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CLEAVER-BROOKS MODELS

CSB, S & CR

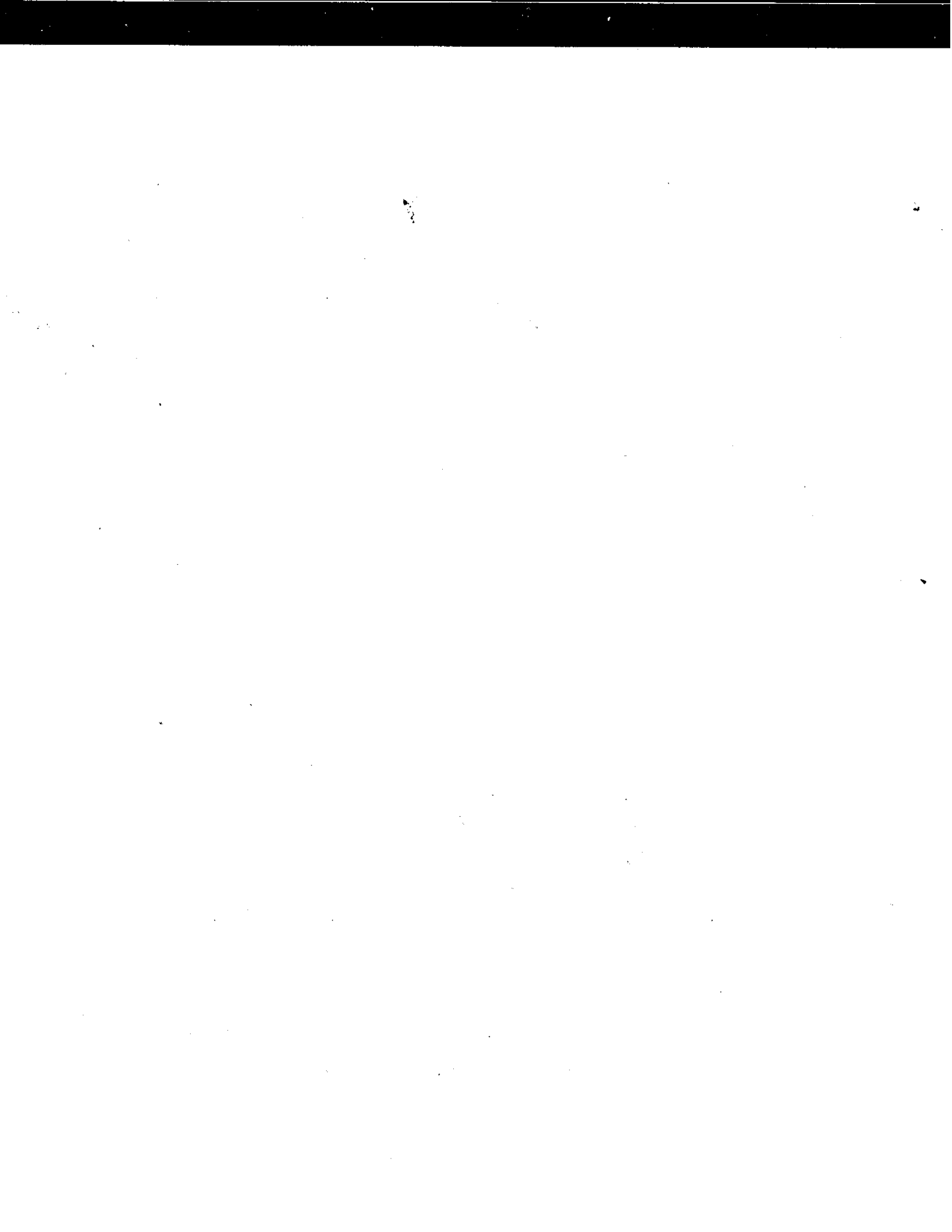
ELECTRIC BOILERS

**Operation,
Service
and Parts
Manual
Steam**

Manual Part No. 750-137

Cleaver-Brooks

**DIVISION OF AQUA-CHEM, INC.
Milwaukee, WI, U.S.A.**



**CLEAVER-BROOKS
MODELS CSB, S and CR
ELECTRIC BOILERS**

OPERATION, SERVICE AND PARTS MANUAL

STEAM



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Your Local Cleaver-Brooks
Authorized Representative**

MANUAL PART NO. 750-137

Printed U.S.A.



TO: OWNERS, OPERATORS OR MAINTENANCE PERSONNEL

No attempt should be made to operate until the principles of operation and all of the components of the unit, plus the entire system and allied equipment, are thoroughly understood.

This instruction and maintenance manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed.

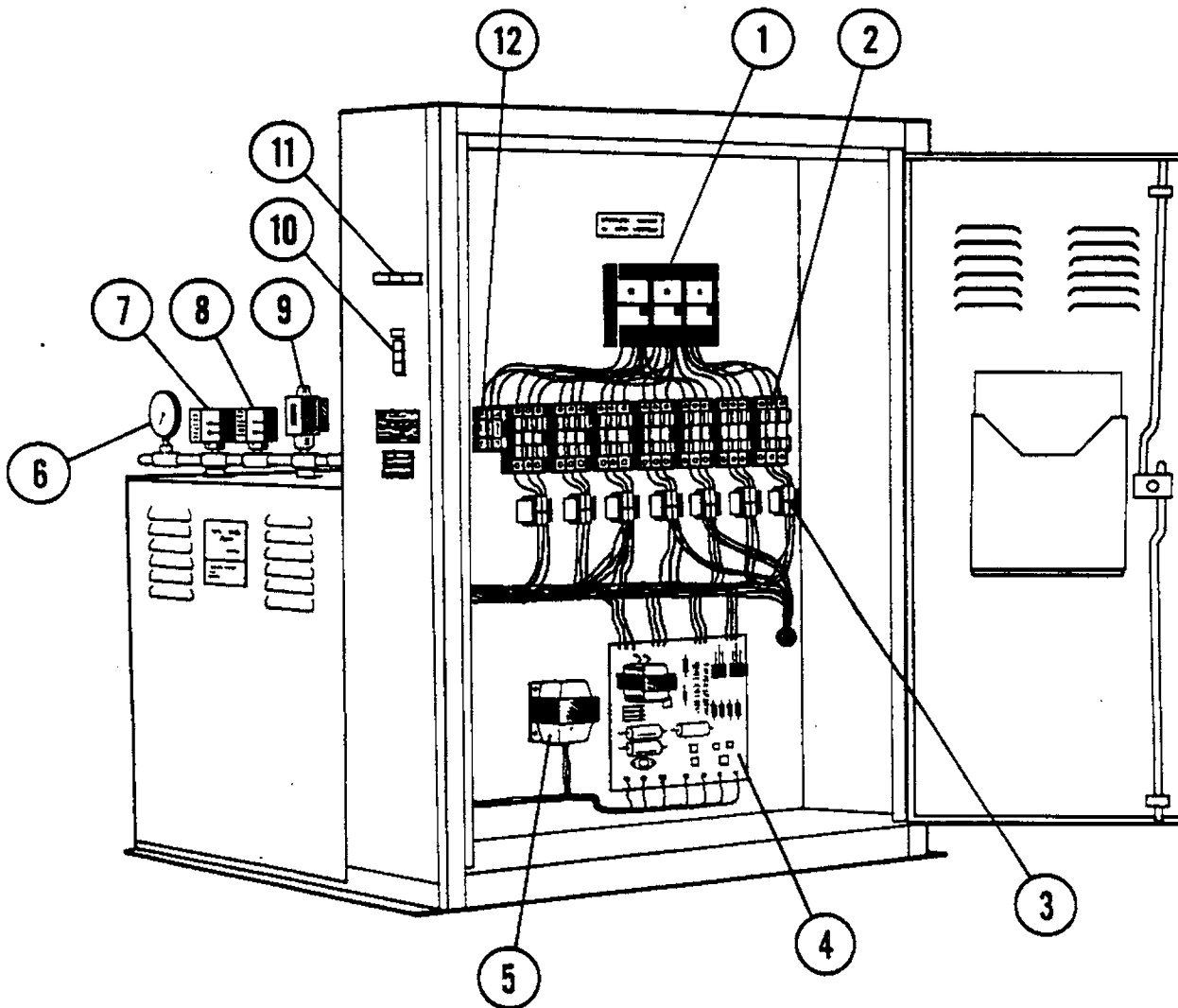
Cleaver-Brooks boilers are designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied were chosen because of their known ability to perform, however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of the equipment is not to be considered free from the hazards inherent in handling electricity, pressurized hot water and steam.

It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation or the application of timely preventive maintenance.

It is recommended that a boiler room log or other permanent record be maintained. Recordings of daily, weekly, monthly and yearly maintenance activities and recording of any unusual operation will serve as a valuable guide to any necessary investigation.

It is customary to engage the services of a qualified water treatment company or a water consultant to recommend the proper water treating practices. Contact your local Cleaver-Brooks authorized Representative for details about Cleaver-Brooks Water Treatment services.

