow, and air damper adjustments are made to produce O_2 readings specified in the performance standards. The burner is returned to low fire, and low fire fuel flow rate is adjusted to produce the specified turndown ratio for the burner. The burner is again

gradually brought to high fire as finer adjustments are made through the firing rate range. This process is repeated several times until the burner modulates smoothly through the range, and meets the performance standards.

CAUTION: Burner low fire rates and turndown ratios must be set to Kewanee Boiler Manufacturing Co., Inc., specifications. Adjustment to lower than specified rates will produce a flame front too close to the burner head, and may result in distortion and deterioration of the diffuser and burner head.

Performance Standards

The following performance standards for Oxygen (O_2) and Carbon Dioxide (CO_2) in the flue gases of boilers are given below as a guideline only for boiler start-up. Oxygen and Carbon Dioxide will differ according to the application and specifications of individual installations. (All % values given as a percentage by volume of dry flue gases.)

A. Oxygen (O_2) in flue gas

Firing Rate	Gas & #2 Oil	#4,#5,#6 Oils
	$\%O_2$	$\%O_2$
High Fire	3.5 ± 0.5%	4.0 ± 0.5%
Mid Fire	4.5 ± 0.5%	5.0 ± 0.5%
Low Fire	7.0 ± 0.5%	8.0 ± 0.5%

B. Carbon Dioxide (CO_2) - in flue gas by fuel

Fuel	% CO2 (Dry Base)		
	High Fire	Mid Fire	Low Fire
Natural Gas	10.1 ± 0.3%	9.5 ± 0.3%	8.1 ± 0.3%
Propane	11.3 ± 0.3%	10.7 ± 0.3%	9.1 ± 0.3%
#2 and #4 Fuel Oil	12.6 ± 0.4%	11.9 ± 0.4%	10.1 ± 0.4%
#5 and #6 Fuel Oil	13.0 ± 0.4%	12.2 ± 0.4%	9.9 ± 0.4%

C. Carbon Monoxide (CO) in the flue gas of gas fired burners, should not exceed 50 ppm at any firing rate.

D. Smoke readings should be taken at high, mid and low firing rates for all oil firing burners. Smoke spot numbers (Bacharach Scale) should not exceed the following values:

Fuel	Smoke Spot		
	High Fire	Mid Fire	Low Fire
#2 Fuel Oil	1	1	2
#4,#5 and #6 Fuel Oil	2	2	3

6. All adjustments should be made in small increments and results tested by flue gas analysis equipment. Tighten set screws and lock nuts on all linkages after final setting to prevent slippage.

CAUTION: Special care must be taken to ensure all movable swivels and bearing surfaces are maintained to prevent binding.

7. Damper blade shaft bearings are vulnerable to dirt because of the large volume of air being pulled past the surfaces. Depending on the environment in the boiler room, these surfaces should be lubricated at least monthly. Kewanee recommends a graphite based (dry) lubricant.

Section 30

KEWANEE CAMCOMMAND FUEL AIR RATIO CONTROL

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: Before proceeding with this section, the operator should study Figure 164.

1. INTRODUCTION

CAMCommand was developed for more precise control over fuel/air ratio through the complete firing spectrum of all of Kewanee's modulating burners. This is accomplished with the combined utilization of individual fuel, spring loaded crank arms and 16 finite adjustments to fuel input to characterize the fuel to the air. On return to low fire the CAM is further enhanced by the design which physically drives the fuel metering valve to the low fire position toprevent the possibility of the metering valve being stuck open.

2. OPERATION

The CAMCommand prime mover is a conventional modulating motor with a 90° throw in 30 seconds. Switches in the modulating motor provide the purge airflow interlock and low fire start interlock. Positive drive of the CAM's drive shaft is accomplished through a flexible coupling. Meteringdevices are of set dimensions (butterfly valve for gas and oil metering valve for oil). The geometry of the air damper crank arm is dependent on the burner size and degrees of opening required for each damper.

