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CLEAVER-BROOKS MODELS

CWB & HW

ELECTRIC BOILERS

Operation, Service and Parts Manual Hot Water

Manual Part No. 750-136

Cleaver-Brooks

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

CLEAVER-BROOKS
MODELS CWB & HW
ELECTRIC BOILERS

Operation, Service, and Parts Manual

Hot Water

Cleaver-Brooks®

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MANUAL PART NO. 750-136

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TO: OWNERS, OPERATORS OR MAINTENANCE PERSONNEL

No attempt should be made to operate this unit until the principles of operation, 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.

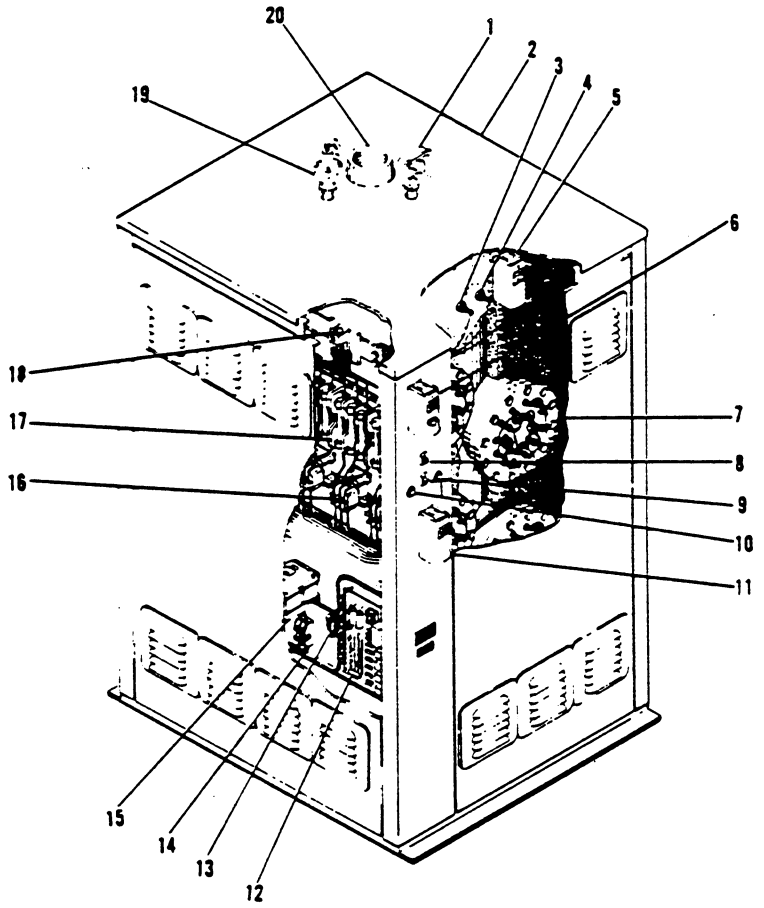
Cleaver-Brooks Boilers are designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied were chosen because of their known ability to perform, however, proper operating techniques and maintenance procedures must be followed at all times. Although 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. Recording daily, weekly, monthly and yearly maintenance activities and recording any unusual operation will serve as valuable guides 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 operating personnel must comply with all requirements or regulations of the insurance company and/or any other authority having jurisdiction. These legal requirements take precedence over anything contained herein.