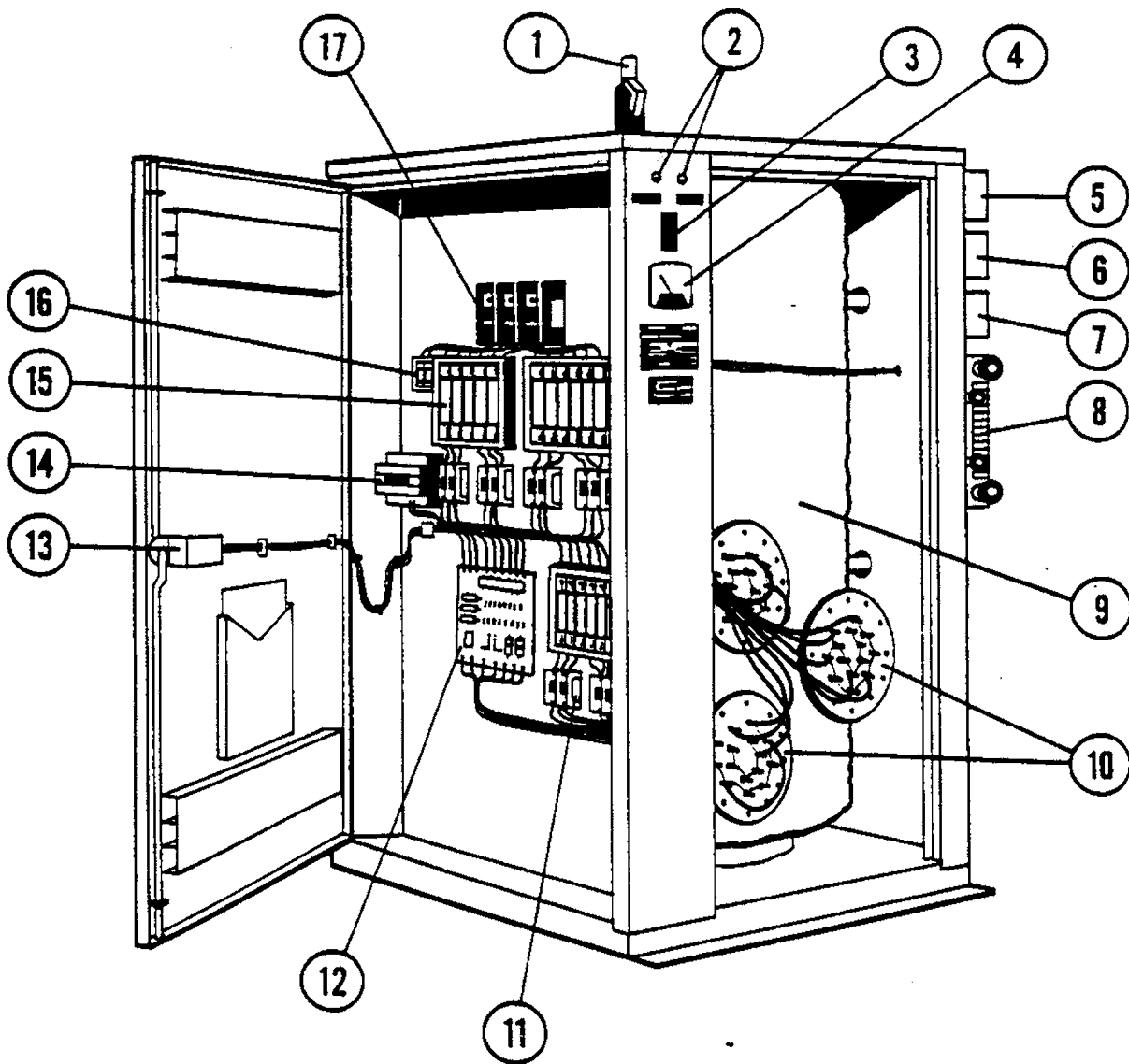
The operation of this equipment by the owner and his operating personnel must comply with all requirements or regulations of his insurance company and/or any other authority having jurisdiction. These legal requirements take precedence over anything contained herein.



**FIGURE 1 — ELECTRIC STEAM PACKAGE BOILER
MODEL CSB-121 THROUGH-240**

STANDARD FEATURES

- | | |
|---|---|
| <ul style="list-style-type: none"> 1. Main Supply Lugs 2. Branch Circuit Fusing 3. Integral Magnetic Contactors 4. Step Control 5. 120V Control Transformer 6. Pressure Gauge 7. Pressure Limit — Manual Reset 8. Pressure Limit — Auto Reset | <ul style="list-style-type: none"> 9. Pressure Control 10. Pilot Switch 11. Control and Limit Circuit Pilot Lights 12. Primary Transformer Fusing <p>NOT SHOWN</p> <ul style="list-style-type: none"> Safety Valve Water Level Gauge Glass Heating Element Assemblies |
|---|---|



**FIGURE 2 – ELECTRIC STEAM PACKAGE BOILER
MODELS CSB-301 THROUGH 422 AND S-120 THROUGH 480**

STANDARD FEATURES

- | | |
|--|--------------------------------|
| 1. Safety Valve(s) | 13. Safety Door Interlock |
| 2. Pilot Lights: Control Power & Limit | 14. 120V Control Transformer |
| 3. Pilot Switch: Control Circuit | 15. Branch Circuit Fusing |
| 4. Ammeter | 16. Primary Transformer Fusing |
| 5. Pressure Limit — Manual Reset | 17. Main Supply Lugs |
| 6. Pressure Limit — Auto Reset | |
| 7. Pressure Control | |
| 8. Pump Control/Low Water Cut-Off | |
| 9. Pressure Vessel | |
| 10. Heating Element Assemblies | |
| 11. Magnetic Contactors | |
| 12. Step Control | |

NOT SHOWN

- Automatic Blowdown Timer
- Bottom Blowdown Valve(s)
- Water Column Blowdown Valve

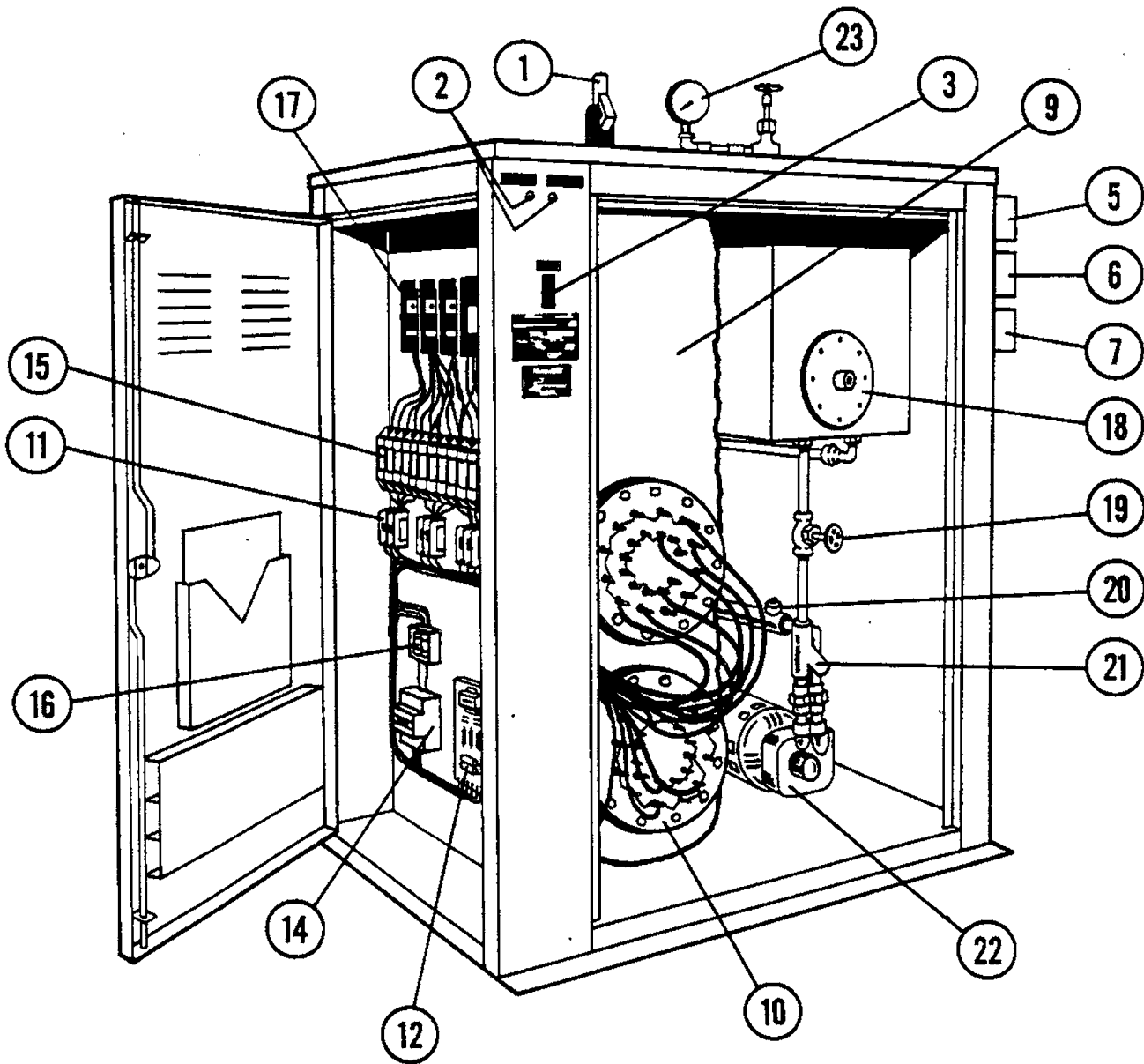
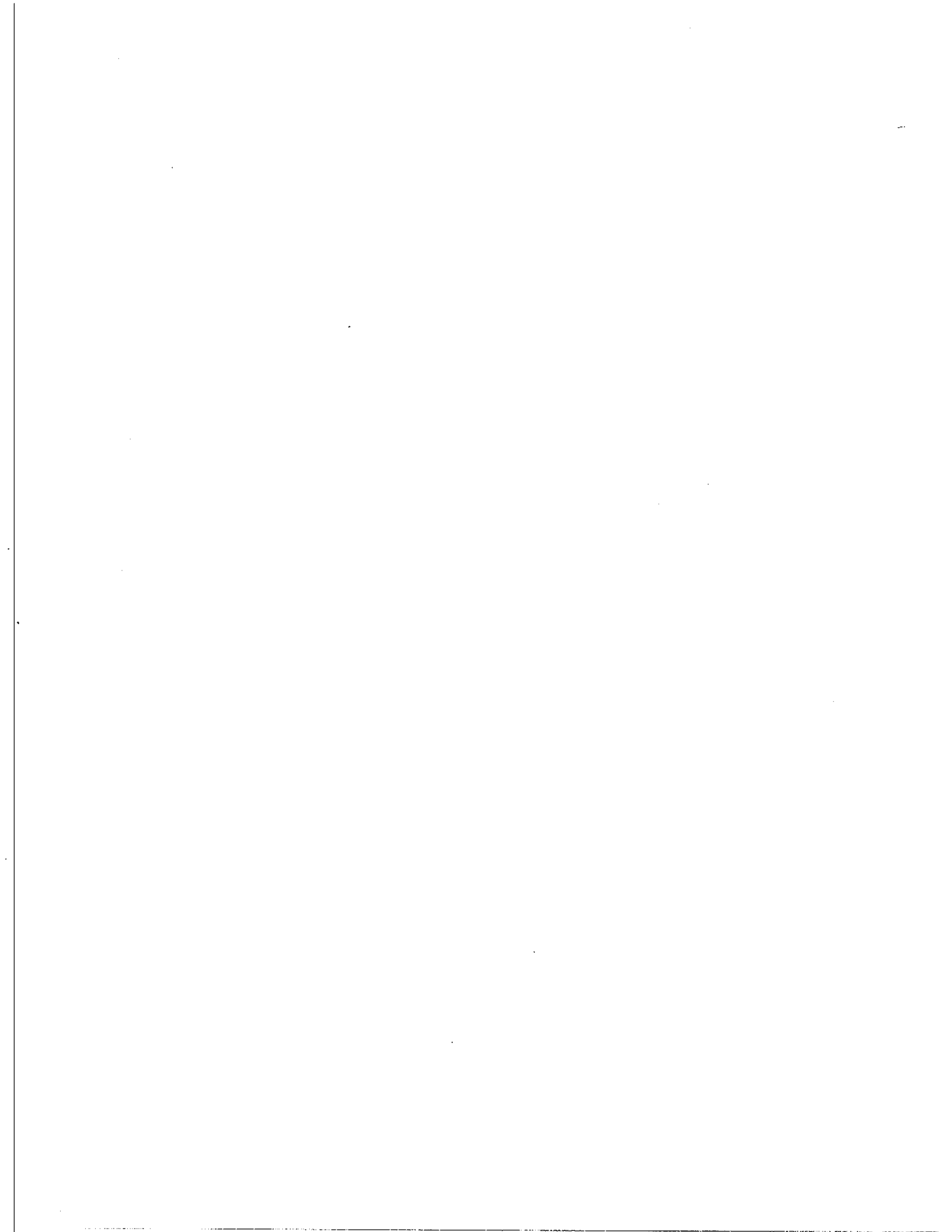