3. SET-UP

On a package unit the CAMCommand should be set reasonably close to the fuel air ratio required at any point on the firing spectrum. Fine adjustments can be made by adjusting the set screw closest to the V-notch on the indicator plate.

NOTE: There will be some resistance to movement of the set screws, as they are held in place by a nylon locking strip to prevent turning due to vibration. (Access to the set screws is obtained by loosening the cap screw in the center of the adjusting screw cover and removing same.) UNIT SHOULD BE SERVICED BY TRAINED PERSONNEL ONLY. It should be noted that due to the close proximity of the adjustment screws, changing the fuel/air ratio on one screw will affect the fuel/air ratio on adjacent screws, but to a lesser degree.

Set-up of CAMCommand on the burner requires that the throw and rate of travel of the butterfly valve, oil metering valve and combustion air inlet damper be rough set as one would set up a jack shaft arrangement. Adjust the longitudinal swivel positions and angles of the respective crank arms. It is advisable to run the system through several dry runs to insure that there is no binding, interference or over travel on the various linkages and drive rods. Typically, the butterfly valve and oil metering valves travel is around 70°. Damper opening on a specific size burner is relative to the required input. Once again, after the burner linkages have been stroked to give satisfactory high and low fire settings, fine adjustments are made through the modulating range with the 16 adjusting screws.

CAUTION: Do not make radical adjustments with the CAM, as large rates of change influenced by the CAM follower can create sensitive areas that can create instability when the burner becomes over-sensitive. All should be aware that in the first 50% of the firing spectrum, for a given change in displacement on the fuel metering device (i.e. - 5°), the change in input to the burner is significantly higher than in the upper 50%.

4. MAINTENANCE

With a couple of exceptions, the CAMCommand is maintenance free. Endurance tests have shown relatively little wear to components, as long as it is maintained properly. Keep it clean, remove any dirt or foreign matter from moving parts on a regular basis, especially to the flexible strip under the CAM follower. After cleaning, a small amount of spray lubricant on the bearing band will resist rust formation and insure smooth movement. Flexible strips are subject to cracking in extended service. Periodically check for cracks by running your finger over the surface of the strip. The strips can be replaced without CAM disassembly. Just remove the retainer clip at the top corner of the frame, press down on the CAM's fuel lever arm to lift the roller off the strip and pull the strip out. Installation of the new strip uses the same technique and does not normally affect burner adjustments. Check all linkages for tightness. Swivels for rods connecting CAM to fuel metering devices are susceptible to wear and ultimate "slop" over an extended period. Lubrication - a grease fitting has been provided to lubricate the CAM sleeve bearings to insure trouble-free movement over an extended period. Annually, give the fitting a shot of grease, wipe clean any grease that is forced out past the bearing ends. Any conventional, medium grade, non-fiber, industrial grease is acceptable.

5. CAM COUPLING

Kewanee uses two different modulating motors on PhoenX burners. Honeywell's M9174C1025 is used on burners through 350 Hp. Their M9484F1064 is used at 400 Hp and up. These modulating motors have different orientations of the flats on their square output shafts, making it necessary for their couplings to accommodate that difference. We've accommodated the difference at the cam shaft end of the coupling, where two sets of key ways and set screws are machined into the same shaft bore (see Figure 163). You can convert a coupling intended for one modulating motor into the coupling for the other motor just by rearranging the existing parts. First, remove the cam shaft arm from the coupling. Then turn it on its axis, so that the outside surface is toward the flexible plate (leave the top end at the top, and the bottom end at the bottom as shown in Figure 163).

Reinstall the cam shaft arm to the coupling, and move the set screw to its alternate location.

6. MODULATING MOTOR ALIGNMENT

When the burner is at its low fire position, the cam's position indicator should align with the lowest of its adjusting screws. if it doesn't, there are two possible causes. if the alignment mismatch is two adjusting screw positions or more, then the cam's coupling may be incorrectly assembled for the modulating motor it is mounted on. If the mismatch is less than two cam screw positions, then the modulating motor's shaft position may be incorrectly adjusted. Honeywell's literature for the modulating motor provides details for its adjustment.

