

INSTRUCTIONS

FM Boiler.....

for the

CARE AND OPERATION

Burners.....

of

BABCOCK & WILCOX EQUIPMENT

Motors.....

for

BIRD & SON, INC.
Charleston, S. C.

Soot Blowers....

Installed on B&W Contract Numbers

Water Column....

FM-269

BA-1472, DSB-10229, ACC-10926

Valves.....

Approximate Water Holding Capacity
To Normal Water Level in Pounds per Unit

Boiler

6970

Air Compressor..



Controls.....

THE BABCOCK & WILCOX COMPANY
161 EAST 42ND STREET, NEW YORK 17, N. Y.

Products of

THE BABCOCK & WILCOX COMPANY

AND SUBSIDIARIES

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 Stirling Water-Tube Boilers
 Type H Stirling Water-Tube Boilers
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THE BABCOCK & WILCOX COMPANY
 161 E. 42ND STREET NEW YORK 17, N. Y.



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FM BOILER

OPERATING INSTRUCTIONS

The FM boiler is a safe, efficient, dependable, shop assembled water-tube boiler that can be operated for long periods with low maintenance. The oil and gas fired arrangement shown here is very simple and consists of two drums connected by tubes. All furnace walls are water cooled except for the burner wall which is 9" refractory backed by adequate insulation. While heat input is not high in terms of modern boiler practice, the maintenance of proper water conditions in the boiler is of prime importance and to a large extent determines the length of time the boiler can be operated between cleanings and the amount of troubles that may occur.

Improper boiler water treatment and control can result in three major potential difficulties which may require interruptions to service and costly repairs. These are:

1. Scale inside tubes
2. Corrosion of drums and tubes
3. Carryover of water with the steam

The scale is liable to cause tube failures. Since the furnace wall tubes are closer to the heat, they evaporate more water, will collect more scale and are more vulnerable to overheating than the tubes back in the cooler gas temperature zones if proper feedwater treatment is not used. Thus if tube failures occur due to scale they are most likely to be the furnace tubes or the boiler tubes at the furnace exit.

Corrosion may occur in the tubes but is more likely to occur in the drum plates near the water level unless oxygen-free water is fed to the boiler. Corrosion in the drums takes a long time to approach an unsafe condition but when it does, it virtually means scrapping the boiler. Any evidence of pitting or more general corrosion should immediately be followed by prompt action to prevent further attack.

Carry-over can occur if the salts in the boiler water are allowed to concentrate to the point where the boiler foams and the highly concentrated water is carried out with the steam. This will result in plugged steam lines and traps, damage reciprocating or rotating machinery, or contamination and ruin of product if used in process work. Carry-over may also result from the presence of oil in the boiler. Oil can also lead to tube failures.

All of these troubles can be avoided by proper water treatment. Many small plants employ outside water treating service to periodically check the analyses and to determine the necessary quantity and frequency of feeding of chemicals and also to set the blow-down rate. Other plants successfully take care of this themselves. In either case, trouble-free operation depends on the conscientious attention of the plant operator to the water treating problem. A great deal has been published on water treatment both in the technical magazines and in book form. Below are given the minimum requirements for feedwater and boiler water.

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FEEDWATER

1. Dissolved oxygen: Preferably zero, and not over 0.007 ppm (0.005 cc per liter).
2. Hydrogen Ion Value (pH): Not less than 7.
3. Hardness: Not over 17 ppm in terms of calcium carbonate.
4. Total solids: Reduce to minimum.
5. Suspended solids: None.
6. Oil: Zero.

BOILER WATER

1. Alkalinity: Between 100 and 250 ppm total alkalinity expressed as sodium carbonate.
2. Sodium Phosphate: With residual hardness in the makeup, 30 to 80 ppm excess phosphate expressed as disodium phosphate.
3. Chloride: Not over 500 ppm expressed as chlorine. Preferably as low as possible.
4. Hydrogen Ion Value (pH): Not less than 10.8, preferably 11.0 to 11.5.
5. Sulphate-Carbonate Ratio: In accordance with ASME Code, which indicates that if ratios not less than the following are maintained, caustic embrittlement will be inhibited.

Operating Pressure of Boiler, psi gage	Sodium Sulphate	Total Sodium Alkalinity in Terms of Equivalent Sodium Carbonate
0 to 150	1 to	1
150 to 250	2 to	1

6. Oil and Organic Matter: Preferably zero.
7. Total Solids: To prevent carry-over the following values should not be exceeded:

Operating Pressure	Steady Load	Rapid Load Swings
0 - 50	1250 ppm	-
50 - 250	3500 ppm	1700

The importance of good boiler water treatment cannot be overstressed when discussing successful boiler operation and that is why it is given such prominence in these instructions. The arrangement of internal piping in the steam drum for the chemical feed and continuous blowdown is shown elsewhere in these instructions. The continuous blowdown pipe is arranged to take boiler water which discharges from the No. 12 and 13 row tubes that form the division wall. The chemical feed pipe is arranged so that the feedwater will be thoroughly mixed with the boiler water before the chemicals are added.

INITIAL START-UP

Shop assembled boilers are thoroughly cleaned of all foreign material before they are shipped. If the manhole covers have not been removed, it will not be necessary to make an internal inspection.

All timber and spacer boards installed for supporting the furnace brickwork during transit should be removed from the furnace before firing the boiler. This is essential, to permit the boiler to expand properly, as well as to avoid the possibility of a glowing ember igniting explosive gases which can accumulate due to improper burner adjustments during the initial firing of the boiler.

A water soluble lubricant was used with the expanding equipment when the tubes were expanded into the drums, and the following procedure is recommended to prepare the boiler for the initial start-up.

When the boiler is ready for operation, open the manhole cover in the top drum and fill the boiler with water (soft water if obtainable) to within 2 or 3 inches of the manhole opening. Thoroughly dissolve in buckets, the quantities of chemicals listed in the following table for the size boiler, and pour the solution into the boiler through the open manhole.

BOILER SIZE	WATER CONTENT TO NORMAL LEVEL, lbs	TRISODIUM PHOSPHATE	CAUSTIC SODA
		lbs for 3000 ppm	lbs for 3000 ppm
17	4870	15	15
21	5910	18	18
26	6970	22	22
30	8020	24	24
35	9110	28	27
39	10150	31	30
43	11160	34	33
48	12270	37	37
52	13280	40	40
57	14390	43	43
61	15400	47	47

Close up the manhole, open the drum vent and raise the water level to slightly above normal. Light the burner and adjust it to the minimum firing rate as described in the burner operating instructions. The drum vent should be left open until steam blows out at a steady rate, about five lbs. pressure, so as to vent air from the boiler and reduce corrosion possibilities. Close the drum vent, continue firing at the minimum rate until 30 psi pressure is reached, at which point the burner should be shut off for 15 minutes. Relight the burner and continue firing at the minimum rate so that about one hour will be required to reach 75 per cent of line pressure. Shut off the burner and fire again as necessary to hold this pressure for four hours. Care should be taken not to let the safety valves pop since the highly concentrated water may damage the seats. Blow down a full gage glass of water through the lower drum blowoff valves. Fill the boiler to the top of the glass, firing as necessary to maintain the boiler at 75 per cent of line pressure, and again blow down another full gage glass of water. This is done to de-concentrate the chemical solution added to aid in improving the cleanliness of the internal surface of the boiler tubes. Restore the water level to normal (center of the glass), increase the boiler pressure to operating pressure and place

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INITIAL START-UP (Cont'd)

the boiler on the line. It is recommended that the load be increased gradually to not more than 1/2 load and after four hours of operation again blow down the boiler until the boiler water concentration is below the recommended limits given in the Boiler Water Section of this instruction. In case 1/2 load steam flow cannot be attained because of limited steam demand, the four hour period given above should be increased to a maximum of 12 hours before blowing down. Inspect the gage glass for signs of oil on top of the water level. If there is an indication of oil present continue operating the unit at low loads, occasionally blowing down the gage glass, water column and continuous blowdown line until there is no sign of oil. (The boiler safety valves should now be tested to see that they operate at their nameplate pressures.)