FIGURE 3 — ELECTRIC STEAM PACKAGE BOILER MODEL CR
STANDARD FEATURES

- | | |
|---|---|
| 1. Safety Valve | 13. Blowdown Valve (Not Shown, Opposite Side) |
| 2. Control and Limit Circuit Pilot Lights | 14. 120V Control Transformer |
| 3. Pilot Switch | 15. Branch Circuit Fusing |
| 4. Water Level Gauge Glass (Not Shown) | 16. Control Circuit Fusing |
| 5. Pressure Limit — Manual Reset | 17. Main Supply Lugs |
| 6. Pressure Limit — Auto Reset | 18. Water Feeder |
| 7. Pressure Control | 19. Stop Valve |
| 8. Low Water Cut-Off (Not Shown) | 20. Check Valve |
| 9. Insulated Pressure Vessel | 21. Y-Strainer |
| 10. Heating Element Assemblies | 22. Boiler Feed Pump |
| 11. Integral Magnetic Contactors | 23. Pressure Gauge |
| 12. Step Control | |

Table of Contents

CHAPTER 1	1-1
<hr/>	
GENERAL DESCRIPTION	1-1
A. Introduction	1-1
B. Application	1-2
C. Description	1-2
D. Principles of Operation	1-4
CHAPTER 2	2-1
<hr/>	
INSTALLATION INSTRUCTIONS	2-1
A. Receiving Inspection	2-1
B. Location	2-1
C. Piping	2-1
D. Electrical	2-2
CHAPTER 3	3-1
<hr/>	
PRE-START PREPARATION	3-1
A. Inspection	3-1
B. Boiler and System Cleaning	3-2
C. Boiler Water Treatment	3-3
CHAPTER 4	4-1
<hr/>	
OPERATING INSTRUCTIONS	4-1
A. Initial Start-Up	4-1
B. Control Adjustment	4-2
C. Blowdown	4-3
D. Maintenance	4-4
E. Element Replacement Procedure	4-5
CHAPTER 5	5-1
<hr/>	
TROUBLESHOOTING	5-1
CHAPTER 6	6-1
<hr/>	
PARTS/ORDER LIST INSTRUCTIONS	6-1



CHAPTER 1

GENERAL DESCRIPTION

- A. Introduction
- B. Application
- C. Description
- D. Principles of Operation

A. Introduction

1. Safety Precautions

A complete understanding of this manual is required before attempting to operate or maintain the equipment.

It is essential to read and understand all safety precautions before attempting to operate the equipment.

Failure to follow these precautions may result in damage to equipment, serious personal injury or death!

The equipment should be operated and maintained only by personnel who have read this manual and who have a working knowledge and understanding of the equipment.

!WARNING

Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION!

Indicates a potentially hazardous situation which, if not avoided, could result in damage to the equipment.

NOTE: This symbol indicates information that is vital to the operation of this equipment.

2. Abbreviations

Following is an explanation of the abbreviations, acronyms, and symbols used in this manual.

ASME	American Society of Mechanical Engineers
AR	Automatic Reset
BHP	Boiler Horsepower
BTU	British Thermal Unit
C	Degrees Celsius
Hz	Hertz
F	Degrees Fahrenheit
FT	Feet
GPM	Gallons Per Minute
Ht	Height
KW	Kilowatt
Lb	Pound

LWCO	Low Water Cut Off
MR	Manual Reset
pH	Measure of the degree of acid or base of a solution
P/N	Part Number
PPB	Parts Per Billion
PPM	Parts Per Million
PSI	Pounds Per Square Inch
T	Temperature
TC	Temperature Control
TI	Temperature Gauge
ws/i	Watts Per Square Inch

B. Application

The Cleaver-Brooks models CSB, S and CR are Immersion Element Steam Boilers designed for the heavy duty, continuous demand of commercial and industrial applications. They can be used as a primary, supplementary, or auxiliary source of steam for space and process heating. The model CSB comes equipped with a 75 wsi Incoloy element. The models S and CR come equipped with a 67 wsi Incoloy element.

C. Description

Typical Cleaver-Brooks Models CSB, S and CR Steam Boilers are described in Figures 1, 2 and 3, respectively. Illustrated are packaged steam boilers with either horizontal or vertical insulated vessels. The boilers include control cabinets mounted on a common base, and operating controls, elements, fuses, contactors, safety valve, and instrumentation. All boilers are wired, piped, tested, and ready for installation.

The vessel construction complies with ASME Boiler & Pressure Vessel Code — either Section I “Power Boilers,” or Section IV “Low Pressure Heating Boilers.” Section I vessels are either “M” stamped for 100 psi design and up to 90 psi operating pressure (Models CSB-121/122/160, and S & CR-120 thru -162) or “S” stamped for operation and design pressures of 125 psi or

more. Section IV vessels have the “H” stamp for 15 psi design for 13 psi maximum operating pressure. All boilers are National Board Inspected and registered, and are UL listed.

Refer to the Dimension Diagram (DD) and Wiring Diagram (WD) prepared by Cleaver-Brooks for your specific installation.

The following items are standard on all Cleaver-Brooks Electric Steam Boilers:

1. Main Lugs for Supply Circuit

Standard boilers are supplied with solderless wire connectors suitable for copper supply wires. The main lugs are mounted on distribution busses that provide individual connections for each heating element circuit. Standard boilers are designed for top connection to main power supply.

2. Supplemental Internal Protection Fuses

Boilers are provided with supplemental internal protection fuses rated at approximately 125% of the element circuit load. These current-limiting cartridge fuses have a minimum 200,000 ampere interrupting capacity to provide protection for the element circuit wiring.

3. Built-In Magnetic Contactors

All boilers use definite purpose magnetic contactors designed for use with resistance heating loads. Contactors are rated for at least 50 amps resistive load and a minimum of 500,000 duty cycles.

4. Heating Elements

Standard heating elements are Incoloy sheathed and rated at 75 watts per square inch (Model CSB), or 67 wsi (Models S and CR). These elements are individually replaceable, except on Models CSB-121 through 240, which use 4-bolt flange elements in 3-element clusters.

5. 120 Volt Control Circuit

All boilers have 120 volt control circuits. Control circuit transformers with primary fusing and grounded secondary are provided on all models, except when customer specifies a 208/120 volt,

3 phase, 4 wire configuration. All boilers have 120 volt control circuits and are available for either 50 or 60 Hz.

6. Customer Control Interlock Connection

A terminal strip is provided on all boilers for connection of the customer's control devices and interlocks.

7. High Pressure Cutoff

All standard boilers with more than 2 control steps are supplied with one automatic-resetting and one manual-resetting high pressure cutoff. These normally are set at 10% and 5% below the safety valve set pressure respectively, unless otherwise specified. On smaller boilers, one auto-resetting high pressure cutoff is standard as a back-up to the limit duty rated pressure control.

8. Water Level Controller/Low Water Cutoff

An automatic resetting, float type, combination low water cutoff and water level controller is installed on each Cleaver-Brooks electric steam boiler. If the vessel water level drops, the controller closes a switch, which may be used to operate either a feed-pump relay or feedwater solenoid valve. If the water level drops below the cutoff level, the heating elements are de-energized by the controller until the water level returns to operating level.

9. Pressure Control System

Boilers with 1 and 2 stages of control are standardly provided with on-off pressure controls. Larger boilers are provided with a solid state, proportional, modulating step-type pressure control system. As the system steam pressure varies, the pressure control system proportions the input power to the boiler demand, by increasing (or decreasing) the number of heating element groups (steps) in use.

Both control systems (on-off and proportional) have adjustable pressure ranges. The on-off controls have fixed differentials. The proportioning controls have adjustable proportioning ranges.

The proportional solid state electronic sequencers also have an adjustable time delay between steps varying from 1 to 15 seconds. These adjustable controls enable the boiler to be tuned to the system it regulates in order to optimize boiler responsiveness and system operation.

The controller features rapid recycling after power interruption. When power is restored, the boiler starts with all elements off. To prevent current surges, the step control ensures that the element groups are switched on, one at a time.

10. Pilot Switch and Pilot Lights

Pilot lights are standardly provided to indicate "power on," "high pressure," and "low water."

11. Safety Valve

The safety valve is properly sized according to the boiler's electrical rating and per ASME and National Board.

12. Built-in Condensate/Make-up Tank and Feedpump (Model CR boilers only)

This includes a condensate return tank and feedwater pump, completely wired and piped. The condensate return tank is provided with a float-type make-up valve, drain valve, and the necessary condensate return, vent, and overflow connections.

13. The following optional equipment can be furnished by Cleaver-Brooks.

Your Dimension Drawings (DD) and Wiring Diagrams (WD) will show the optional equipment on your boiler.