7. REPAIR PARTS

Repair parts may be ordered through your local Kewanee representative.

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KEWANEE CAM COUPLING ASSEMBLY

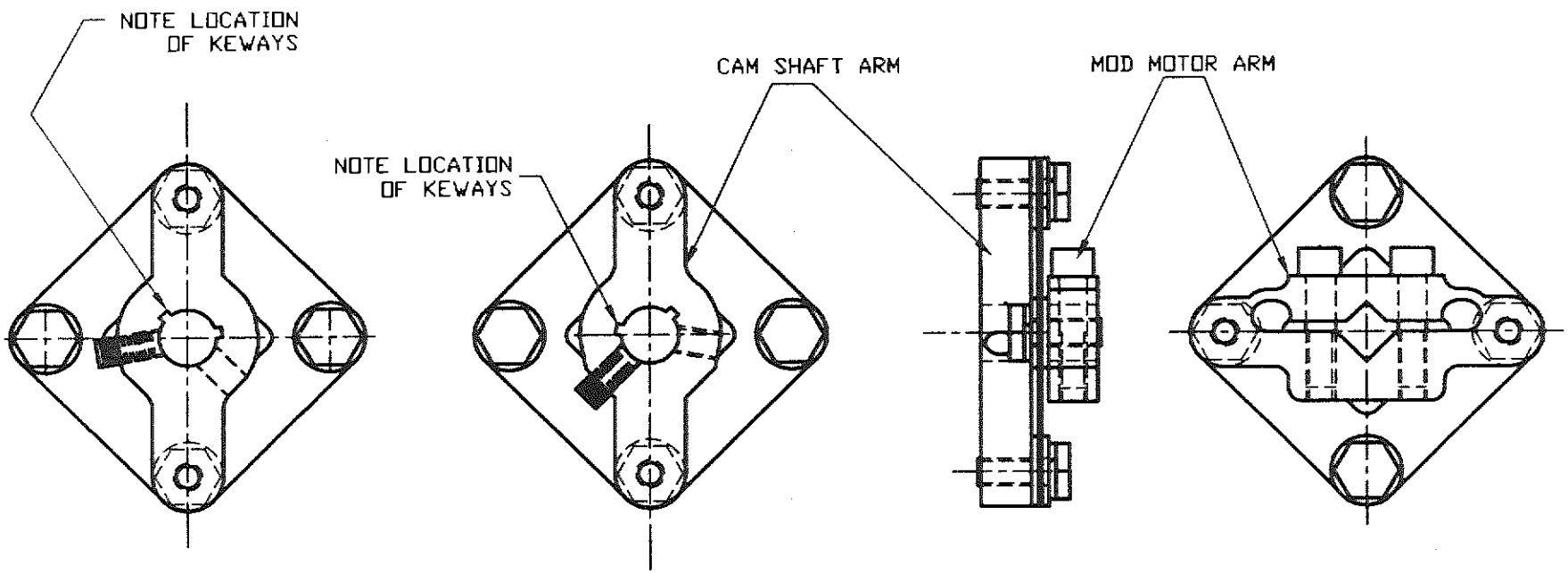


Figure 163

KEWANEE CAMCOMMAND

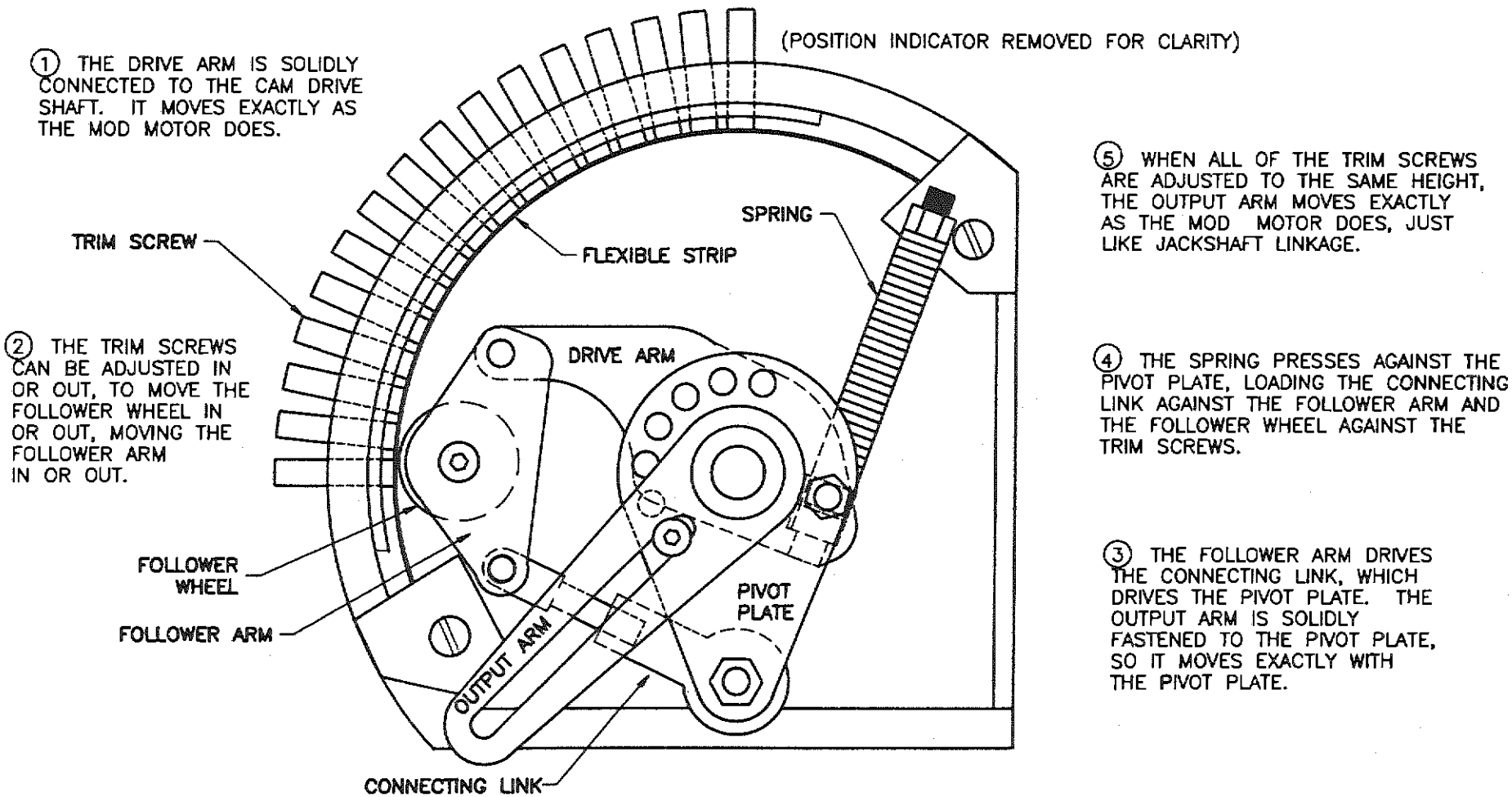


Figure 164

Section 31

AIR COMPRESSOR

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in the Component Literature. Many of the repairs can be made by any boiler operator, others should be made by a skilled serviceman. Call your Kewanee service representative for dependable service assistance. All warranties are void if maintenance is neglected.

CAUTION: This procedure is for the Atlas-Copco compressor. Specifics on compressor are found in the Component Literature supplied with the burner. For compressor layout see Figure 165.

1. MAINTENANCE

Routine maintenance insures trouble-free operation and protects your investment. All warranties are void if maintenance is neglected.

When servicing, replace all disengaged packings, e.g. gaskets, o-rings, washers. The "longer interval" checks must also include the "shorter interval" checks.

2. LUBRICATION

It is recommended to use the Atlas-Copco approved compressor oil to keep the unit in excellent operating conditions. If not available, a good-quality, mineral motor oil (not multigrade) with a viscosity grade of SAE 10 W 20 may also be used. The oil should meet the requirements of the API (American Petroleum Institute) classification code SE-CC or SE-CD, military specification MIL-L-46152 or MIL-L-2104C.