NORMAL START-UP

When the boiler is to be started up from cold condition after the initial starting up procedure described above has been carried out, the following procedure should be used.

Close the boiler stop valve, open the drum vent, and raise or lower the water level to slightly below normal. Start the burner and fire at the minimum firing rate. See the OPERATING INSTRUCTION CARD for a list of specific steps to take in placing the burner and controls in operation. When there is a steady flow of steam from the vent at about 5 psi, close the drum vent valve and continue firing at the minimum rate until 30 psi is reached at which point the burner should be shut off for 15 minutes. Relight the burner and continue firing at the minimum rate so that it will take 45 minutes to 1 hour to reach line pressure.

BOILER CONNECTIONS

As an aid to proper installation, a drawing is attached showing the B&W Company terminals and also the more usual and acceptable means of connecting steam, feed and blowdown lines.

SOOT BLOWING

When firing oil, the soot blower should be operated every eight hours. It should be operated only while the burner is in service at a rate of combustion sufficiently high to insure a low oxygen content in the flue gases and to prevent the fires being blown out. It is best to have the boiler operating between half load and full load when operating the soot blowers. Operation at low load, with its resulting colder furnace, may result in some unburned combustible escaping from the furnace and depositing on tubes or collecting in pockets. Agitation of these combustibles during soot blowing at low load may result in an explosion. It is therefore important to have all of the areas of the gas passes thoroughly swept with flue gas when blowing soot thus purging any combustible gas from pockets where it may collect.

INSPECTION AND CLEANING - INTERNAL

A boiler unit should be taken out of service periodically for routine inspection and cleaning, the interval between these outages to be determined by experience with the conditions of operation, water, and fuel.

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INSPECTION AND CLEANING - INTERNAL (Cont'd)

Prior to entering the boiler for inspection or cleaning particular care must be taken to guard against the possibility of steam or hot water entering the unit through open drains or blowdown valves connected with similar parts of other units under pressure at the time, or through the careless opening of any steam or feed valve to the unit. Serious and sometimes fatal cases of scalding have resulted from neglect of these precautions.

The pressure parts should be examined internally for signs of scale, oil, corrosion, or other potential sources of trouble directly attributable to water conditions. Obviously, the finding of these conditions should result in proper remedies and precautions against a recurrence of the troubles.

Particular care should be taken to see that the connections to the water column, gage glass, and steam pressure gage and safety valves are unobstructed, and in a condition satisfactory for the purpose intended.

INSPECTION AND CLEANING - EXTERNAL

The external surfaces should be inspected for signs of overheating, leakage, corrosion, and any other distress which will impair the safety of the pressure parts. The inspection should also cover the conditions of burners, gas baffles, refractories, and safety appliances. Repairs should be made from the standpoint of safety as well as to insure continuity of service.

Cleaning of the boiler heating surface should be done as is necessary to supplement the soot blower provided and used during the operation of the unit. This cleaning can be accomplished by brushing, scraping, or air-lancing, as permitted by access. As little cleaning of refractories or refractory-faced surfaces as is compatible with safety should be attempted with the unit out of service, for clearing of slag from a refractory surface will inevitably tear away the refractory surface to a damaging extent.

The inspection should also include the fuel-burning equipment, especially those parts which are not accessible when the unit is in service, and repairs or replacements should be made to permit proper functioning of the equipment as well as to reduce the possibility of interruptions during subsequent operation.

A check of the soot blower should be a regular maintenance item during regular scheduled boiler outages. Tubes near the soot blower should be inspected closely for any signs of metal loss due to steam cutting. Direct impingement of steam on tubes may result from the shifting of the soot blower element, or from elongation of blower elements which may move the nozzles out of register with the spaces between the tubes.

SPECIAL INSPECTION - STATE OR INSURANCE

In addition to routine operation inspections, a thorough inspection from the viewpoint of safety should be made yearly at the time of the visit of the Insurance Inspector or State Inspector. This should include a most careful search for evidence of internal and external corrosion, leakage of expanded, screwed or welded joints, evidence of overheating.

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IDLE BOILERS

Boilers to be held out of service must be carefully prepared for the idle period and closely watched during the outage to reduce the possibility of corrosion to the minimum.

PROTECTION OF INTERNAL SURFACES - DRY STORAGE

When it is known that a boiler will be stored for a considerable length of time and allowance can be made for a brief period of preparation for demanded service, the dry storage method is recommended. In this method, the unit is emptied, thoroughly cleaned internally and externally, dried, and then closed up tight to exclude both moisture and air. Trays of lime, silica gel, or other moisture absorbent may be placed in the drums to absorb the moisture in the air trapped by the closing up of the boiler. The pans should not be more than three quarters full of the dry absorbent to be sure that there will be no overflow of corrosive liquid after the moisture has been absorbed. Particular care must be taken to prevent water, steam, or air leakage into the unit. Periodic inspections should be made to insure that no corrosive action is taking place, and at those times the absorbent should be replenished as required.

PROTECTION OF INTERNAL SURFACES - WET STORAGE

Wet storage is not normally recommended but when dry storage cannot be used due to the necessity of having the boiler available on very short notice, the following procedure should be followed: The boiler should be steamed in service in order that boiler water conditions may be stabilized and oxygen bubbles cleared from the boiler surfaces. The boiler should be brought down in rating slowly and the water level raised as high in the glass as is consistent with safe operation while still unloading some steam to the line. Sodium sulphite will aid in preventing oxygen corrosion.

When the pressure, as indicated by the boiler vent, has practically disappeared, but before a vacuum due to cooling off is produced, the boiler should be slowly filled completely full. The drain on the boiler side of the main steam stop valve should be wide open so that any water getting past the non-return valve will not accumulate on the boiler side of the stop valve. Filling should be continued until a pressure of at least ten pounds per square inch against the non-return valve is evident. Close watch should be kept by the operators to guard against building any undue pressure against the non-return valve due to leaking feedwater valves.

Boiler connections should be checked for leakage.

PROTECTION OF EXTERNAL SURFACES

The external surfaces of all pressure parts and other metallic surfaces should be completely cleaned of all ash and soot deposits.

The settings should then be closed and kept closed, but periodic inspections should be made regularly to guard against sweating and corrosion of the external surfaces of the pressure parts, particularly when the wet storage method is used. In this connection, it may be found necessary to use coke stoves, or similar heating devices, at convenient points to keep all metal surfaces above the dew point, particularly during protracted spells of damp weather accompanied by rising temperature.

B&W OIL AND GAS BURNER FOR TYPE FM INTEGRAL-FURNACE BOILERY-JET ATOMIZEROPERATING INSTRUCTIONS

The burner shown on Fig. 1 can be furnished to burn either oil alone, gas alone, or it can be combined so that either gas or oil can be handled without any changes other than proper manipulation of valves. Gas enters through the ring shown on the drawing, while oil is supplied through the atomizer at the center. The same air register supplies combustion air and mixes it with the oil or gas to give good combustion conditions.

Four burner sizes, 11-1/2", 15-1/2", 16-1/2" and 18-1/2" are used on FM boilers. Each boiler is provided with the size burner best suited to its capacity. The burner size is determined by the nominal inside diameter of the throat. The designs are similar to that shown on Fig. 1 and provision has been made for the same adjustments on all sizes.

Before placing the burner in service, the impeller should be positioned in the throat as shown on Fig. 1 for the 11-1/2", 15-1/2" and 16-1/2" burners and placed about midway in the cylindrical part of the throat tile for the 18-1/2" burner. The air doors should be adjusted to the wide open position on the 11-1/2", 15-1/2" and 16-1/2" burners. The air doors on the 18-1/2" burner are individually adjustable and the shop setting of 4" opening between the end of the air door and the register frame angle should be checked.