1. Manual reset low water cutoff
2. Auxiliary low water cutoff (manual or auto-reset)
3. Low pressure alarm
4. Pilot lights for individual steps
5. Toggle switches to enable/disable individual steps

6. Solid state progressive sequencing step control
7. Preheat switch
8. Manual load limiter
9. Pneumatic control interface
10. Demand limiting controls or interface
11. Control cabinet door interlock
12. Boiler disconnect switch or circuit breaker (with or without shunt trip; shipped loose for field mounting)
13. Ground fault detection
14. Ammeter, voltmeter or KWH meter
15. Audible alarm circuit (with or without horn/silence push button)
16. Automatic surface blowdown system

power applied to these elements is converted into heat and conducted into the surrounding water. Steam bubbles form at the element surface and then rise to the steam space at the top of the vessel.

Controls are provided in order to match the input of electricity with the load requirements of the system. Heating elements are switched on and off by magnetic contactors in response to the pressure control system. The simplest pressure control consists of a single pressure activated switch that energizes all heating elements simultaneously. This on-off control is suitable for small steam boilers (single stage). For 2-stage boilers, two pressure controls are used to provide on-off switching of selected element groups at different settings.

The close control of boiler output demanded by large, complex, or critical steam systems requires the use of fully modulating step controls. To proportion input power to steam demand, these modulating step controls select the number of heating element groups, or steps, in sequence, in order to maintain the desired steam pressure.

D. Principles of Operation

Immersion element steam boilers consist of a number of resistance-type heating elements assembled within a pressure vessel. Electrical

CHAPTER 2

INSTALLATION INSTRUCTIONS

- A. Receiving Inspection
- B. Location
- C. Piping
- D. Electrical

!WARNING

Installation should be performed only by qualified personnel who are familiar with this equipment. Failure to heed this warning may result in serious personal injury or death.

Before proceeding, make sure you have read and understand the contents of this manual. Failure to do so may result in serious personal injury or death.

A. Receiving Inspection

Each Model CSB, S and CR Boiler is completely inspected at the factory and carefully packaged for shipment. Inspect the packing for signs of exterior damage. After placing the unit as close as possible to the point of actual installation, carefully uncrate and check all boxes and cartons against the packing slip. In case of damage or shortage, notify the carrier immediately.

B. Location

Consult local codes for specific requirements. Refer to the Dimension Drawings (DD) and Wiring Diagram (WD) prepared by Cleaver-Brooks for your specific installation. Position the boiler to provide adequate clearance on all sides for necessary access when operating and servicing the boiler.

Set the boiler on a strong foundation and make sure it is level. The boiler must be level so that the water gauge glass indicates the true water level and so that the water level controller functions properly.

C. Piping

Install the steam and water lines according to the job requirement.

The steam piping from the boiler to the point of steam use must be pitched to assure proper drainage of condensate formed in the steam line. If possible, pitch the horizontal runs away from the boiler and provide a drip leg at the end of the run and at any other low point so that the condensate runs away from the boiler.

A condensate return line must be installed with a minimum pitch of 1/4 inch per foot toward the condensate receiver.

When a direct water feed is used, the water supply main must have a pressure of at least ten pounds greater than the maximum pressure at which the boiler is to be operated. A solenoid valve is usually required to control the flow of feedwater to the boiler. Solenoid valves should be sized to feed the boiler at twice the steaming rate (#/hr. divided by 500 = steaming rate in gpm). The coil should be the same voltage as the boiler control circuit (refer to the Wiring Diagram).

It is advisable to insulate steam and condensate return lines to minimize heat loss. This should be done after leak testing has been completed.

!WARNING

Discharge from the boiler blow-down and safety valves is hot and could burn or scald personnel. It is of the utmost importance that these valves are piped to a safe point of discharge, and that pipes are insulated or guarded to prevent burns due to accidental contact, serious personal injury or death. The piping for all blowdown must be the same size as the blowdown valve.

NOTE: These water and steam pipe installation instructions are for your guidance only. In all piping installations, be sure to check that the piping is in accordance with applicable federal, state, and local codes, regulations, and other statutory requirements.

It is recommended that a vacuum breaker be installed in the steam line when a condensate return system is being used. The breaker will prevent flooding of the boiler during shutdown.

D. Electrical

!WARNING

Lock out and disconnect main power before proceeding with electrical installation in order to avoid the hazard of electrical shock, which could cause serious personal injury or death.

The procedures listed here are based on requirements of the National Electrical Code. Local electrical codes and/or boiler codes may require slightly different procedures. It is therefore recommended that the electrical installation be performed under the supervision of a qualified and licensed electrical contractor familiar with local codes and inspection procedures.

Typical electric steam boilers are designed for top connection to the main supply lugs and are supplied with solderless wire connectors suitable for copper supply wires.

If aluminum supply wires are selected, Cleaver-Brooks strongly recommends that the installing electrical contractor splice a short length of copper wire to the aluminum supply conductors and terminate this copper wire in the main supply lugs on the unit. If copper splices are not used and the customer chooses to terminate the aluminum supply wires directly in the main supply lugs, the following procedure should be carefully adhered to:

1. An oxide inhibitor paste should be applied liberally to the conductors.
2. The main supply lugs should be tightened (with the power off) every 24 hours for the first week of operation.
3. After the first week, the main supply lugs should be tightened (with power off) once every 30 days.

WARNING

Before tightening the main supply lugs, lock out and disconnect main power to avoid the hazard of electrical shock, which could cause serious personal injury or death.

CAUTION!

Main supply lugs should be tightened every 24 hours during the first week of operation in order to avoid damage to the equipment.

Power wiring should be selected for high temperature use (minimum wire rating, 75 deg.C per National Electrical Code) and/or per local electrical codes.

Electrical Installation Checklist

1. Check all electrical connections for tightness. Vibration during transit sometimes loosens connections.
2. Check the boiler nameplate for the boiler kilowatt rating, frequency, voltage, amperage and to determine whether it is single or three phase.
3. Check the electrical supply voltage to verify that it conforms to the boiler requirements, and that sufficient circuit capacity is available for the boiler.
4. Refer to the Wiring Diagram (WD) prepared by Cleaver-Brooks for your specific installation for the number and rating of supply circuits required by the boiler.
5. Refer to the Wiring Diagram (WD) prepared by Cleaver-Brooks for your specific installation for proper wire and conduit sizes for these ratings.
6. Install the wiring to the boiler and connect it to the main supply lugs as indicated on the boiler Wiring Diagram (WD).
7. All Cleaver-Brooks Electric Steam Boilers are supplied with factory-mounted magnetic contactors. All internal circuits are factory installed and tested.
7. The external solenoid valves for the feedwater supply may be connected to the boiler control circuit. Refer to the boiler Wiring Diagram (WD) for details and voltage.
8. If an external feedwater pump is to be used, it will require a separate electrical supply circuit and a magnetic motor starter (coil not to exceed 25-VA). This circuit can be controlled through the unit control circuit. CR Series boilers have a built-in boiler feed pump and controls.

WARNING

On boilers requiring more than one supply circuit, be sure that phasing is correct and circuits are not "mixed" before energizing in order to avoid the hazard of electrical shock, which could cause serious personal injury or death.

10. Upon completion of all installation work, recheck all of the connections for tightness and test for correct control circuit operation as described in Chapter 4 of this manual.

CHAPTER 3

PRE-START PREPARATION

- A. Inspection
- B. Boiler and System Cleaning
- C. Boiler Water Treatment

!WARNING

Make certain that you have read and understand Chapters 1 and 2 before proceeding. Failure to do so may result in serious personal injury or death.

Pre-startup should be performed by a qualified technician who is familiar with this equipment. Failure to heed this warning may result in serious personal injury or death.

A. Inspection

Boilers which have been exposed to dust or wet or humid conditions must be thoroughly cleaned and dried out. The buildup of dust and rust on the contactors or moisture at the terminal end of the elements may result in severe damage. The following precautions must be taken:

!WARNING

Lock out and disconnect the main power to avoid the hazard of electrical shock, which could result in serious personal injury or death.

1. Make certain all electrical connections and element terminals are thoroughly cleaned, dried, and tightened.
2. Inspect all contactors, fuse bases, and wire bundles for stray or loose metal objects (screws, bolts, metal shavings, knockout slugs, etc.) that may lodge there. All such material must be removed before startup.
3. There is a very high probability that, during shipment or storage prior to operation, the elements will accumulate moisture. The moisture will turn to steam when the elements are turned on, rupturing the element casing.

CAUTION!

Moisture in the elements may result in damage to the elements.

!WARNING

Lock out and disconnect the main power before measuring with an ohmmeter in order to avoid the hazard of electrical shock, which may result in serious personal injury or death.

To check for this condition, take a reading with an ohmmeter between one of the contactor terminals (load side) to ground for each contactor. If the reading is less than 17,000 ohms for standard 3-phase connection, or 50,000 ohms for a single element, remove the fuses going to that contactor. The fuses should be removed so that, during the first day of operation, the effected element will not be energized allowing the hot boiler to drive the moisture out at a controlled rate.

There are alternate heating methods. Direct a heat lamp at the offending elements or remove the element assembly, bake it in a 200 degree F. oven for 8 hours, then reinstall and rewire. Following any of these procedures, the suspect element then may be put in operation by replacing the fuses after the elements have been rechecked with an ohmmeter.

B. Boiler and System Cleaning

The entire steam system must be cleaned prior to startup. No matter how carefully a system is installed, it will be contaminated with pipe dope, thread cutting oils, soldering flux, rust preventatives, core sand, welding slag, and dirt, sand, or clays.

Cleaning a hot water system (either steel or copper piping) is neither difficult nor expensive. The three most common materials used for cleaning are:

- a. Trisodium Phosphate (TSP)
- b. Sodium Carbonate
- c. Sodium Hydroxide (Lye)

Their preference is in the order named. Prepare the cleaning solutions as follows, do not mix different types of cleaners together.

- a. Trisodium Phosphate: One lb. for each fifty gallons in the system.

NOTE: Check local codes for restrictions on use of TSP.

- b. Sodium Carbonate: One lb. for each thirty gallons in the system.

- c. Sodium Hydroxide: One lb. for each fifty gallons in the system.

NOTE: Do not use Sodium Hydroxide for copper or galvanized systems.

!WARNING

Cleaning compounds are hazardous and protective clothing and face and eye protection must be used when mixing or handling chemicals and chemical solutions in order to avoid serious personal injury or death.