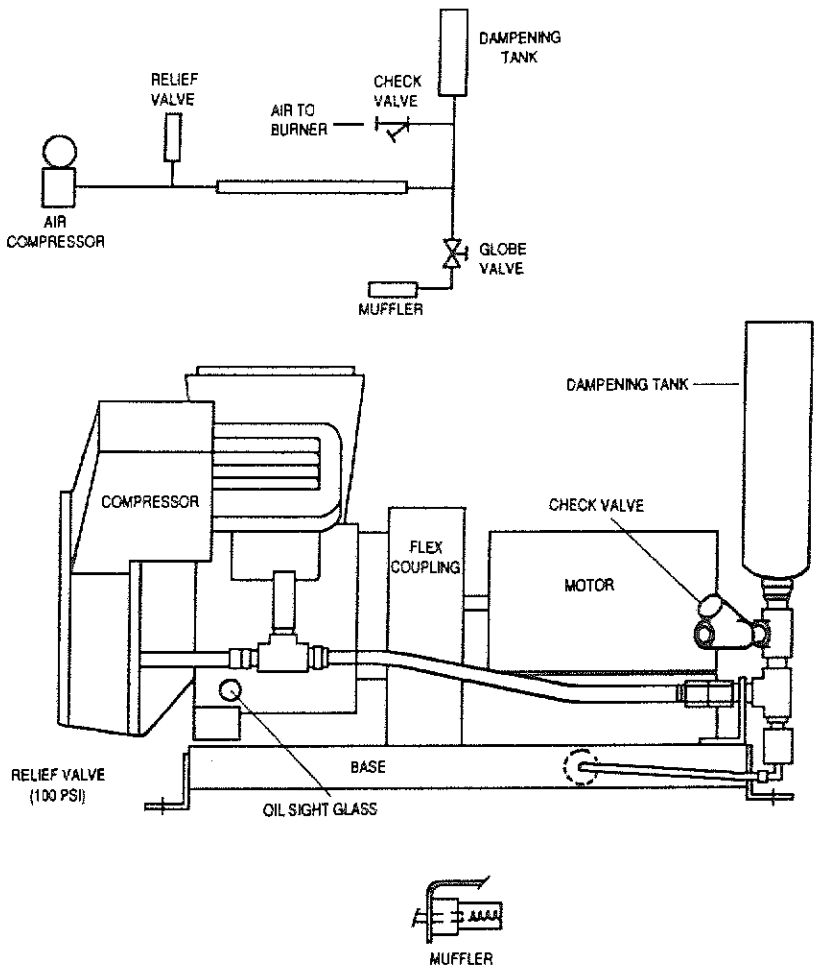
At extreme operation conditions (high ambient temperature, high loading factor, high pressure) a special digester synthetic lubricant is recommended. Consult the nearest Atlas-Copco service representative.

Use only reputable brands of oil and once a brand has been adopted, keep to it. Never mix oils of different brands or types.

NOTE: The crankcase is connected to the air intake silencer or suction line through a breather valve. Faulty operation of this valve or clogging of the metering orifice will result in too high a crankcase pressure and promote oil consumption.

Always securely tighten the oil filler plug after oil topping up.

AIR ATOMIZING COMPRESSOR ARRANGEMENT



1. Direction of rotation - CCW as viewed from compressor end.
2. Lubrication depends on severity of duty. Refer to compressor manual for details.

Figure 165

Section 32

ELECTRIC OIL HEATER

NOTE: 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 burner. Additional service instructions on various controls which are components of Kewanee burners may be found in the Component Literature. Many of the repairs can be made by any boiler operator, others shonld be made by a skilled serviceman. Call your Kewance service representative for dependable service assistance. All warranties are void if maintenance is neglected.

1. Do not turn on power to heater unless elements are fully immersed in oil.

2. Thermostat setting should be as low as is consistent with satisfactory operation. Too high oil temperature may cause irregular oil flow to the nozzle.