Operating experience may dictate some minor changes to the door adjustment. *However, after this has been made and the combustion control adjusted for the proper fuel and air relationship, the air door position and the impeller position should not be changed as it will alter the fuel-air relationship of the automatic combustion control.*

OIL BURNER

The Y-jet atomizer with sprayer plate and resistor plate assembly as shown on Fig. 2 are provided as the load carrying plate for boilers operated at 100 psi or higher. The Y-jet sprayer plate requires steam of at least 100 psi for full load operation.

For starting the boiler up when steam is not available, a steam mechanical plate and adaptor plate are furnished. Either type sprayer plate can be used with the same atomizer assembly as shown in Fig. 2 but it will be noted that *an adaptor plate must be installed with the annular grooves next to the steam mechanical plate.*

A resistor plate is shown with the Y-jet assembly. This resistor plate is necessary in order to coordinate the burner with the automatic control because it gives a better relation between air flow and oil pressure at the burner. If an existing pumping and heating set is used to supply the boiler and it can not be set for a high enough oil pressure to permit using the resistor plate, the resistor plate may be omitted from the Y-jet atomizer assembly. Curves showing the typical relationship of oil pressure and atomizing steam pressure both with and without the resistor installed are shown on Fig. 3.

Before placing the burner in service the atomizer with proper sprayer plate assembly should be installed in the burner and the coupling tightened with the double

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OIL BURNER (Cont'd)

ported gasket (Item 6, Fig. 2) installed. After making this assembly, the furnace face of the end cap should extend 1/4" to 3/8" on the furnace side of the center hole in the impeller plate. This dimension may be adjusted by removing the handle from the coupling, loosening the set screw and turning the distance piece into or out of the coupling. Best performance of the burner is obtained by keeping this dimension to a minimum consistent with avoiding excessive carbon deposits on the impeller.

Before placing the burner in service the atomizing steam supply line from the drum or steam main to the control panel, through the control panel and to the burner should be inspected to make sure it is installed so the line is properly trapped and there are no pockets in which condensate can collect.

In order to start up a cold boiler when steam is not available, the steam mechanical plate is used as a mechanical atomizing plate and operated with not less than 100 psi oil pressure. The valve at the drum in the atomizing steam line should be opened before lighting the burner so that steam will flow to the burner as soon as the pressure begins to rise. When line pressure is reached the steam-mechanical atomizer is removed, the Y-jet atomizer installed and the boiler put on automatic control after the controls have been adjusted in accordance with the instructions given in the Bailey Meter Co. manual on FM boiler controls. Before adjusting the combustion controls the burner should be operated over its load range to determine if any adjustments are necessary to the air doors and to establish the best position of the impeller in the burner throat. The best burner performance is obtained by pulling the impeller back as far as possible without building carbon on the throat tile.

The inspection and care of the atomizer is very important in maintaining satisfactory operation of an oil burner. The atomizer must be clean always, for a very slight obstruction of an oil or steam passage leads to poor atomization which will result in unsatisfactory combustion and probably smoke. An atomizer should be replaced by a clean assembly as soon as it fails to give a uniform oil spray. To enable this change to be made as quickly as possible, a spare atomizer assembly is furnished. The fouled assembly should be cleaned when it is removed and then placed in a rack so that it is immediately available.

Atomizers should be dismantled and assembled with the wrenches and vise furnished. Do not permit the use of pipe wrenches, since these will badly scar the machined surfaces and result in premature replacement of these parts. The sprayer plates and sprayer heads should be washed in kerosene. Scraping with metallic instruments should be avoided because this will mar the highly finished surface and result in leakage of oil or steam from their respective passages.

GAS BURNER

The gas burner is very simple in that it consists of only a ring drilled with a number of 1/8" holes, the number of holes depending on the quantity of gas to be burned. Since the holes are quite small, they may become plugged by pipe scale, weld beads, or similar debris. For this reason, it is necessary to blow out newly installed gas lines with compressed air or other means to insure that they are thoroughly cleaned.

The following procedure for initially placing a ring type burner in service applies to natural gas. For other types of gas it may be necessary to vary the specific values given.

GAS BURNER (Cont'd)

Before attempting to light the gas burner, it is recommended that a U gage filled with mercury or water be connected temporarily to indicate the gas pressure to the burner. This is essential to obtain accurate gas pressure readings during the initial firing period and should be used until the minimum stop is adjusted on the fuel gas regulator valve.

The forced draft fan damper should be adjusted so the difference between the windbox pressure and the furnace pressure is about 0.4 inches of water. The master selector valve should be turned to the hand position and adjusted to about 8 psi control pressure. If the burner ignites satisfactorily, note the gas pressure and adjust the load adjusting knob on the master selector valve to obtain 0.4 inches of mercury or 5.5" of water gas pressure to the burner. If the burner fails to ignite immediately shut off the gas and thoroughly purge the furnace as described under "Safety shutdown" in the condensed operating instructions. The control pressure should be adjusted to more or less than the 8 psi as indicated by the gas pressure to the burner observed during the first trial. When the correct position of the fuel regulating valve has been established to give 0.4" of mercury gas pressure to the burner, the minimum stop on the regulating valve should be adjusted so the gas pressure to the burner can not be reduced below this value. While the burner will operate at lower gas pressures than this, it is not recommended as there is a minimum gas pressure and maximum air flow relationship at which the burner will not light immediately.

LIGHTER

Each burner is equipped with a spark-ignited, gas fired lighter shown in Fig. 4 which can be supplied with L.-P. bottle gas, natural gas, or manufactured gas. Its purpose is to ignite the main burner whether this is an oil or gas burner and it remains on only long enough to light the main burner.

The lighter is provided with a gas discharge orifice which is threaded into the lighter tip holder. It may be necessary to increase the orifice diameter or remove it depending upon the type of gas and pressure available. On gas fired units with main gas supply pressure over 3 psi available to the control panel, the reducing valve in the lighter line should be adjusted to provide 3 psi to the lighter.

The recommended minimum capacity of the lighter for the various burner sizes are:

11 1/2" Burner	-	150,000 Btu/hr, input
15 1/2" & 16 1/2" Burner	-	250,000 Btu/hr, input
18 1/2" Burner	-	400,000 Btu/hr, input

The following table will serve as a guide in selecting the size of gas discharge orifice for various types of gas and gas supply pressures available to the lighter:

LIGHTER DISCHARGE ORIFICE SIZE

TYPE OF GAS	GAS PRESSURE TO LIGHTER, psi	BURNER SIZE, in.		
		11-1/2	15-1/2 & 16-1/2	18-1/2
Manufactured	1/4	9/32	Remove	*
	1/2	1/4	5/16	Remove
	1	7/32	1/4	5/16
Natural	1/4	7/32	1/4	5/16
	1/2	3/16	7/32	9/32
	1	5/32	3/16	1/4
	5	#46	1/8	5/32
Low Pressure Bottled	1/2	5/32	3/16	7/32

* Lighter not suitable for Manufactured gas at 1/4 psi

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LIGHTER (Cont'd)

The spark ignition for the lighter is supplied by a 5000 volt transformer and the spark gap should be set for a 1/16" gap. If the lighter fails to ignite with the fan damper at minimum stop but ignites with the damper partly open, it may be due to the spark being in too rich a part of the gas stream as evidenced by more than the usual amount of sparking at the gap. This may be corrected by bending the electrode and re-adjusting the gap. If the lighter loses ignition at high air flow through the burner it may be due to insufficient gas supply or an excess of air flowing through the spark chamber. The amount of air flowing through the spark chamber may be reduced by adjusting the position of the end of the insulator with respect to the spark chamber.