ELECTRIC HOT WATER PACKAGE BOILER

BOILER COMPONENT LIST

1. Pressure/Temperature Gauge
2. Boiler Enclosure
3. Low Water Cutoff Probe
4. Temperature Control Sensor
5. High Temperature Cutoff — Auto Reset
6. High Temp Cutoff — Manual Reset
7. Heating Element Assembly
8. Alarm Switch: Control Circuit On-Off
9. Pilot Light: Control Circuit Power "On"
10. Pilot Lights: High Temp & Low Water Alarms
11. Temperature Control
12. Solid State Step Control
13. Terminal Block: External Interlocks
14. Control Transformer Primary Fusing
15. Control Circuit Transformer:120v
16. Magnetic Contactors
17. Fuse Blocks: Element Circuits
18. Main Supply Lugs
19. ASME Pressure Relief Valve
20. Outlet
21. Inlet (Not Shown — Lower Back Side)
22. Expansion Tank Connection (Not Shown)

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CHAPTER 1

GENERAL DESCRIPTION

A. Introduction
B. Application
C. Description
D. Principle 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 heed these precautions may result in damage to equipment, serious personal injury or death!

The equipment should be operated only by personnel 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 infromation 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
WSI	Watts Per Square Inch

B. Application

The model CWB comes equipped with 75 wsi copper elements. The model HW comes equipped with 50 wsi copper elements.

The Cleaver-Brooks Model CWB and HW boilers are designed to operate in hot water heating systems, and to deliver maximum kilowatts in minimum space requirements. Each is ideal for new boiler applications or as a replacement unit to upgrade existing installations.

These boilers are also designed for use as supplemental heat for heat pump systems operating between 55 - 175 degrees F., or standard hot water systems up to 250 degrees F. (Higher temperature boilers are available on special order.)

C. Description

A typical Cleaver-Brooks Model CWB or HW hot water boiler is described in Figure 1. This illustrates a typical packaged unit. This system includes operating controls, elements, fuses, contactors, relief valve, drain valve, etc.; wired, tested and ready for installation.

The vessel construction complies with the ASME Boiler & Pressure Vessel Code, Section IV, and is suitable for operation at pressures to 160 psig and temperatures to 250 degrees F. All CWB and HW boilers carry the "H" stamp.

An 11"x15" manhole is provided on Models CWB and HW-361 through 422; smaller boilers are supplied with handholes as required by ASME Code, Section IV.

The following items are standard on all Cleaver-Brooks Electric Hot Water boilers:

1. Main Lugs for Power Supply

Standard boilers are designed for top entry to main power terminals and are supplied with solderless wire connectors suitable for copper supply wires. These main lugs are mounted on distribution buses which provide individual connections for each heating element circuit.

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. Minimum contactor rating is 50 amps resistive duty rated for 500,000 duty cycles.

4. Heating Elements

Standard heating elements are copper sheathed rated at 75 wsi (Model CWB), or 50 wsi (Model HW). These elements are individually replaceable hairpin type.

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.

6. Customer External Interlock Connection

A terminal strip is provided on all boilers for connection of the customer's external control devices, interlocks, and switches to enable/disable the boiler, from remote locations.

7. High Temperature Cutoff

All standard boilers with more than 4 control steps are supplied with one automatic-resetting, and manual-resetting high temperature cutoff. These are normally set at 235 degrees F. and 240 degrees F. respectively, unless otherwise specified. On smaller boilers, one auto-resetting temperature cutoff is standard as a back-up to the limit duty rated temperature control.

8. Low Water Cutoff

Each boiler is equipped with an automatic resetting electrical low water cutoff of the probe type.

9. Temperature Control and Temperature Sensor

Boilers with 1 to 4 stages of control are standardly provided with on-off controls. Larger boilers are provided with a solid state, proportional, modulating, step-type temperature control system. The temperature control system controls the input power to the boiler by increasing (or decreasing) the number of heating element groups (steps) in use. As the temperature of the water returning from the system varies due to system load. The controller switches on or off banks of elelments in order to maintain a constant outlet temperature. Both control systems (on-off and proportional) have adjustable temperature ranges. The on-off control has a fixed differential of approximately 5 degrees F. The proportioning control has an adjustable differential or proportioning range from 3-30 degrees F.

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

The proportional controller also prevents serious electrical damage in the event of a power interuption. As power is restored to a cool system, the controller turns on each step in timed sequence until full load is achieved. This avoids the high current surges that would result if the steps were all energized at once.