3. The thermostat for the oil heater is located under the end cover cap of the heater. Turn the knob as indicated for higher or lower oil temperature.

4. The auxiliary switch operates independently of the thermostat and prevents burner operation if oil is too cold for proper burning.

5. The adjustment for changing the setting of the auxiliary or cold-oil lockout switch is also under the end cover cap of the heater.

6. The auxiliary switch should close to permit burner operation when the temperature of the oil is approximately 10° F below the average operating temperature of the oil.

7. Allow the oil to flow through the heater for several minutes (preferably at high firing rate) before changing adjustments to insure accurate temperature readings.

Section 33

PARTS PROCEDURES

1. ORDERING REPLACEMENT PARTS

A. Where to Order Parts

Parts for Kewanee units should be ordered from the authorized Kewanee Service Representative who started and adjusted your unit or Kewanee Sales Representative. Contact Kewanee Boiler Manufacturing Co., Inc. at (309) 853-3541 for your local representative.

B. How to Order Parts

1. Always include nameplate data as shown on the boiler and on the burner.

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 complete name, description of Kewanee part number of each part included in your order (if possible).

4. State quantity desired of each item.

5. State whether shipment is to be made by UPS or truck. We ship UPS wherever possible.

C. Parts Returned Under Warranty or for Repair

1. Notify your local Kewanee Sales Representative for the part to be returned; model and serial number of unit from which it was taken; whether the part is being returned for credit or replacement. A Return Goods Authorization Number will be provided to you and an authorization form will be forwarded to you to attach to the defective part.

2. Do not send any part to the Kewanee plant without a Return Material Authorization form.

3. Remove usable fittings from the part, drain oil (if any), clean and attach the appropriate section of the Return Material Authorization form securely to the part.

4. Pack the part properly to avoid shipping damage and ship prepaid to Kewanee Boiler Manufacturing Co., Inc., 101 Franklin Street, Kewanee, IL 61443 USA.

2. 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.

Section 34

TROUBLESHOOTING

NOTE: Section 2 of this manual contains a description of how the various systems function in a properly operating Kewanee PhoenX burner. Section 13 contains illustrations and schematics of those systems and their intended adjustment. Study the portions of those sections which apply to your burner before proceeding with this section. Refer to them as necessary when using this section.

NOTE: The following table includes common service problems, cause and recommended actions to be taken to rectify the problem. These problems are not all inclusive, however, they are general in nature and cause. If the recommended actions do not solve the problem, consult the factory.

Problem	Possible Cause	Recommended Action
A. Motor will not start	1. Line starter tripped (overload)	1. Reset
	2. Switch "off"	2. Put in "on" position
	3. Blown fuse	3. Replace
	4. Combustion control in safety position	4. Reset
	5. Control circuit open	5. Check limits and operating controls for power to proper terminal of combustion control
	6. Loose wiring connections	6. Check and retighten
	7. Defective motor	7. Replace
	8. Low voltage	8. Minimum operating voltage, 102V AC if motor nameplate 115/120V AC; 204V AC if 220/240V AC; 408V AC if 440/480V AC; 510V AC if 550/600V AC
	9. Frozen oil pump on direct drive burners	9. Replace with new oil pump. Check coupling for visual signs of undue wear; replace if necessary
B. Motor starts but pilot does not light	1. No gas to pilot valve	1. Open all manual gas cocks; purge air from gas supply line, tighten fittings
	2. Gas solenoid valve not open	2. Check combustion control and operation of gas valve coil