FLAME SCANNER

A lead sulphide cell type of flame scanner is mounted on the burner front as shown on Fig. 1. The scanner looks through the burner air door opening to sight the lighter flame and the main gas burner flame. The air doors must be open or the scanner will prevent the main fuel from being turned on to the burner. The scanner is provided with an adjustable mount and its line of sight should be aimed at a point on the lighter flame about one foot from the end of the lighter. This adjustment should be made with minimum air flow through the burner. The setting of the scanner should be checked to see that it will not pick up the lighter flame when the size of the lighter flame is reduced by high air flow through the burner or low gas supply pressure to the lighter.

On oil fired units there is a second flame scanner of the same type mounted in the center of the rear wall as shown on Fig. 5. The front scanner is cut out of service by a relay in the control circuit when the lighter is turned off, so that the oil flame is monitored only by the rear scanner. Scanning the oil fired from the rear results in the scanner shutting off the oil if an excessively smoky fire should occur. The rear scanner should be aimed just off the center of the burner so that it looks at the zone between the burner impeller and the throat tile. The sensitivity of the scanner is varied by the size of the opening on the end of the sight tube. The rear scanner is provided with a 1/16" diameter opening and the front scanner with a 1/8" diameter opening. If a steady scanner voltage cannot be obtained by adjusting the line of sight, the size of the opening should be increased slightly. (See Bailey Meter Company's instructions for checking scanner voltage.)

INSTALLATION

Most sections of the country have State or Municipal Codes and the requirements of these codes are occasionally revised so that the latest governing code should be checked when a new installation is being made. The "National Board of Fire Underwriters" have prepared their pamphlet No. 31, "Standard of the National Board Fire Underwriters for the Installation of Oil Burner Equipment", and this gives valuable information.

In addition Fig. 6 shows an arrangement of oil storage and connections which will satisfy most requirements. The thermostatic control valve should be set to maintain oil temperature in the storage tank around the suction line at about 100 F if No. 6 or No. 5 oil is being used. If it is expected that there will be occasions when it will be necessary to start up when no steam is available, an auxiliary electric heater should be installed.

The main oil pump furnished with the controls for this boiler has a suction equivalent of 11 ft of water. If the total of the lift and friction loss exceeds

INSTALLATION (Cont'd)

this, a transfer pump is required to deliver oil from the tank to the main oil pump. In practically all cases, this transfer pump will be desirable.

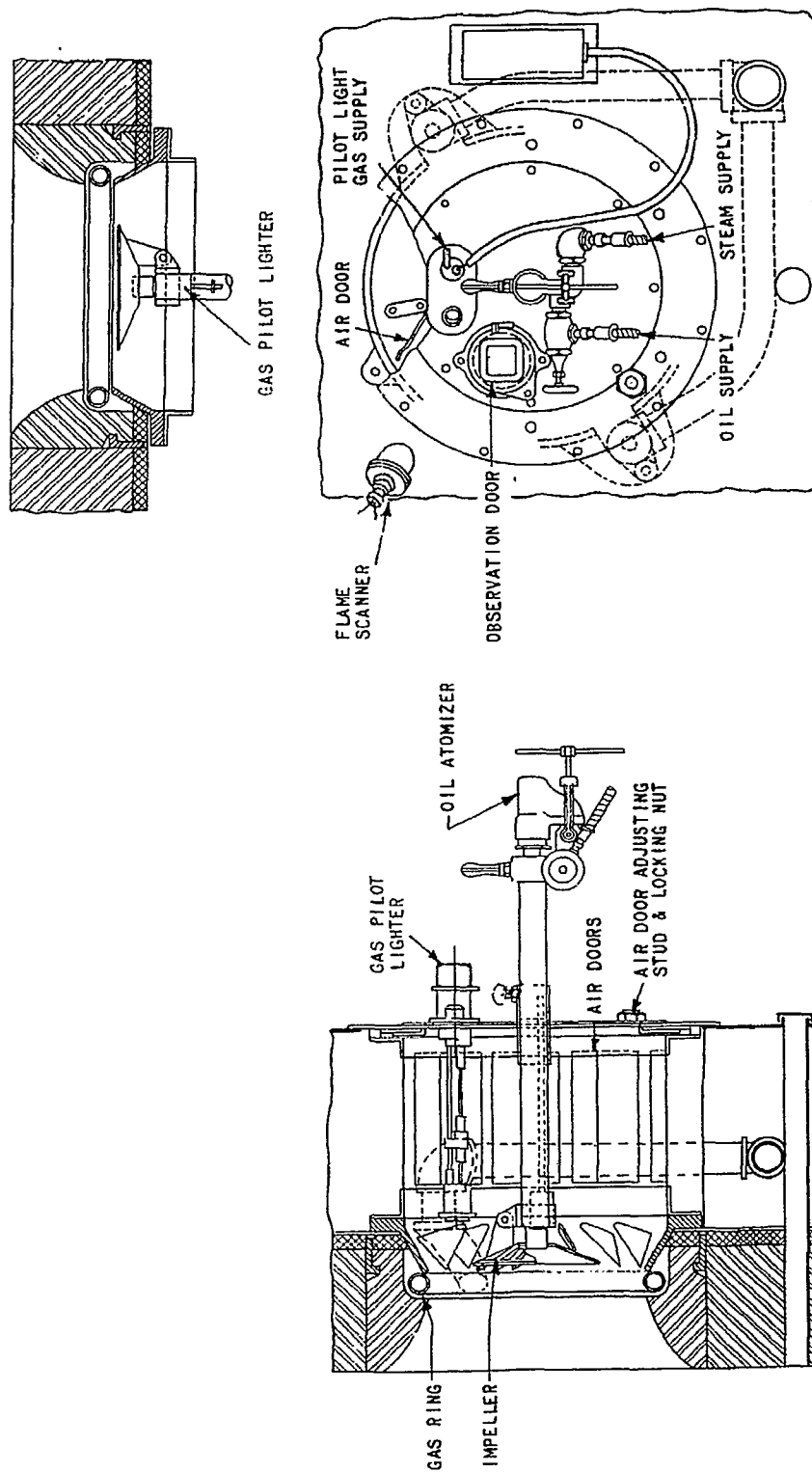
Since heavy oil becomes very viscous at low temperature, there will be difficulty starting pumps if they contain No. 6 oil that is very much below 70 F. If conditions arise where it is known that the oil will drop below 70 F, it would be best to drain the system. A word of caution on the use of electric heaters may be appropriate here and that is they will burn up very quickly if not completely surrounded by oil.

For best operating conditions, oil temperatures at the burner should be maintained at 200 F for No. 6 and 160 F for No. 5 oil. As a minimum for starting, 160 and 130 F respectively can be used. Oils lighter than No. 5 will normally not require heating unless subjected to sub-zero temperatures.