10. Pilot Switch and Pilot Lights

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

11. Pressure/Temperature Combination Gauge

NOTE: Models CWB-202 and smaller are supplied with a combination pressure/temperature gauge. Larger Models are supplied with individual pressure and temperture gauges.

12. Pressure Relief Valve

This valve is sized according to the boiler's electrical rating (3500 BTU/KW) per the ASME Code and National Board.

Optional Equipment

The following optional equipment may be added and supplemental descriptive information (suppliers' literature) may be included with your manual for these options.

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

6. Solid State progressive sequencing step control.
7. Outdoor reset controls.
8. Proportional outdoor load limiter.
9. Pneumatic control interface.
10. Demand limiting controls or interface.
11. Door interlock.
12. Boiler disconnect switch or circuit breaker (with or without shunt trip).
13. Ground fault detection.
14. Metering (ammeter, voltmeter or KWH meter).
15. Alarm circuit (with or without horn/silencer push button).
16. Flow switch (with or without time delay).
17. Preheat switch.

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

D. Principles of Operation

An electric hot water boiler is a simple device. Water passes through a steel drum (vessel) containing resistance type heating elements. As the water circulates, it absorbs heat from the heating elements. The heated water is then circulated through the external system to heat buildings, to provide heat for manufacturing processes, or for use wherever it is required.

Cleaver-Brooks boilers are designed to keep water volume as low as possible to provide close control and rapid response to the heating needs. Close temperature control of the water is maintained by turning off or on, groups of resistance elements. Controls in the boiler automatically select the number of heating element groups (or steps) needed to maintain the water temperature, while supplying the system's heat demands.

NOTE: Although circulation pumps are not supplied with these boilers, they should, however, be sized to provide a flow rate adequate to deliver the boiler's full output to the system, without high boiler temperature rise (100 degrees F). Pumps should operate continuously and, for the best control, the flow through the boiler should be constant.

CHAPTER 2

INSTALLATION INSTRUCTIONS

!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 read and understand the contents of this manual. Failure to do so may result in serious personal injury or death.

A. Receiving Inspection

Every Model CWB and HW Boiler is completely inspected at the factory and carefully crated for shipment. Inspect the packing for signs of exterior damage. After placing the unit as close as possible to the point of actual installation, uncrate carefully 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 Dimensional Drawings (DD) and Wiring Diagrams (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.

CAUTION!

To avoid damage to the equipment, be sure to:

1. Check your local electrical code for minimum clearances required around electrical equipment.

2. For installation in a closet, provide ventilation openings of 200 square inches per 100KW of boiler rating.

3. Some local codes specify greater clearances over top of boiler and must take precedent.

4. Models CWB and HW boilers are designed ONLY for indoor installation.

C. Piping

This boiler is intended for use on forced circulation systems with a pump of adequate capacity to overcome the system head loss (pressure drop at required flow rate), and to provide a flow rate adequate to permit the boiler to generate its full heat output. Radiators and convectors in the system must have adequate capacity to dissipate the boiler output at system design operating water temperature.

The pressure drop through the boiler is equivalent to the pressure drop through 30 feet of pipe equal to the diameter of the inlet and outlet fittings.

Failure to provide adequate radiator capacity may create a low flow rate through the boiler, raising the temperature too high, and will result in "short cycling" of the boiler due to operation at the limiting or maximum temperature. This also will prevent the boiler from supplying its rated output to the system.

Tight-closing valves should be installed on the inlet and outlet piping to facilitate isolating the boiler from the system for annual boiler internal inspection and/or repair that requires the boiler to be drained.

An expansion tank should be provided with a volume equal to 1/16 of the total water volume of the system, inclusive of the boiler vessel, radiators, coils, and all piping. The expansion tank may be connected to the fitting provided on top of the boiler vessel. If another location for the expansion tank connection is used, the boiler opening must be plugged.