Problem	Possible Cause	Recommended Action
B. Motor starts but pilot does not light - continued	3. No ignition spark	3. Check setting of electrodes, cracked electrode insulator, excessive carbon build-up, operation of transformer, ignition wiring
	4. Low or high gas pressure	4. Pressure downstream of pilot solenoid valve to be 4" to 6" water column
	5. Air damper open too wide	5. Reset air damper
	6. Running interlocks not closed	6. Check fuel pressure, low fire interlock, high oil temperature, atomizing air interlock and/or combustion air interlock for power to terminals. If pilot does not light, check for damaged air or fuel lines. Make sure low fire interlock is in the correct position
C. Motor starts - pilot lights but scanner signal reading is low or fluctuating	1. Weak pilot	1. See above - check gas pressure, air damper opening
	2. Obstructed scanner pipe	2. Clean
	3. Dirty or weak scanner cell	3. Clean or replace
	4. Inoperative combustion control	4. Replace amplifier or control
	5. Low voltage to combustion control	5. Increase to at least 102V AC
	6. Scanner viewing hot refractory	6. Review burner mounting details with Kewanee Service Department
D. Oil fire does not light	1. No oil pressure or low pressure on discharge	1. Check for fuel in tank, open suction line valves, check and clean strainer, check suction line for leaks - use vacuum gauge, reprime pump
	2. Oil solenoid valve not opening	2. Check wiring connections, check and replace solenoid coil
	3. Excessive combustion air - too little oil	3. Reset air damper or CAM setting on oil valve lever. Dirty nozzle or improperly assembled nozzle
	4. Fluctuating oil pressure	4. Check for foreign objects or air in fuel line
	5. Atomizing air pressure too low/high	5. Check air pressure and change accordingly
E. Gas fire does not light (USE CAUTION)	1. Manual gas valve closed	1. Open
	2. Butterfly valve closed	2. Readjust
	3. Automatic electric gas valves not opening	3. Check for power to actuator; replace actuator
	4. Excessive primary air	4. Reset air damper

Problem		Possible Cause	Recommended Action
F.	Oil fire smokes	1. Improper air/fuel mixture	1. Readjust linkage and CAM setting, use combustion testing instruments
		2. Insufficient combustion air	2. Provide more openings to boiler room
		3. Unit being overfired	3. Check rating of boiler and firing rate of burner
		4. Dirty nozzle	4. Clean and reassemble properly; replace if worn out
		5. Oil temperature too low/high	5. Check oil temperature; reset controls according to chart recommendations
		6. Atomizing air pressure too low/high	6. Check air pressure and adjust accordingly
G.	Gas fire smokes or has high CO (over 50 ppm)	1. Improper air/fuel mixture	1. Readjust linkage and CAM setting, use combustion testing instruments
		2. Insufficient combustion air	2. Provide more openings to boiler room
		3. Unit being overfired	3. Check rating of boiler and firing rate of burner
H.	Oil fire noise or pulsation	1. Fire too lean	1. Readjust linkage and CAM settings to increase rate or reduce air supply
		2. Excessive atomizing air pressure	2. Readjust air valve on air compressor
		3. Excessive oil temperature	3. Readjust control at heater
		4. High or variable draft	4. Install draft controls
I.	Gas fire noise or pulsation	1. Fire too lean (likely)	1. Readjust linkage
		2. Fire too rich (less likely)	2. Check boiler rating and reset burner
		3. High or variable draft	3. Install draft controls
J.	Excessive carbon build-up	1. Incorrect fuel/air ratio	1. Re-set per Performance Standards
		2. Oil temperature too low/high	2. Readjsut oil temperature controls
		3. Nozzle setting incorrect	3. Set nozzle as specified in Section 13
		4. High or variable draft	4. Install draft controls
		5. Overfiring boiler	5. Check boiler rating and reset burner
		6. Improper heat transfer	6. Readjust operating controls to allow boiler to operate in temperature rating
		7. Uneven airflow through diffuser	7. Check for diffuser centered in plenum; air diffuser vanes to be opened evenly
		8. Low fire (gas) set too low	8. Reset to burner standards

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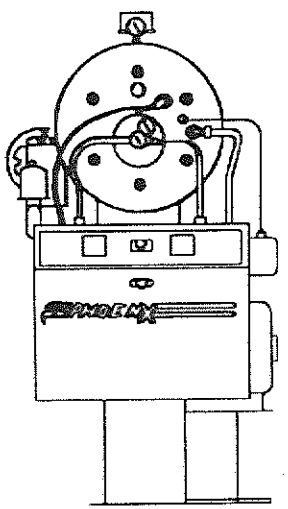

Installation, Operation and Maintenance Manual

for

PhoenX 40-800 HP

Gas/Pressure Atomized/Air Atomized Oil Burners

Thank You for Purchasing Kewanee Boiler Room Equipment

Since 1868, Kewanee has been committed to providing equipment of lasting quality and value to each of its many customers. It is our goal that every piece of Kewanee equipment purchased provides the same reliable operating excellence that was built into it by the skilled craftsmen at our Kewanee factory.