SPARE PARTS

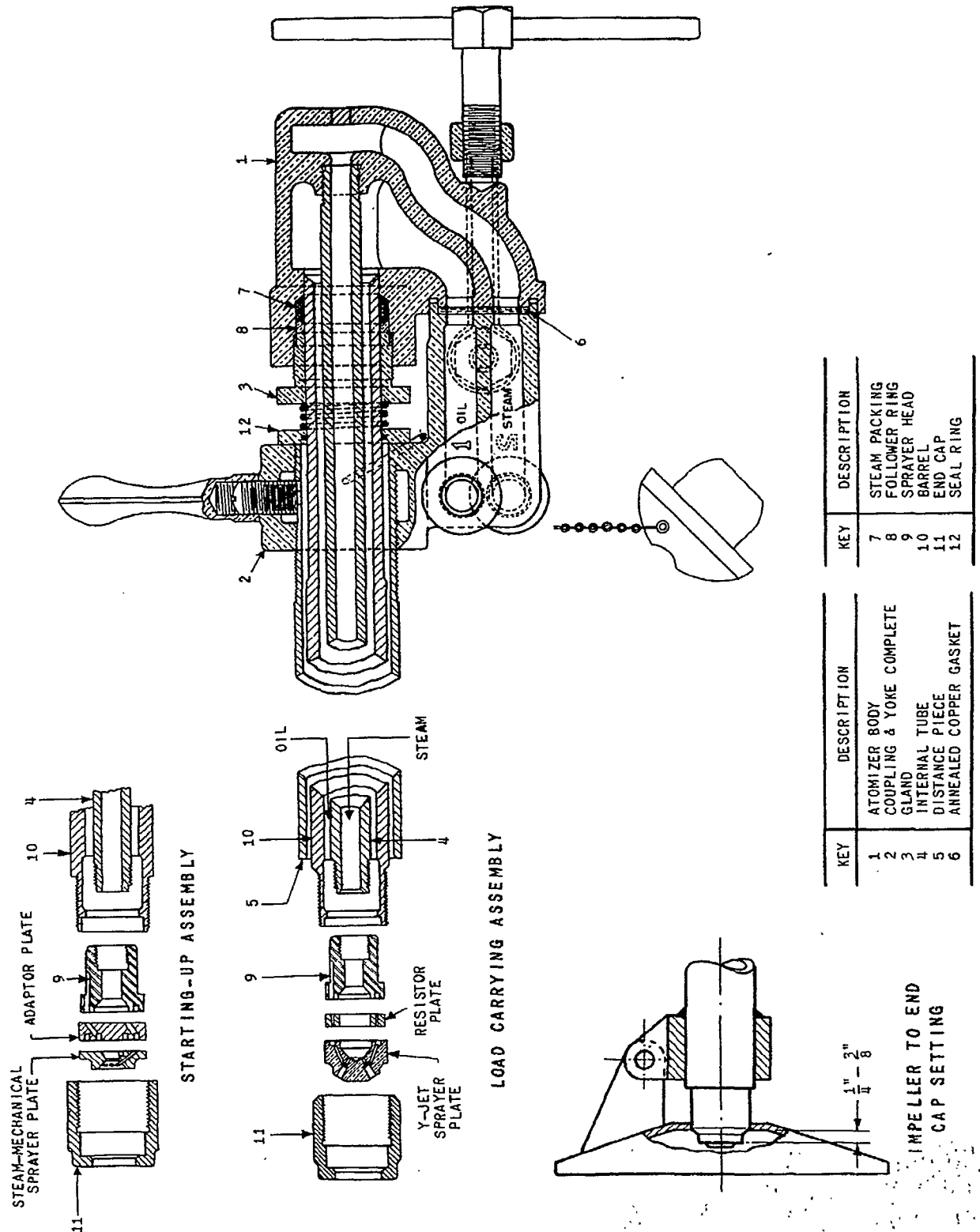
The following spare parts should be kept in stock for use as replacements on:

1. The burner
 - 1 Impeller
 - 1 Set of throat tile
2. The oil atomizer
 - 1 End cap (11)
 - 1 Sprayer head (9)
 - 12 Load carrying sprayer plates & resistor plate.
 - 1 Starting-up sprayer plate & adapter plate.
 - 1 Double-ported copper gasket (6)
3. The lighter
 - 2 Insulators & ignition electrode



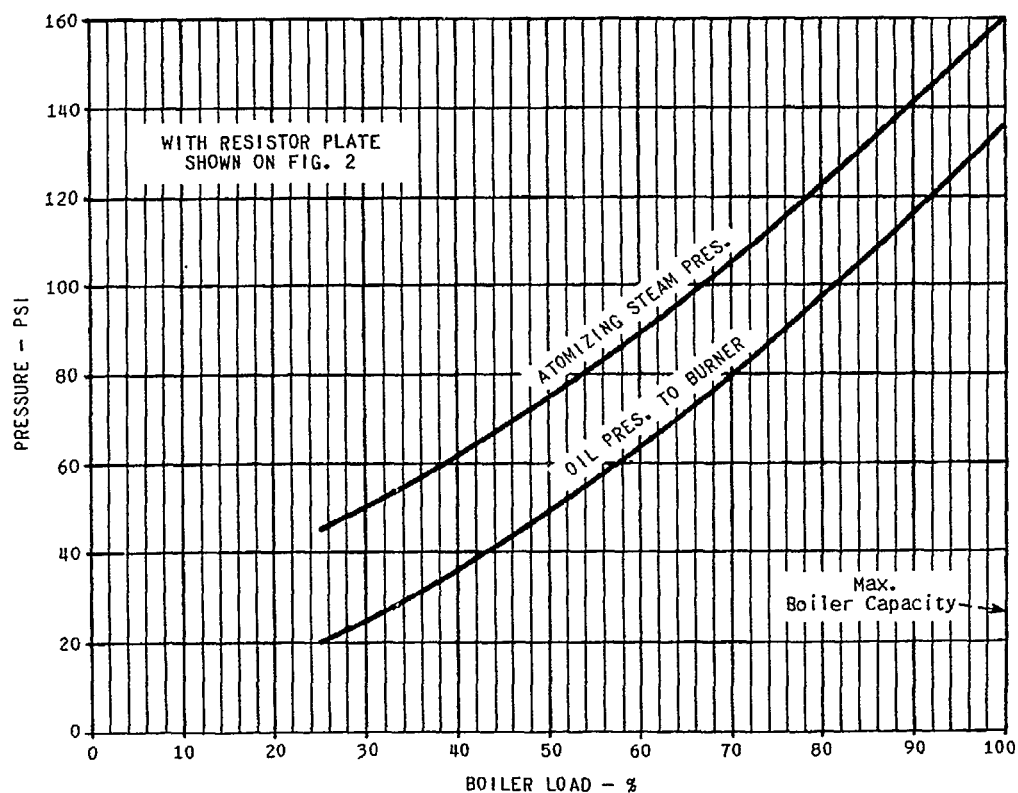
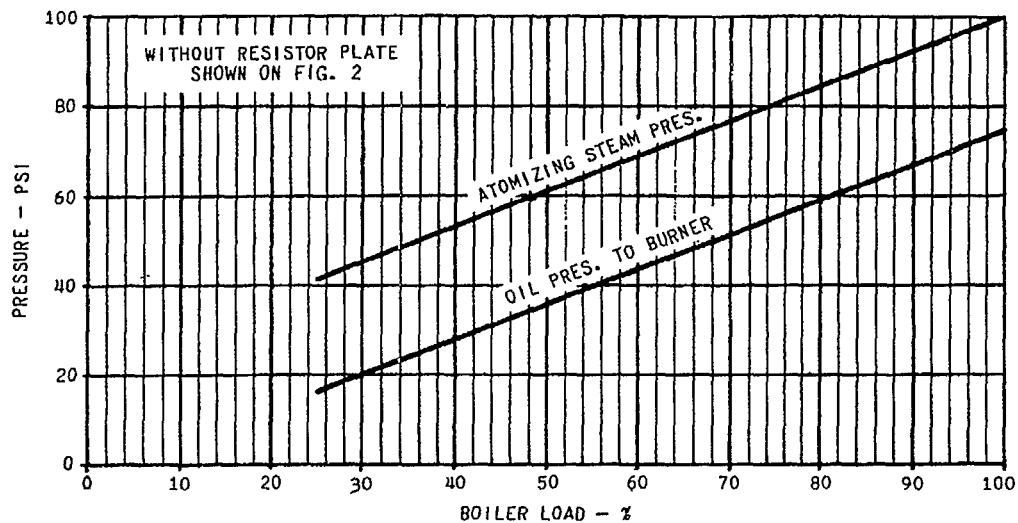
ARRANGEMENT OF COMBINATION OIL AND GAS BURNER