Fill, vent, and circulate the system with one of the solutions, allowing it to reach operating temperatures if possible. After circulating for three hours, drain the system completely and refill it with fresh water. Usually enough of the cleaner will adhere to the piping to give an alkaline solution satisfactory for operation. A pH reading between 8.5 and 9.5 is preferred, and a small amount of cleaner can be added if necessary to raise the pH value.

There are definite indications of an unclean system. Here is a check list. If any of these conditions occur when filling the system, the boiler and associated system piping need cleaning.

1. Obviously discolored, dirty water.
2. A pH or alkalinity test that gives a pH test reading below 7. (Below 7 indicates the water in the system is acidic and corrosive.)
3. The appearance of dirty foam or scum lines of the surface.

In some cases, there are sufficient quantities of such materials to break down chemically during the operation of the system causing gas formation and acidic system water. All such materials should be removed.

Hot water systems, in most cases, naturally operate with a pH of 8.5 or higher. If a system indicates pH values below 7 on the scale the following symptoms may occur:

1. Gas formation in system.
2. Pump seal and gland problems.
3. Air vent sticking and leaking.
4. Piping leaks at the joints.

If system deterioration is permitted and leaks develop and water losses increase, it is possible to cause serious damage to the boiler. Therefore, it's important to have a closed system that is clean, neutral, and water tight.

C. Boiler Water Treatment

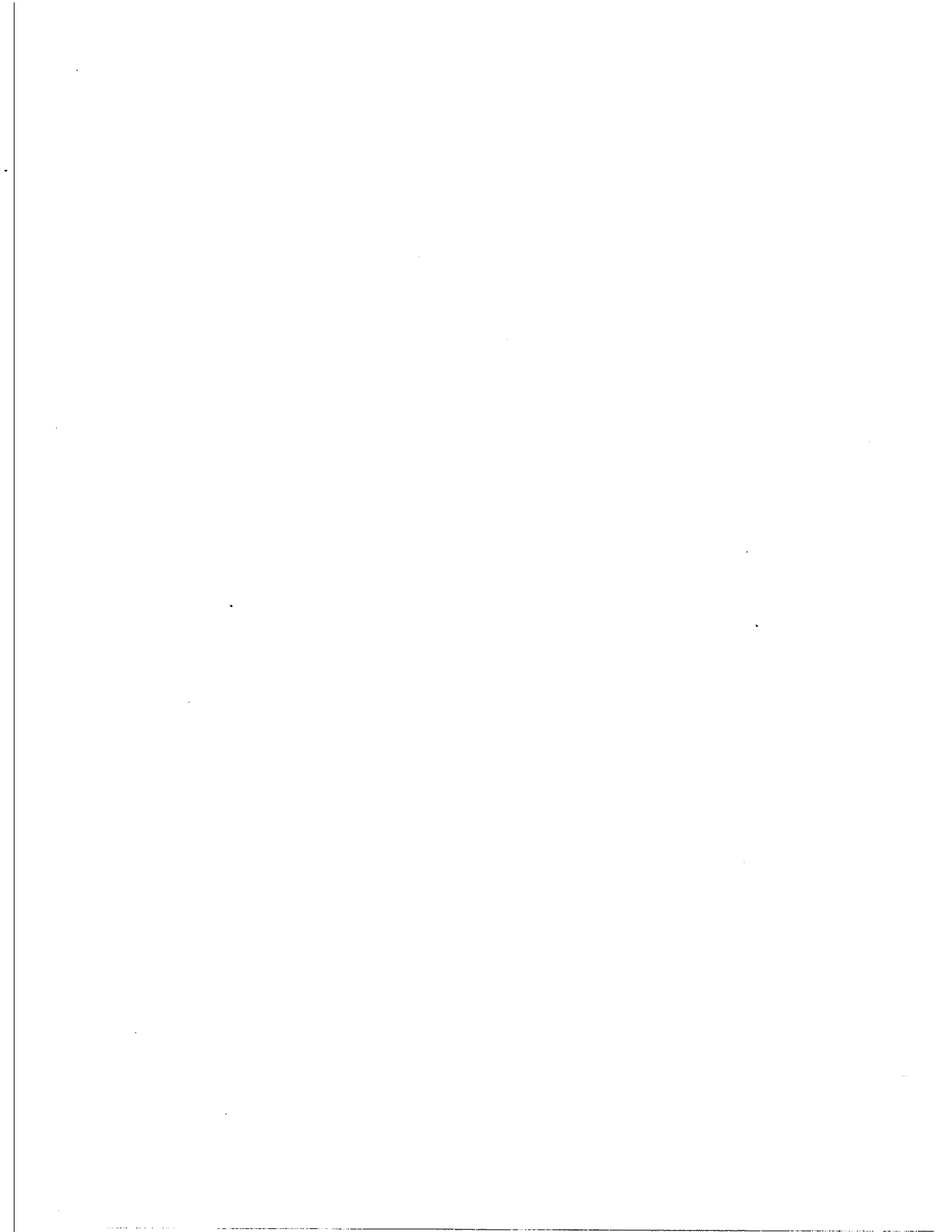
The recommended water quality to facilitate keeping the boiler clean and to prevent corrosion and scaling is:

Hardness	3 PPM maximum
pH	Value 8-9.5
Total Alkalinity	600 PPM maximum
Total Dissolved Solids	3,000 PPM maximum
Iron Content	5 PPM maximum
Oxygen Content	.00 PPB maximum
Total Silica	150 PPM maximum

These recommended guidelines do not include all dissolved minerals. For more information about maintaining water quality, contact your Cleaver-Brooks local representative.

The purchaser should be sure that the boiler is not operated for long periods for approval tests, temporary heat, or any other operations without water treatment. It also should be noted that water boilers will need chemical treatment for the first filling of water and additional periodic chemical treatment.

Water treatment may vary from season to season or over a period of time; therefore, there should be a requirement that the water treatment procedure be checked no less than four times a year, and possibly more frequently, as the local water conditions may require.



CHAPTER 4

OPERATING INSTRUCTIONS

- A. Initial Startup
- B. Control Adjustment
- C. Blowdown
- D. Maintenance
- E. Element Replacement Procedure

!WARNING

Make certain all startup procedures listed in Chapter 3 have been completed prior to proceeding. Failure to heed this warning could result in serious personal injury or death.

!WARNING

Before gaining access to any electrical wiring or controls, disconnect and lock out the main power to the boiler to avoid the hazard of electrical shock, which could result in serious personal injury or death.

A. Initial Start-Up

1. Close the control cabinet doors.
2. Close all blowdown valves and steam outlet valves, including the gauge drain valves and the water level controller.
3. Close the main power switch(es).
4. Turn on the pilot switch to energize the control circuit. Both the white "power on" and the red "low water" pilot lights will light.
5. Monitor the gauge glass until the water nears the halfway mark on the glass and the red, low water alarm light de-energizes.

NOTE: On CR model boilers, the boiler feed pump may be capable of pumping water from the condensate receiver into the boiler faster than the make-up water feeder can handle. Therefore, on initial start-up of the CR boilers, it may be necessary to fill the boiler vessel by intermittently turning the pilot switch off and on to allow the make-up water feeder in the boiler condensate receiver to catch up. Under normal operation, when condensate is being returned to the receiver, the make-up feeder will adequately maintain the water level in the receiver.

6. Listen for the contactors to snap closed, which indicates that the elements are being energized.
7. Monitor the pressure and the water level.
8. When the pressure reaches the operating setting of the pressure controller, the contactors will start to drop out.
9. The boiler now can be placed in service by slowly opening the steam outlet valve. Adequate draining and slow warming of the piping will help to avoid water hammer and excessive temperature gradients in the piping.

B. Control Adjustment

The operating pressure and the high pressure limits have been set at the factory to comply with the customer's specifications and normally do not require resetting. However, the demands upon your particular boiler may require some deviation from the factory settings. If adjustments are necessary, use the following instructions as a guide.

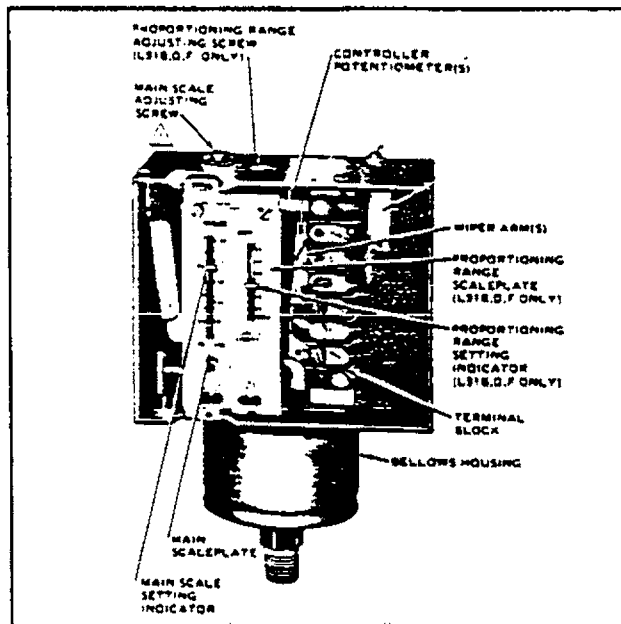


FIGURE 4 — PROPORTIONING PRESSURE CONTROL TYPICAL OPERATION

Setting the Pressure and Proportioning Range on the Modulating Control (See Fig. 4)

Main Scale Set Point

Adjust the main scale set point for the desired operating pressure by turning the main scale adjusting screw until the main scale setting indicator is at the minimum pressure desired. The pressure will be maintained between this setting and the main scale setting plus the proportioning range.

Proportioning Range

Adjust the proportioning range (throttling range) by turning the proportioning range adjusting screw on the top of the case until the proportioning range setting indicator is at the desired value. The proportioning range scale is graduated. The value of each division depends upon the operating range of the controller.

Setting the Operating Limit and High Limit Pressure Controls (See Fig. 5)

Main Scale Set Point

Adjust the main scale set point for the desired operating pressure or limit by turning the main scale adjusting screw until the main scale setting indicator is at the maximum pressure desired.

Differential Range Set Point

Adjust the differential by turning the differential adjusting screw until the differential indicator is at the required value for the lower operation point.