The following **Installation, Operation and Maintenance Manual for Kewanee PhoenX Burners** is designed to help you properly install, operate and care for your Kewanee equipment. We recommend that you read this manual through to familiarize yourself with its contents before installing and operating your Kewanee equipment.

Due to a wide variety of everchanging state and local codes, this manual contains information designed to show how a basic unit operates. The operation of all equipment must comply with all applicable regulations and codes by any authorities having jurisdiction. These legal requirements take precedence over anything contained herein. At Kewanee, engineering and development toward product improvements are a continuing process, therefore, the specific information in this book may be subject to change without notice.

Kewanee Boiler Room Equipment has been designed and manufactured to produce a long lifetime of dependable efficient service. All components of Kewanee equipment were chosen for their ability to enhance this design goal. Although these components provide a high degree of protection and safety during normal operating conditions, we highly advise that you pay close attention to any notes, cautions and warnings and maintain an awareness of the hazards and dangers inherent in careful handling of fuel firing devices.

In our many years in business, we have found that two things alone greatly impact the dependable operation and long life of our equipment:

- **Operator responsibility and knowledge**
- **Consistent preventive maintenance**

Operator Responsibility

It is the operator's responsibility to provide the daily care and attention required to properly maintain the boiler room equipment. This manual is intended to act as a guide and reference source for those operations, but it cannot replace the keen eye and experienced touch of a trained boiler room operator. It is recommended that a boiler room log be maintained to record daily, weekly, monthly and yearly activities as well as any unusual occurrences.

Consistent Preventive Maintenance

Regular effective maintenance is the best way to obtain the most efficient operation of Kewanee boiler room equipment. We have found that the life and efficiency of this equipment is dependent upon the consistency of care it receives. Often efficient operation is a matter of keeping the boiler clean and the firing equipment properly regulated. With proper installation, regular care and the use of Genuine Kewanee Renewal Parts, your quality Kewanee equipment will last indefinitely.

Safety Precautions and Abbreviations

It is important for all personnel operating this Kewanee product to read and fully understand the following safety precautions and abbreviations and the various sections of this manual before operating the equipment.

Failure to obey these safety precautions may result in damage to your Kewanee equipment, serious personal injury or even death.

Safety Precautions

NOTE: This safety precaution iudicates information that is vital to the operation or maintenance of your Kewanee equipment.

CAUTION: This safety precaution indicates a potentially hazardous situation which, if not avoided, could result in damage to the equipment.

WARNING!!! THIS SAFETY PRECAUTION INDICATES A POTENTIALLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

DANGER!!! This safety precaution indicates a situation which, if not followed exactly, could result in serious personal injury or death!

Abbreviations

AI	Authorized Inspector
ASME	American Society of Mechanical Engineers
BHP	Boiler Horsepower
BTU	British Thermal Unit
BTUH	British Thermal Unit per Hour
CC/Hr	Cubic Centimeters per Hour
CFH	Cubic Feed per Hour
CFM	Cubic Feet per Minute
Cu. Ft.	Cubic Feet
° F	Degrees Fahrenheit
FM	Factory Mutual
HP	Horsepower
In. Hg	Inches of Mercury
IRI	Industrial Risk Insurance
NFPA	National Fire Protection Agency
No.	Number
PHX	PhoenX Model
ppm	Parts Per Million
PSI	Pounds per Square Inch
PSIG	Pounds per Square
RPM	Revolutions per Minute
SSOV	Safety Shutoff Valve
SSU	Seconds Saybolt Universal
UL	Underwriters' Laboratory
WC	Water Column

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