Fig. 1



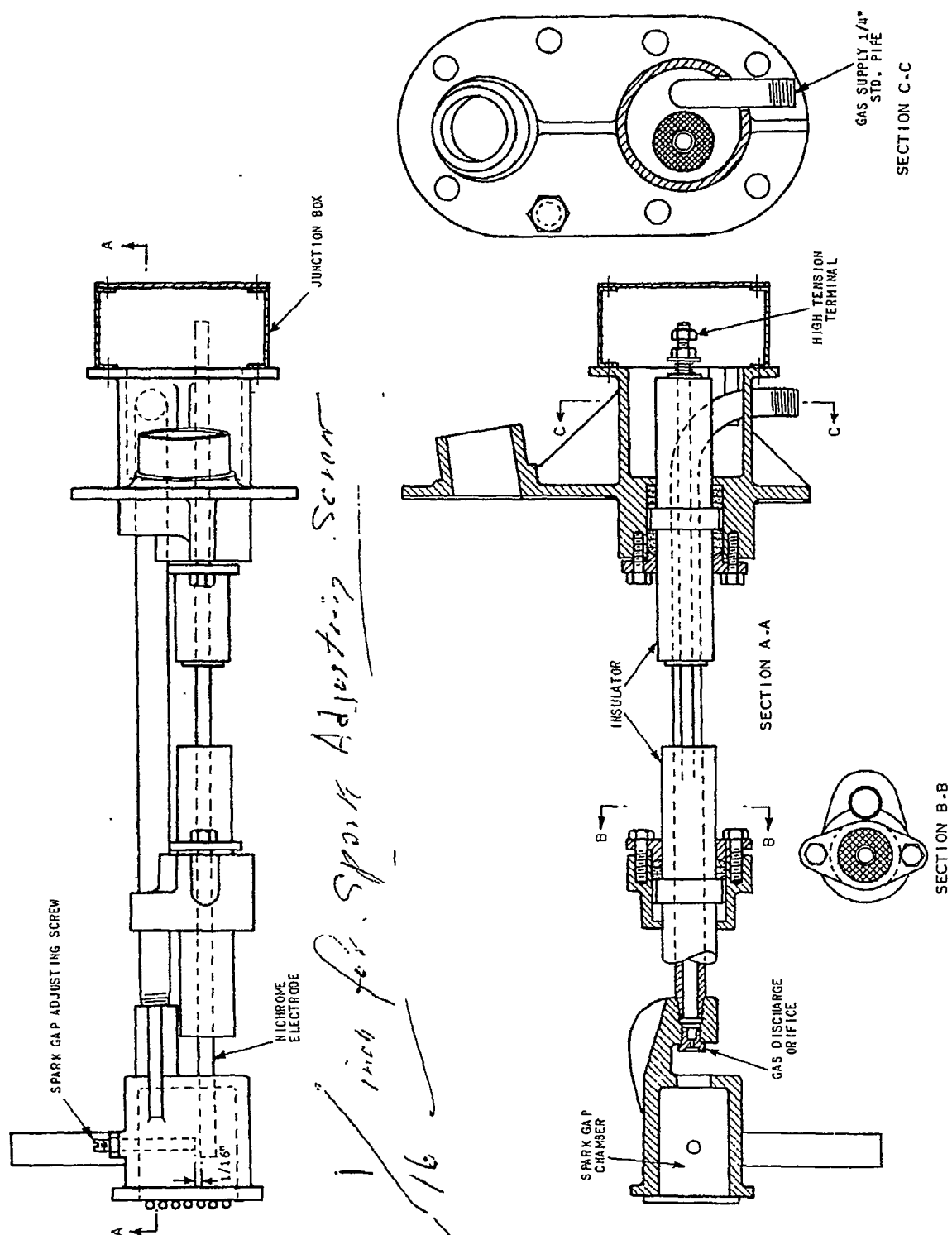
ATOMIZER ASSEMBLY

Fig. 2



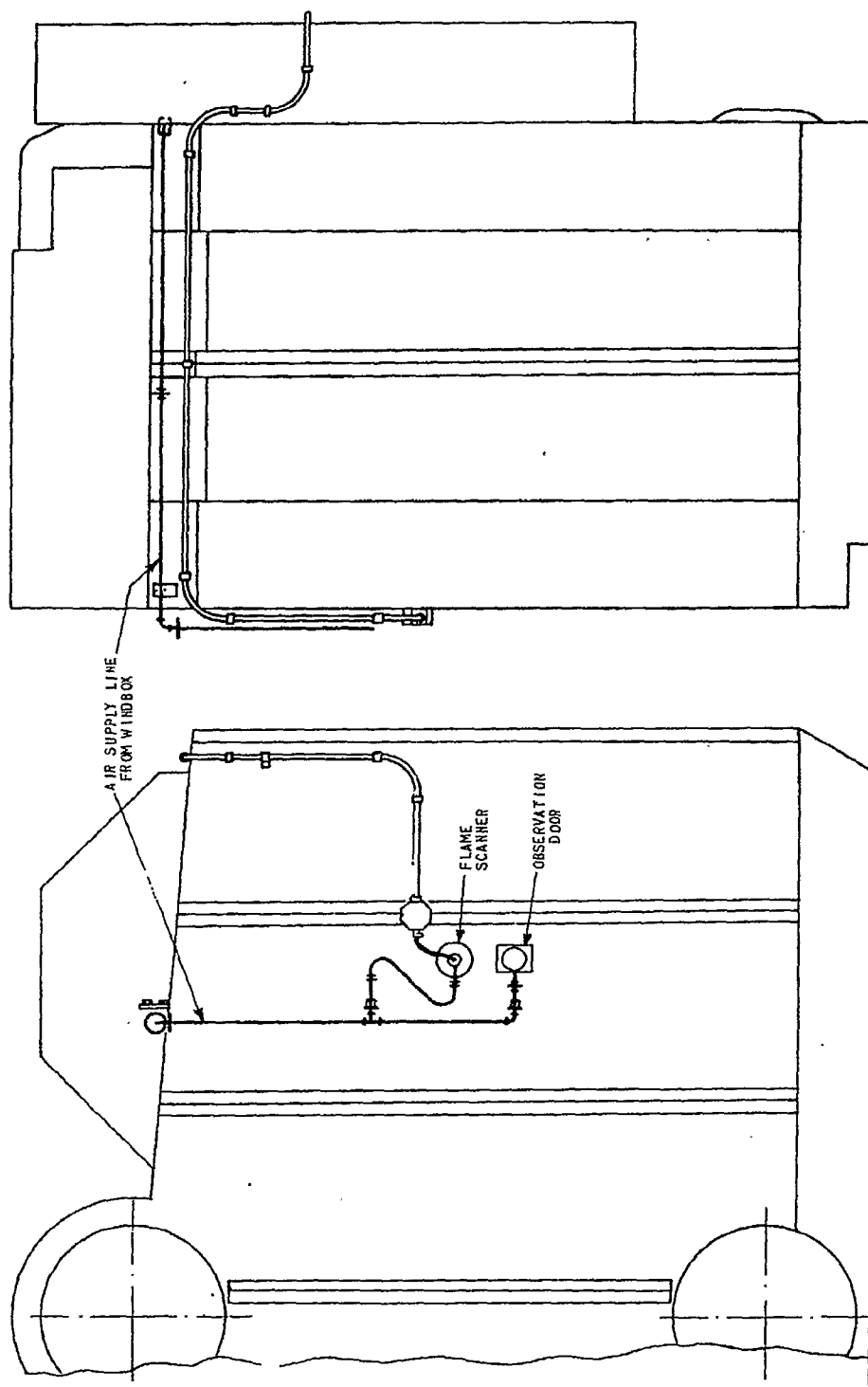
TYPICAL RELATIONSHIP OF OIL PRESSURE
AND ATOMIZING STEAM PRESSURE FOR Y-JET
ATOMIZER.