Water for make up during operation should be added manually or automatically directly to the expansion tank.

!WARNING

The relief valve outlet should be piped to a safe point of discharge where no serious personal injury or death to persons, or impaired access to the boiler controls, would result from unexpected discharge of hot water from the relief valve.

The boiler drain valve should be piped to the drain.

D. Heat Pump Systems with High Flow Rates

Models CWB and HW boilers will accept flow rates that will give a minimum temperature rise across the boiler as low as 3 degrees F., when supplied with optional inlet baffle or oversized connections. Minimum temperature rise can also be obtained by installing a by-pass piping arrangement to adjust the flow through the boiler. (Refer to Figure 2-1)

Use the following formula to determine the maximum and minimum flow rates of a given boiler:

$$\text{FLOW (GPM)} = \frac{\text{KW x 6.816}}{\text{T}}$$

where T is equal to any temperature rise between 3 degrees F. and 30 degrees F., as indicated by TI1 and TI2 at figure 2-1.

If the system flow rate is greater, a by-pass around the boiler with a balancing cock or globe valve will be required to bypass the appropriate portion of the system flow. (Refer to Figure 2-1.)

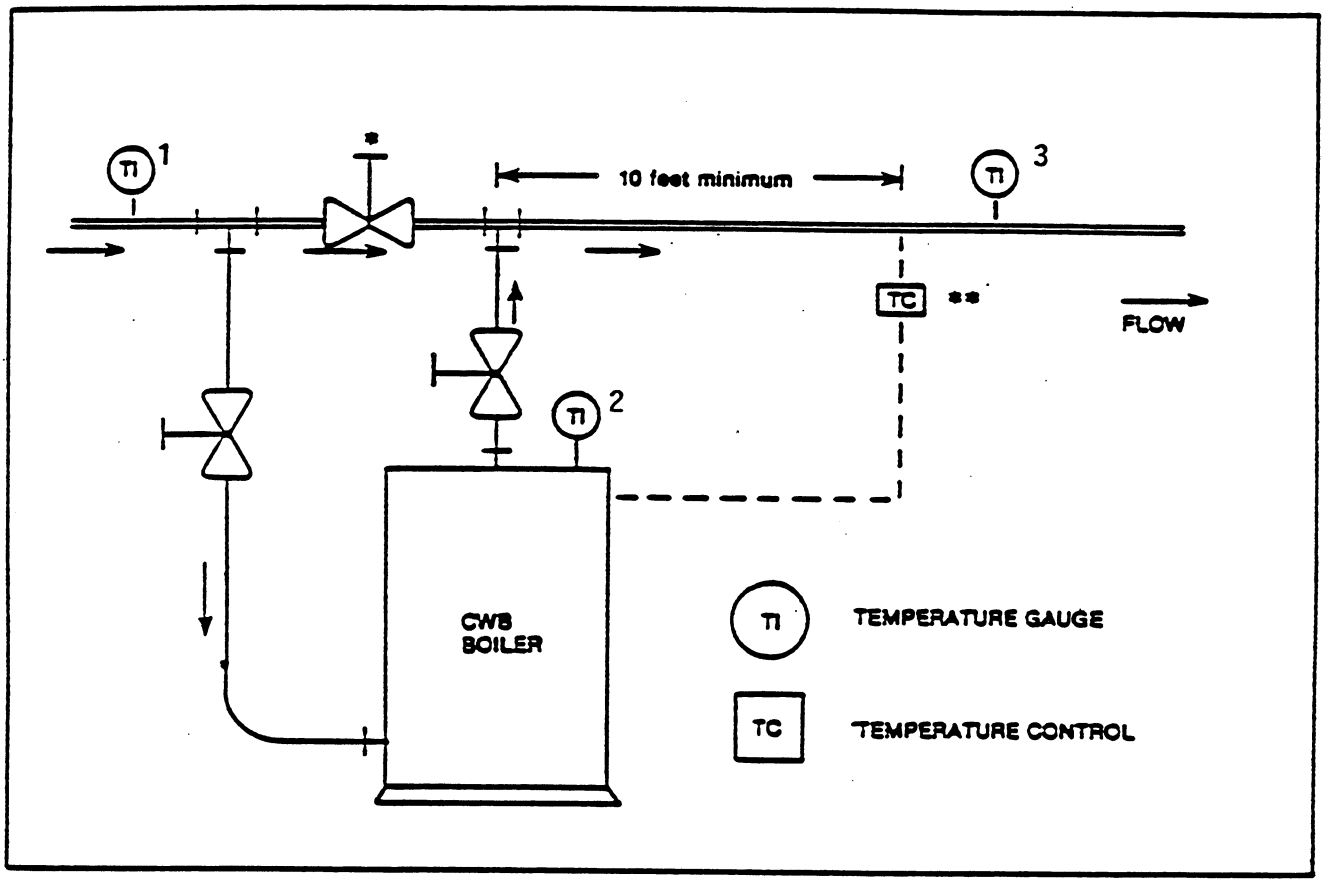


FIGURE 2-1 / TYPICAL PIPING ARRANGEMENT FOR BY-PASS SYSTEM

*If the hot water boiler cannot handle the full system GPM, susbstitute the balancing valve, which will be partially opened, to by-pass the appropriate portion of flow. The flow must be constant.

** The boiler temperature control is to be located so as to the sense temperature of the system water after the boiler water and by-passed water have blended (TI3).

For optimum temperature control without cycling, the flow rate through the boiler must be kept constant.

E. Electrical

!WARNING
Disconnect and lock out the main power before proceeding with the electrical installation in order to avoid the hazard of electrical shock, which can cause serious personal injury or death.

The following procedures are based on requirements of the National Electrical Code. Local electrical codes and/or boiler codes may require slightly different procedures, and 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.

If aluminum supply wires are selected by the customer, 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 heater. If copper splices are not used and the customer chooses to terminate the aluminum supply wires directly in the main supply lugs, an oxide inhibitor paste should be applied liberally to the conductors.