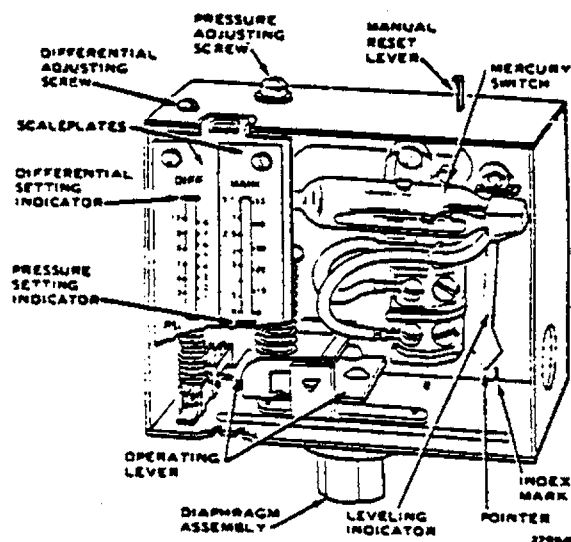


FIGURE 5 — PRESSURETROL CONTROLLER — INTERNAL VIEW OF PRESSURETROL CONTROLLER

The differential is subtracted from the main scale set point. The upper operating point is determined by the main scale set point. The lower operating point is determined by the main scale setting minus the differential setting.

NOTE: The manual reset high limit control should be set above the automatic operating limit control. The high limit pressure control should not be set higher than the pressure rating of the safety valves or pressure vessel.

1. Monitor both the boiler pressure and the operation of the pressure controller. If the boiler pressure varies too much, decrease the proportional range. If the step control cycles too rapidly, adjust the differential to increase the proportional range.

2. If the contactors cycle too rapidly even after increasing the proportional band, the step control may have to be adjusted to increase span, proportional band, or time delay. The type of adjustment necessary depends upon the type of controller. Refer to the appropriate literature for more detailed information on adjusting the step controller.

C. Blowdown

Initially, blowdowns (bottom and water column) should be performed daily until experience suggests otherwise. Where low pressure steam boilers are used solely for heating, and where practically all of the condensate is returned to the boiler, blow down only as often as concentration of solids requires. Boilers used for process steam that require high make-up should be blown down frequently to maintain chemical concentrations at the required levels and to remove precipitated solids.

Vessel Blowdown

- a. Allow the boiler to attain full steam pressure.
- b. Turn off the pilot switch.
- c. Open the vessel blowdown valve to the full open position to allow the water to escape as rapidly as possible in order to remove the sediment.
- d. Close the blowdown valve.
- e. Allow the boiler to refill. When the water is near the normal operating level, reclose the pilot switch.

NOTE: Most element failures are caused by neglect to regularly blow-down.

Blowdown the vessel as necessary to maintain the recommended levels of total dissolved solids.

Gauge Glass Blowdown (See Figure 6)

The water gauge glasses should be kept clean. Dirt on or in the gauge glass may be mistaken for the water level. To clean or blow down the gauge glass, the boiler should be at its operating pressure.

- a. Fully close both the top and bottom gauge glass isolation valves. (See Figure 6)
- b. Open the drain cock.
- c. Open the top valve briefly to purge the dirt and debris from the piping, then close.
- d. Open the bottom valve in the same manner as "c," then close.
- e. Close the drain cock on the bottom valve.
- f. Crack the top valve just enough to allow the slow passage of pressure. When the flow has ceased, fully open the valve.

g. Crack the bottom valve just enough to allow the slow seepage of water to enter the glass.

h. Continue to crack the bottom valve until the water level stabilizes. Then slowly open the valve to its full position.

**Water Level Control Blowdown
(Refer to Figure 6)****CAUTION!**

Be sure to flush your low water cut-off DAILY in order to avoid damage to the equipment.

The float type combination water level control and the low water cutoff must also be flushed while the boiler is in operation. Open the blowoff valve on the water column, draining the water from the control. Close the valve. To check the operation of the water level control and the low water cutoff, slowly open the blowoff valve on the boiler and drain the water just below the bottom of the sight glass. If the magnetic contactors do not turn off, the low water cutoff should be checked. Close the valve. The water level should be restored automatically.

CAUTION

Do not leave the magnetic contactors on after the water recedes from the sight gauge. To do so may result in damage to the element.

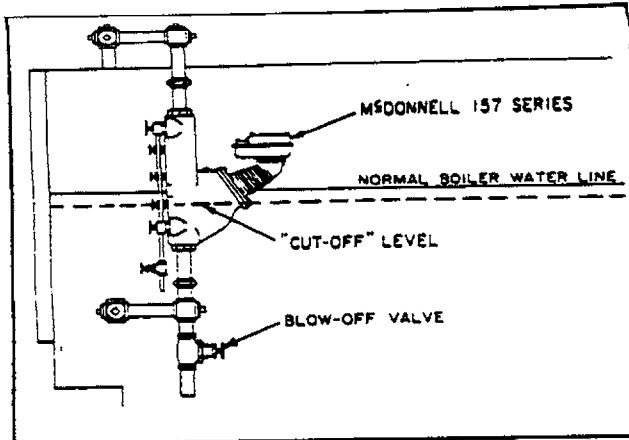


FIGURE 6 — PUMP CONTROL, LOW WATER CUT-OFF, LOW WATER ALARM (For Boilers With Steam Pressures Up To 150 psi)

D. Maintenance

Quarterly Procedure

!WARNING

Lock out and disconnect the main power before tightening the main supply lugs in order to avoid the hazard of electrical shock, which may result in serious personal injury or death.

Tighten the main supply lugs every 24 hours during the first week of operation.

1. While the boiler is operating, lower the pressure setting drastically on the control pressure and listen for the magnetic contactors to open. Then return the setting to normal and again listen for the magnetic contactors to close.

2. Turn off the control pilot switch and the main power supply switch. This is a safety measure to prevent accidental turn-on of power.

3. Tighten all the electrical connections that could have loosened due to heat expansion and contraction. Pay particular attention to the main lugs that receive the power circuit. Examine all the relays and the magnetic contactors for pitting, corrosion, burned or welded contacts, or inoperative 120-volt coils. Inspect for blown fuses or discoloration of fuse clips, which would indicate a loose fit. Correct malfunctions as required. If the boiler was supplied with a probe-type auxiliary low water cutoff, remove the low-water cutoff probe from the vessel, clean the probe and reinstall it.

CAUTION!

When checking the element terminal connections, use a wrench on the both nuts to avoid twisting the terminal stud and damage to equipment.

If all the elements have been operating normally and each element bank draws its rated current or amperage, where

$$\text{AMPS (3 phase)} = \frac{\text{Watts}}{\text{Volts} \times 1.73}$$

or

$$\text{AMPS (1 phase)} = \frac{\text{Watts}}{\text{Volts}}$$

no further element tests are necessary.

However, if there is a low or unbalanced amp reading, further tests with an ohmmeter may be necessary to detect the open or shorted elements in the group. To test individual elements for continuity with an ohmmeter, the jumpers between elements must first be removed.

Annual Procedure

The boiler should be drained and cleaned to remove any accumulated scale or sludge. This normally can be done concurrently with an annual inspection. More frequent cleaning may be required if the boiler supply water contains sediment or if a considerable amount of makeup water is used to replace system losses. The annual checkout and start-up procedure is otherwise identical with the quarterly procedure.

E. Element Replacement Procedure

The smaller, individually replaceable electric heating elements are readily accessible for fast, easy, on-the-job maintenance. They can be removed and replaced with standard tools. The small physical size of each element means the element bundle is lighter and simpler to remove.

!WARNING

Before element replacement, lock out and disconnect the main power to avoid the hazard of electrical shock, which could result in serious personal injury or death.

!WARNING

Before element replacement, make certain the boiler is cooled to an ambient temperature before draining below the element opening. Failure to heed this warning could result in serious personal injury or death.

Replacement of Individual Elements

(for models S or CSB-301 and larger)

(See Figures 7 & 8)

1. Make a sketch or a drawing of the element bussing and the tag wires in order to simplify re-connection later.

2. Disconnect the wires and remove the element assembly flange bolts.

NOTE: To assist in breaking free the gasket, insert one of the flange bolts into the tapped hole provided.

3. Remove the element assembly by pulling it straight out.

4. Remove the jumper wires and the brass ferrule nuts from the element.

5. Slide the element toward the dry side (about 2") to expose the brass ferrules on the element. Cut off the ferrules with a hacksaw. Slide the element out of the steel flange toward the wet side.

6. Inspect and clean the thread and the seat of the steel flange where the new ferrule will seal. If the seats are pitted or rusted, it will be impossible to seal the new elements. Therefore, a new flange may be required.

7. Screw the new ferrule nuts (these are furnished with the replacement element) into the cleaned or new flange plate (finger tight).

8. Slide the element into position. Make sure the element protrudes beyond the ferrule nut approximately 1/4", or to match the original assembly. Some boiler models require the element sheath to extend out further than 1/4", so duplicate the original assembly as closely as possible.

NOTE: Since the elements often differ in length, check to assure that there is an adequate clearance (3/4" min) between the end of the element and the opposite side vessel wall. Check by measuring both the element extension (from flange to tip) and the distance from the tank flange face to the vessel wall.

9. Hold the element to prevent twisting while tightening the ferrule nuts. Tighten the nuts to approximately 35 ft. lbs. (25 ft. lbs. for 208 and 240 volt elements). You will feel the ferrule separate from the nut while tightening. A properly tightened ferrule nut will have separated from its ferrule and the ferrule will be squeezed or compressed onto the element sheath, thus providing a tight seal.

10. Replace the element assembly into the boiler, using a new gasket and anti-seize compound on gaskets and bolts. Torque the element flange bolts to 90-100 ft. lbs.

11. Rewire the element ends.

12. When the boiler is filled and pressurized, inspect for leaks.

Replacement of 4 Bolt Elements

(for Models CSB-121 thru -240)

!WARNING

Before element replacement, lock out and disconnect the main power to avoid the hazard of electrical shock, which could result in serious personal injury or death.

!WARNING

Before element replacement, make certain the boiler is cooled to an ambient temperature before draining below the element opening. Failure to heed this warning could result in serious personal injury or death.

1. Make a sketch of the wire termination block, identifying the wires from the defective element.
2. Disconnect the wires and remove the element by removing the 4 attachment bolts.
3. Install the replacement element with a new gasket and tighten the bolts evenly to approximately 20-25 ft. lbs.
4. Re-connect the element wires to the terminal block per the sketch that you made.
5. When the boiler is filled and pressurized, check for leaks.