Fig. 3



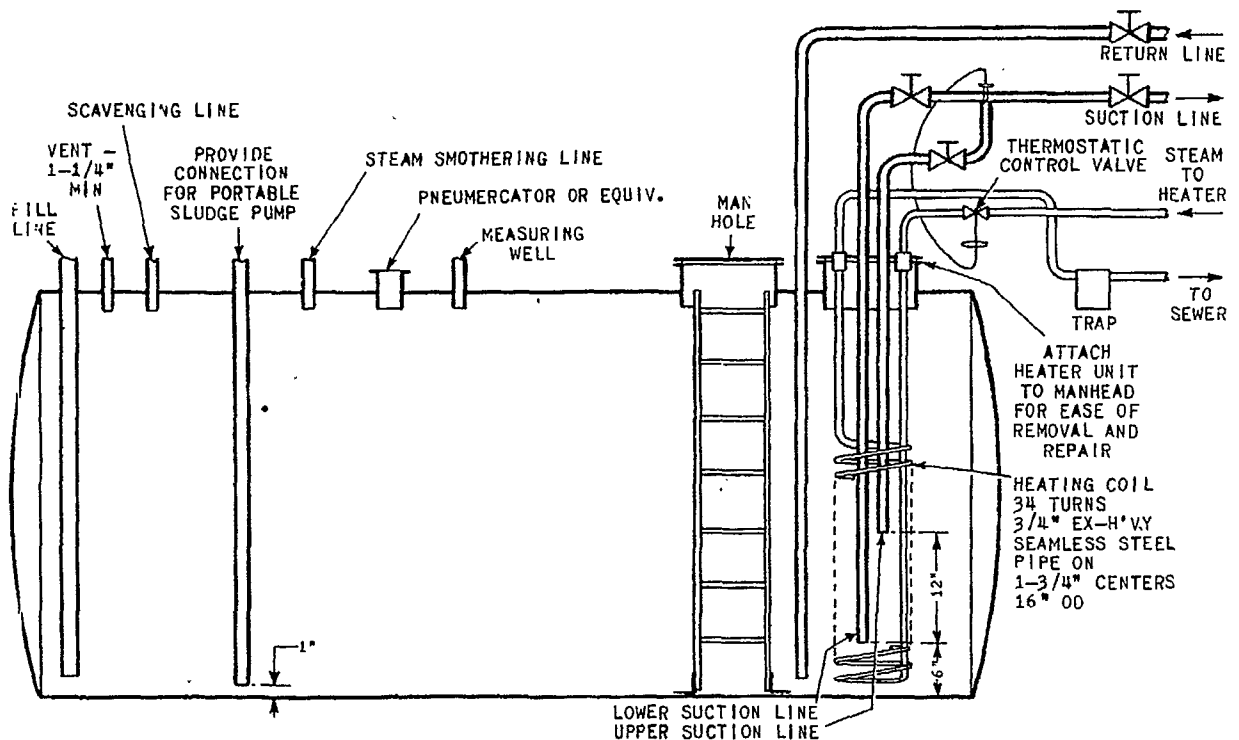
GAS PILOT LIGHT

Fig. 4



AIR PIPING & WIRING CONNECTIONS TO REAR WALL SCANNER & DOOR

Fig. 5



Piping immersed in oil tank should be of black steel.
All fittings should be of flanged type - no packed joints.
Lower suction line is normally used. Upper suction line to be used in emergencies to forestall shutdowns when water collects to level of lower suction line.
Arrangement should be checked against local Code regulations and revised if necessary.

TYPICAL ARRANGEMENT FOR STORAGE TANKS

Fig. 6

CONDENSED OPERATING INSTRUCTIONS

B&W FM-TYPE BOILER WITH BAILEY METER COMBUSTION CONTROL

FUEL AIR RATIO

PRECAUTION

If the unit has been tripped out due to operation of the Flame Failure Detector as shown by the red indicating light-alarm, to prevent an explosion when restarting thoroughly purge the furnace in accordance with Items (1) & (2) under SAFETY SHUT-DOWN.

Periodically check the oil and gas valves and piping for leakage. To reduce fire hazard, keep stuffing boxes on oil pump and valves free from oil drips. Dry tri-sodium phosphate is useful in cleaning oil spots and drips.

Blow down the water column and gage glass once each shift. Tripping the low water cut-out when blowing down the column may be prevented by limiting the blow so the water level does not drop to the trip out point or by having someone hold in PB-1 while blowing down the column.

Check the operation of the low water cut-out and the flame scanner each week.

On oil fired units, blow soot regularly in accordance with the instructions given in the boiler operating instructions.

STARTING UP - OIL FIRING

1. Fill the boiler up with water to center of glass. Release Feed Water Regulator Valve hand jack so that feed water control may operate automatically.
2. Open boiler outlet damper, if one is available.
3. Turn on air supply to control equipment.
4. Turn on ignition gas so that it is available up to the Ignition Gas Shut-Off Valves.
5. Turn on oil so that it is available to the oil pump.
6. If this boiler may fire either oil or gas, turn both Gas-Oil transfer valves to OIL and Gas-Oil switch TS-5 to OIL.
7. Insert oil burner with clean steam mechanical atomizing plate in atomizer. Open the oil hand valve at burner.
8. Check burner air doors operating handle to be sure that it is in its proper position for good combustion.
9. Turn on switches TS-1 and TS-2 to start oil pump and heater.
10. Turn Master Selector Valve to HAND. Adjust the Selector Valve to 8 psig control pressure.
11. Turn the Mech.-Y-Jet Transfer Valve to the MECH. position. This will position the fuel regulating valve to give at least 100 psig, oil pressure to the burner.

Page 2

STARTING UP - OIL FIRING (Cont'd)

12. When the oil temperature is above 130 F for No. 5 or 160 F for No. 6 oil, turn switch TS-3 to the HAND position to make sure the fan motor will start. Then turn the switch to the AUTOMATIC position.

13. Turn on switch TS-4 and push the low water reset button PB-1. The fan and program controller will start.

14. As soon as the fan starts push button PB-2 to by-pass the atomizing steam interlock. The program controller will then start the lighter and oil burner in sequence. The instruction Manual describes this operation in detail.

15. At this firing rate, it will take 45 minutes to 1 hr to bring the boiler up to 100 psig pressure.

16. When 100 psig steam pressure is reached, turn off switch TS-4 and replace the steam-mechanical atomizing assembly with the Y-jet atomizing assembly.

17. Check the operation of the feedwater regulator. If necessary warm up the generator by a short blow down.

18. Turn the Mech. Y-jet Transfer Valve to the Y-jet position. Adjust the Master Selector Valve to 5 psig control pressure. Turn on switch TS-4 and push button PB-1 to relight the burner. (Do not push button PB-2 when the Y-jet atomizer is installed, as it will result in the atomizing steam interlock being inoperative.)

19. When normal steam pressure is reached, place boiler on line and switch controls to automatic operation. This is done as follows:

(a) Make sure that Steam Pressure Controller is set to operate at and reads normal steam pressure.

(b) Transfer Master Selector Valve to AUTOMATIC as follows:

(b-1) Note reading of Selector Valve control pressure gage.

(b-2) Turn the transfer knob to its RESET position.

(b-3) Rotate the load adjusting knob until the control pressure reads the same as previously noted.

(b-4) Turn the transfer knob to AUTOMATIC. Do not leave the knob in RESET position any longer than is necessary to adjust the control pressure.

(b-5) If any difference exists between the readings of the loading and control pressure gages, equalize the pressures by slowly turning the load adjusting knob.

If the boiler load is below 25%, the control will operate the burner on a start-stop schedule. If the load is above 25%, the control will operate the burner continuously at a rate to hold the steam pressure for which the Pressure Controller set point pointer is adjusted.

STARTING UP - GAS FIRING

1. Fill boiler with water to center of glass. Release Feed Water Regulator Valve hand jack so that feed water control may operate automatically.