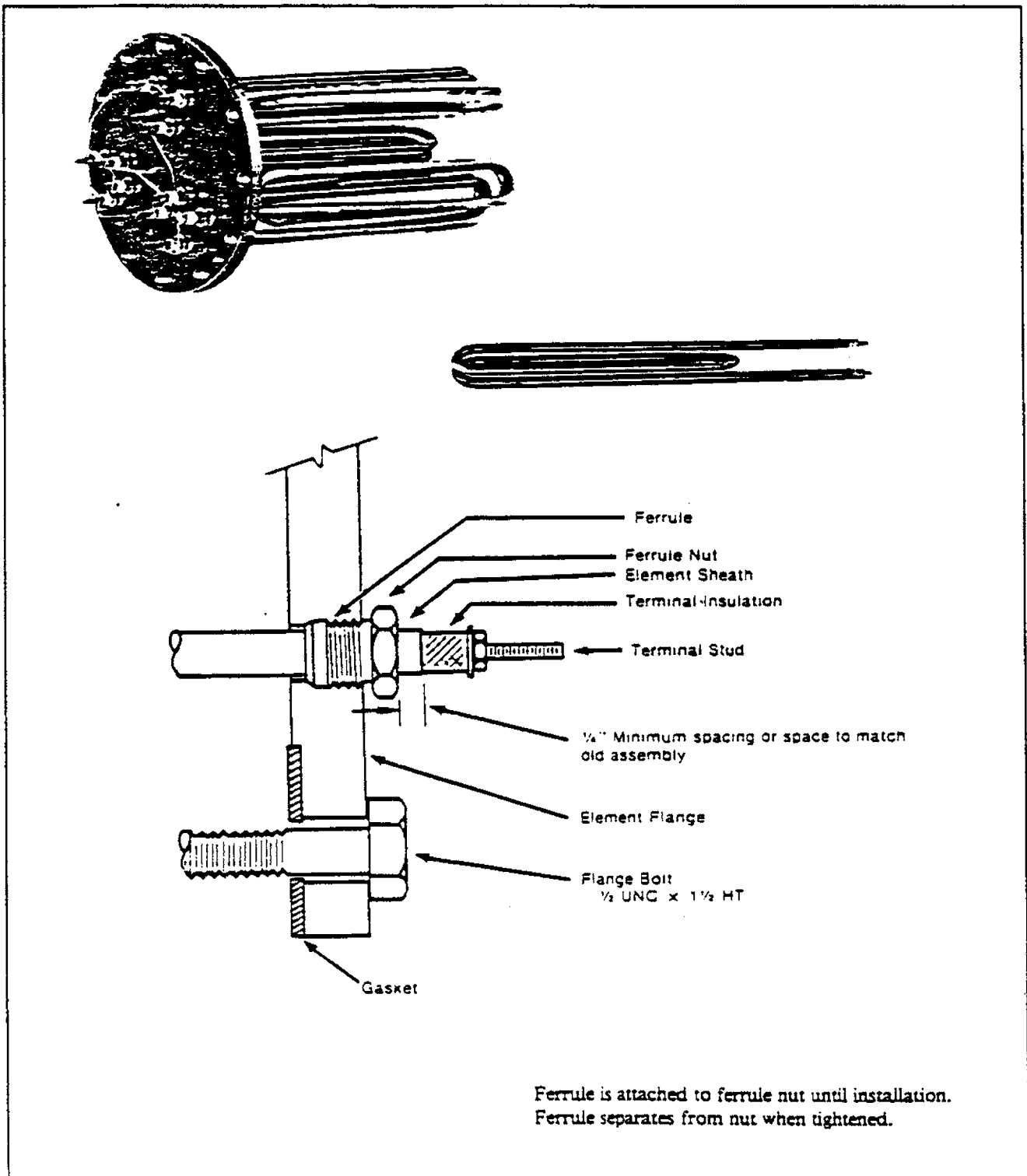


FIGURE 7 — HEATING ELEMENTS AND ELEMENT INSTALLATION DETAILS

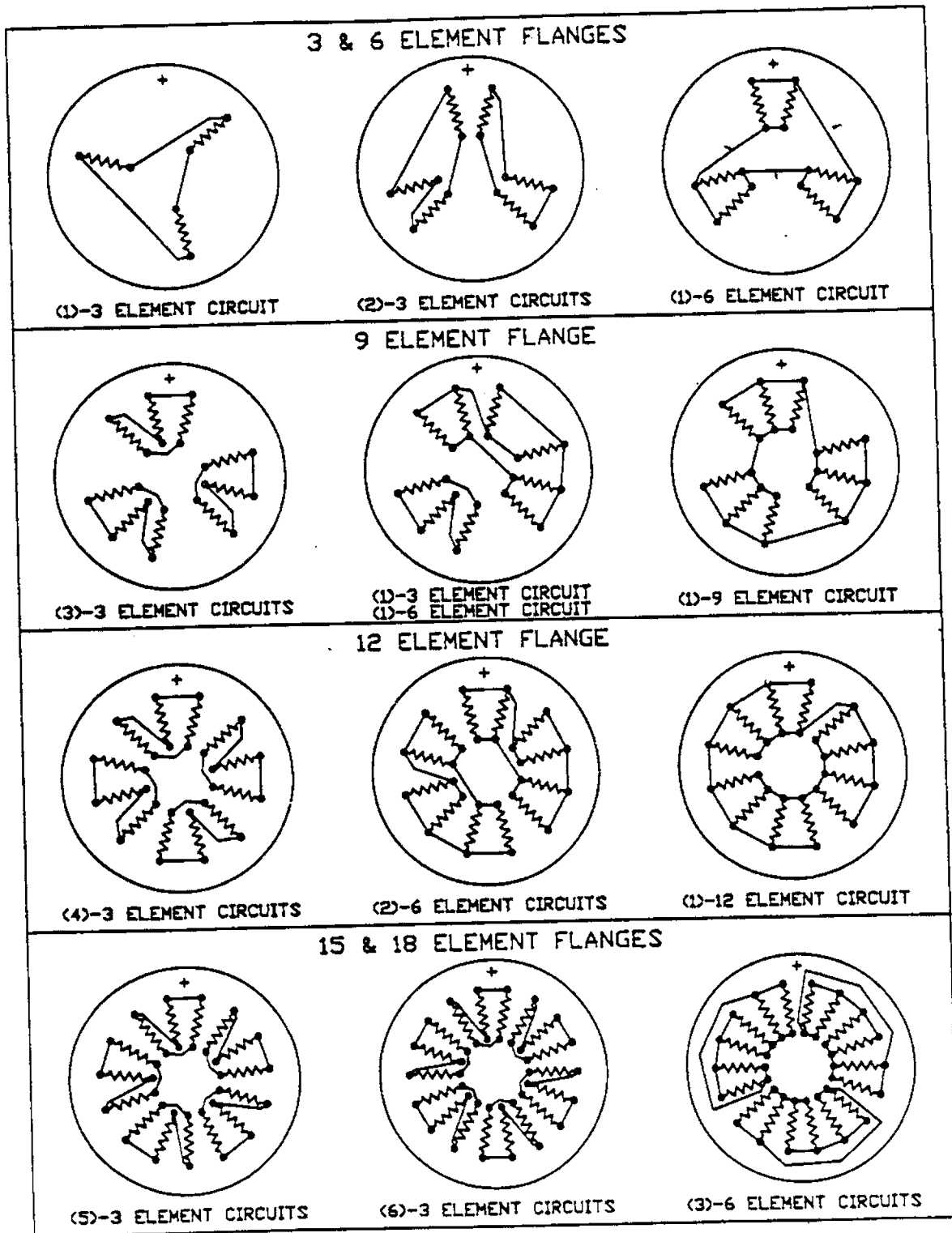
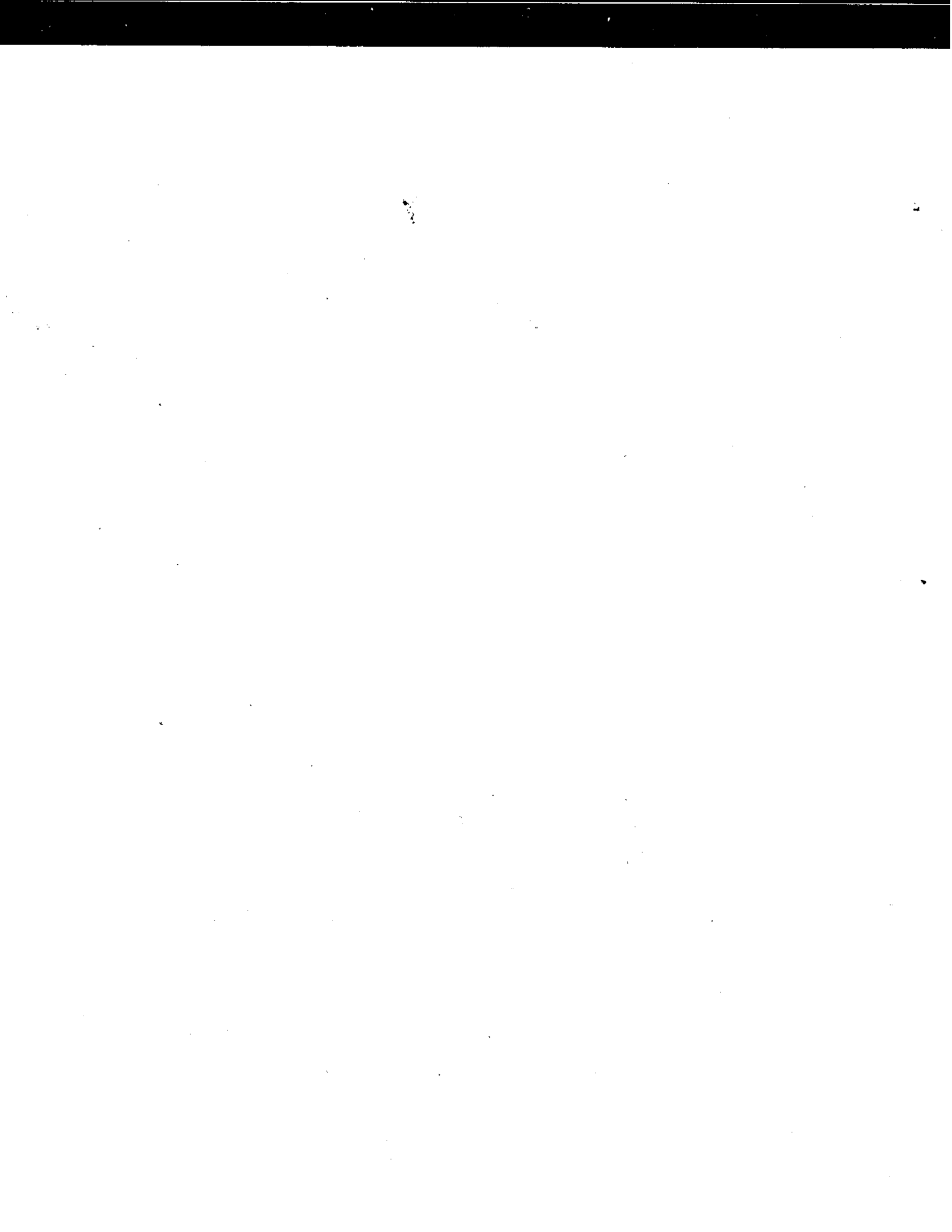


FIGURE 8 — BOILER ELEMENT BUSSING DETAILS



CHAPTER 5

TROUBLESHOOTING

!WARNING

Troubleshooting should be performed only by a qualified technician who is familiar with the equipment and who has read and understands this manual. Failure to heed this warning may result in serious personal injury or death.