STARTING UP - GAS FIRING(Cont'd)

2. Open boiler outlet damper, if one is available.
3. Turn on air supply to control equipment.
4. Turn on gas so that it is available up to the Fuel Gas Shut-Off Valves and Ignition Gas Shut-Off Valves.
5. If this boiler may fire either oil or gas, turn both Gas-Oil transfer valve to GAS and Gas-Oil switch TS-5 to GAS.
6. Turn Master Selector Valve to HAND. Adjust the Selector Valve to 8 psig control pressure.
7. Turn switch TS-3 to the HAND position to make sure the fan motor will start. Then turn the switch to the AUTOMATIC position.
8. Turn on switch TS-4 and push button PB-1. Program Controller will start the fan, gas lighter and gas burner in sequence. The instruction Manual describes this operation in detail.
9. With these settings, it will take 45 minutes to 1 hr to bring boiler up to normal steam pressure. When normal steam pressure is reached, switch controls to AUTOMATIC as outlined above under "Starting Up-Oil Firing" item (19).
10. Check the operation of the Feedwater Regulator, if necessary warm up the generator by a short blow down.

SWITCH FROM OIL TO GAS FIRING

If the boiler is equipped to fire either gas or oil, and it is desired to switch from oil to gas, proceed as follows:

1. Turn off, in this order, switches TS-4, TS-2, and TS-1.
2. Shut off oil hand valve at burner and remove oil burner.
3. Turn Gas-Oil transfer valves to GAS and turn Gas-Oil switch TS-5 to GAS.
4. Light gas burner in accordance with procedure outlined above for Gas Firing

SAFETY SHUTDOWN

Safety interlocks are provided which will cause the boiler to shutdown if:

- (a)* Burner flame fails.
 - (b)* Forced draft fan fails.
 - (c) Boiler drum water level is too low.
 - (d)* Oil pump motor fails (oil burning only).
 - (e)* The lighter flame is too small to light the main burner.
 - (f)* The oil temperature is too low (oil firing only).
- * Red indicating light alarm lights

Page 4

SAFETY SHUTDOWN (Cont'd)

(g)* The atomizing steam is not sufficient for proper operation of the Y-jet atomizer.

If any of the above conditions occur, the Program Controller is cut out of service automatically. This action closes the Fuel Shut-Off Valves and turns off the fan motor.

In case of a safety shutdown which causes the red indicating light-alarm to light, proceed as follows:

1. Turn off switch TS-4.

2. Turn the Master Selector Valve to HAND. Adjust the Selector Valve to about 8 psig control pressure. Start the fan by turning switch TS-3 to the HAND position, and slowly open the damper by increasing the control pressure on the Selector Valve to 25 psig. Run the fan for about 5 minutes or longer in order to thoroughly purge the furnace of any unburned fuel or gases. Then turn switch TS-3 to the AUTOMATIC position and reduce the control pressure on the Selector Valve to return the damper to the starting position.

3. Check thoroughly for the cause of the shutdown. Remedy the cause before proceeding further. See "Trouble Shooting Chart" in the Instruction Manual to aid in finding the cause and remedy necessary.

4. After the cause for shutdown has been remedied, press the reset button on the program controller and start the boiler again as outlined above under STARTING UP.

In case of a safety shutdown caused by low water, restore the water to normal level and follow the procedure outlined under STARTING UP.

When the boiler is operating at loads less than 25% capacity, the control system will automatically start and stop the boiler through its own action. A safety shutdown may be determined at such loads if:

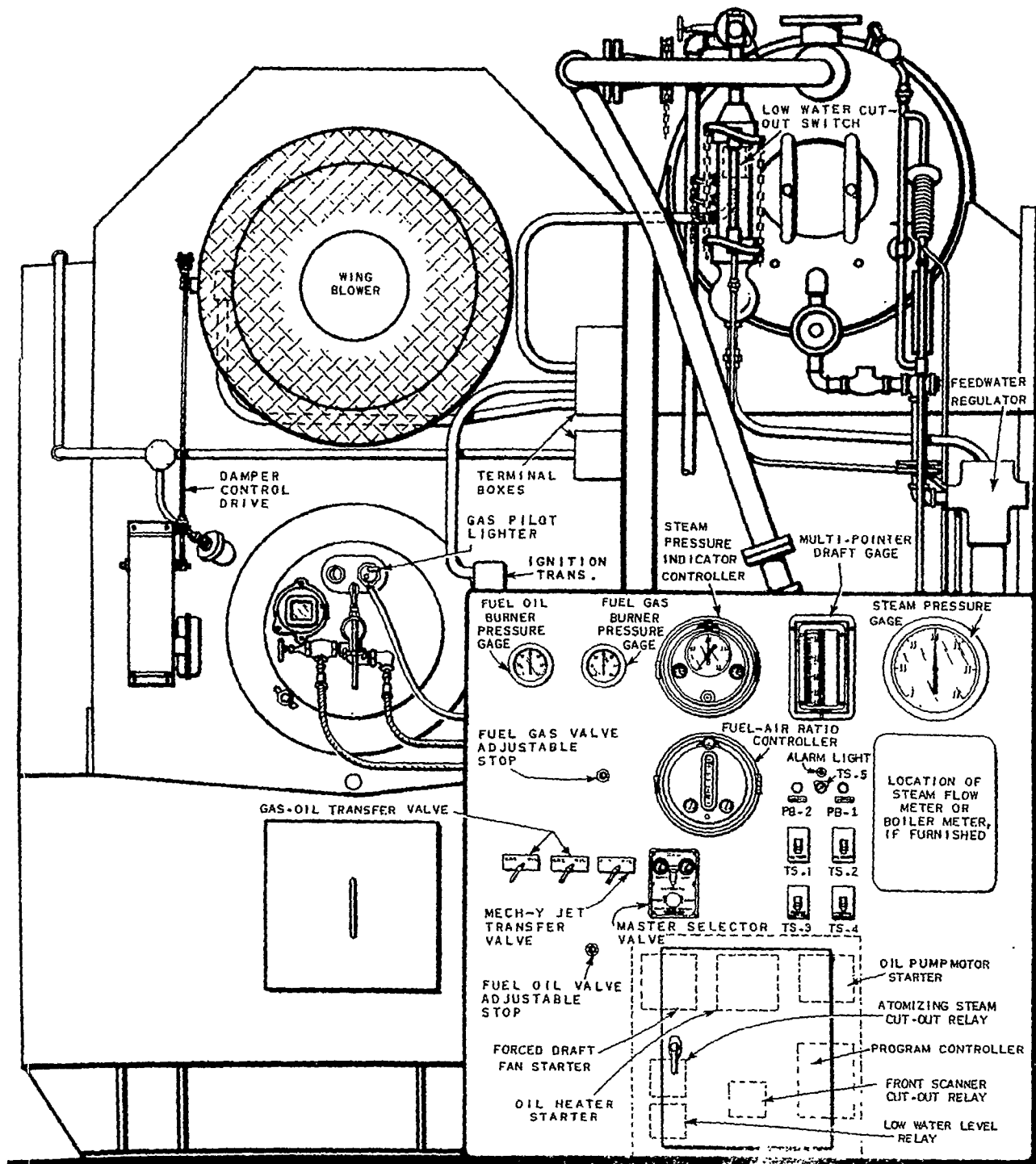
(a) On rising pressure, with the burner in operation, shutdown occurs before the steam pressure has risen to the point where the Steam Pressure Switch will trip out.

(b) On falling pressure, with the burner off, the boiler does not start up again automatically when the steam pressure has fallen to the point where the Steam Pressure Switch will close.

IMPORTANT

Read the Operating Instructions Manual for necessary maintenance and for detailed instruction on the operation of this system.

* Red indicating light alarm lights



FRONT ELEVATION OF FM BOILER
BAILEY METER CO. FUEL-AIR RATIO TYPE CONTROL