When possible during troubleshooting, disconnect and lock out the main power to avoid the hazard of electrical shock, which could result in serious personal injury or death.

PROBLEM

Pilot switch on: "power on"
pilot light off

POSSIBLE CAUSES

Main power supply not on

Control transformer fuse is blown

Control transformer inoperative

Pilot light burned out

ACTIONS

Energize power supply

Check for loose connections, then replace fuse

Check for proper wiring/loose connections; replace transformer

Check for loose connections; replace light

PROBLEM**POSSIBLE CAUSES****ACTIONS**

High pressure/temperature alarm pilot light on

Pressure/temperature has exceeded setpoint on auto reset limit control

Allow pressure/temperature to fall below setpoint less control differential; raise setting if necessary, but not above design limit or manual reset setting

Pressure/temperature has exceeded setpoint on manual reset limit control

Allow pressure/temperature to fall below setpoint less control differential, depress reset button; raise setting if necessary, but not above design limit

Low water alarm pilot light on

Float-type LWCO: Water below cutoff line on float cage

Assure unit has proper water level; check that LWCO line is at proper level

Float-type LWCO: Float stuck/switch mechanism jammed

Check that float blocking plug has been removed; perform blowdown of float cage; assure switch plate operates freely

Probe-type LWCO: Probe circuit open/water below cutoff level

Check for loose connections/improper wiring; assure unit has proper water level

Probe-type LWCO: Probe or relay faulty

Replace probe or relay

CHAPTER 5

TROUBLESHOOTING

PROBLEMS

Control power pilot light on, alarm pilot lights off, contactors not energized

POSSIBLE CAUSES

Alarm pilot light(s) burned out

Step control fuse blown

Pressure/temperature control improperly wired to step control

Steps do not all energize

Step control faulty

Contactor coil inoperative

Step control relay(s) faulty

Steps do not draw rated current

Branch circuit fuse(s) blown

Element bussing improper

Contactors noisy (chatter)

Element(s) open

Contactors damp/dirty

ACTIONS

Replace pilot light(s)

Replace fuse

Check that wiring is per control literature and per unit wiring diagram

Replace step control

Check for loose coil connection; replace contactor.

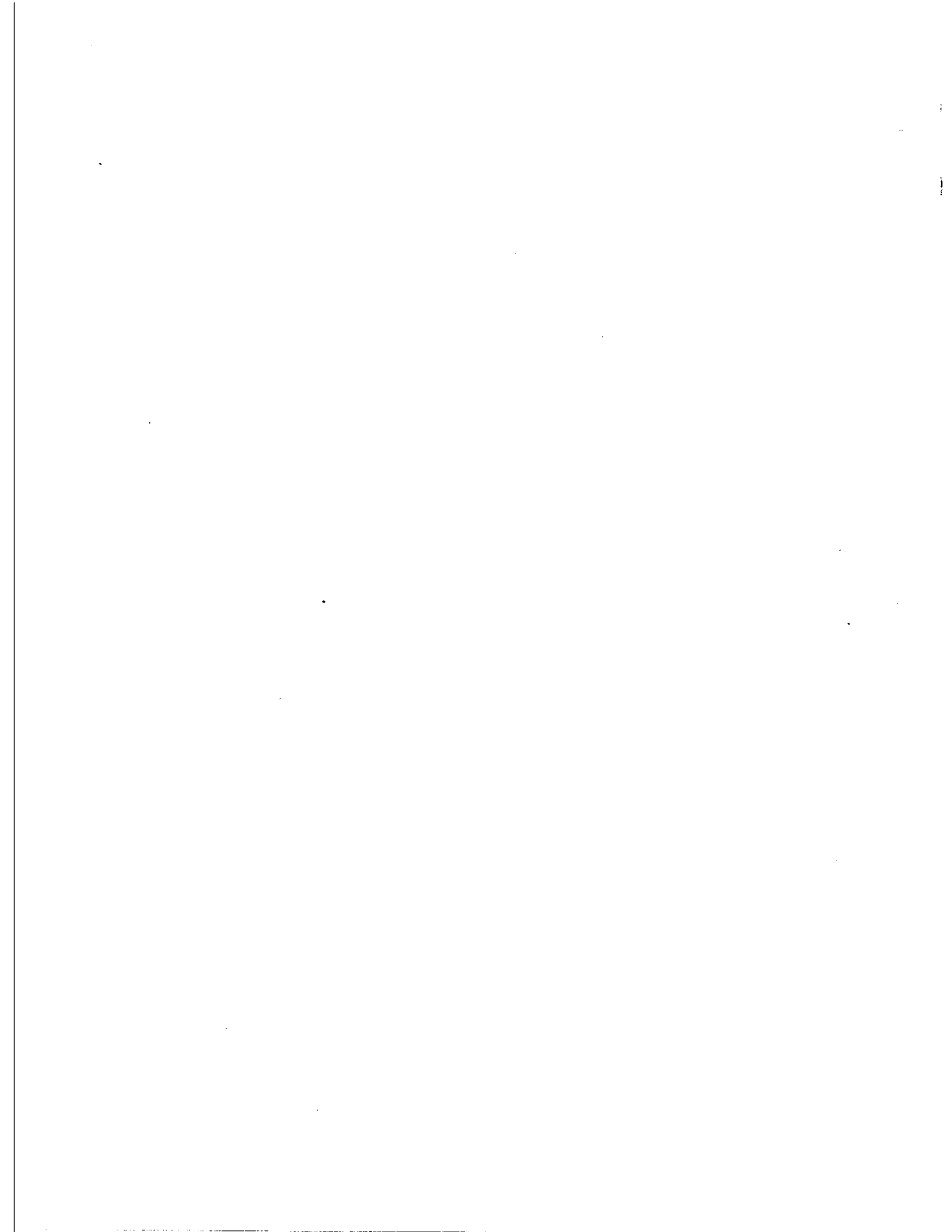
Check that relay is tight in socket; replace relay

Check element(s) for proper ohms and resistance to ground then replace fuse(s).

Check that element bussing is per wiring diagram

Replace faulty element(s)

Blowout contactors with compressed air; remove contactor, disassemble and clean; replace contactor




CHAPTER 6

PARTS/ORDER LIST INSTRUCTIONS

FURNISH COMPLETE INFORMATION WHEN ORDERING PARTS — When ordering parts for repair or spares, give description and state quantity of parts desired, together with the complete nameplate data, including rating, model, and serial number of the motor and all data.

WHERE TO ORDER PARTS. Repair or replacement parts should be ordered from your local Cleaver-Brooks authorized Representative.

ELECTRIC BOILER					
MANUFACTURED BY					
					
MODEL	<input style="width: 150px;" type="text"/>	BHP	<input style="width: 50px;" type="text"/>		
KW	<input style="width: 100px;" type="text"/>	VOLTS	<input style="width: 100px;" type="text"/>		
AMPS	<input style="width: 60px;" type="text"/>	PH	<input style="width: 60px;" type="text"/>	HZ	<input style="width: 30px;" type="text"/> 50 <input style="width: 30px;" type="text"/> 60
SERIAL NO.	<input style="width: 100px;" type="text"/>	MFG DATE	<input style="width: 100px;" type="text"/>		
NAT'L BOARD NO.	<input style="width: 150px;" type="text"/>				
MAX. WORKING PRESS.	<input style="width: 150px;" type="text"/>				PSI

CB PARTS LIST
CSB, S and CR
Models Electric Steam Boiler

Part No.	Description	Usage
ELEMENTS		
129-100	208/240 Heating Element Ferrule Nuts	
129-104	380/480/600 Heating Element Ferrule Nuts	
129-409	Element Flange Gasket, 8"	
129-204	Element Flange Gasket 10"	
129-233	4-Bolt Flange Gasket Heating Element (consult factory for wattage)	
CONTROLS		
817-16	A/R Limit Control	15#
817-415	M/R Limit Control	15#
817-229	Mod Control	15#
817-109	M/R Limit Control	150#
817-110	A/R Limit Control	150#
817-244	Mod. Control	150#
817-2074	Low Water Cutoff	
817-2075	Low Water Cutoff Probe for above	
817-2156	Low Water Cutoff	
873-128	Low Water Cutoff Probe for above	
CONTACTORS		
833-2196	50A	
833-2531	60A	

Part No.	Description	Usage
FUSES		
832-1721	Power Fuse 1.5 amp	600 V
832-1376	Element Fuse 60 amp	600V Class T
848-1019	Fuse Block for Class T Fuse	
STANDARD STEP CONTROL AND TRAILER BOARDS		
Step Controls		
833-2537	4-step	
833-2536	6-step	
833-2535	8-step	
Trailer Boards		
833-2542	4-step	
833-2541	8-step (Consult factory for special boards)	
SWITCHES		
832-1652	On-Off Switch	
PILOT LIGHTS		
811-249	White	
881-250	Amber	
881-251	Red	