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

Main supply lugs should be tightened every 24 hours during the first week of operation. After the first week, the main supply lugs should be tightened once every 30 days.

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

The following procedures are recommended:

1. Check the boiler nameplate for the boiler kilowatt rating, voltage, amperage and whether it is single or three phase.

2. Check the electrical supply voltage to verify that it conforms to the boiler requirements, and that sufficient circuit capacity is available for the boiler.

3. Refer to the boiler Wiring Diagram (WD) included with the boiler, for the number and rating of supply circuits required by the boiler.

4. Refer to your local electrical code for proper wire and conduit sizes for these ratings.

5. Install wiring from the feeder switch or circuit breaker to the boiler, and connect to the bus assembly as indicated on the boiler Wiring Diagram (WD).

6. All Cleaver-Brooks Electric Boilers are supplied with factory-mounted magnetic contactors, and all internal circuits are factory installed and tested.

7. Check all electrical connections for tightness. Vibration during transit sometimes loosens connections.

!WARNING

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

CHAPTER 3

PRE-START PREPARATION

A. Inspection
B. System Cleaning & Boiler Out
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, wet and/or humid conditions must be thoroughly cleaned and dried out. Otherwise, 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 undertaken:

!WARNING
Disconnect and lock out main power to avoid the hazard of electrical shock, which could casue serious personal injury or death.

1. Make certain all electrical connections and element terminals are thoroughly cleaned, dried, and checked for loose connections.

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 start up.

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 energized, rupturing the element casing.

CAUTION!
Moisture in the element may result in damage to the element.

!WARNING
Lock out and disconnect the main power before measuring with an ohmmeter in order to avoid the hazard of electrical shock, which could 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 so that, during the first day's operation, the low reading elements will not be energized, but will be heated by the other dry elements and the moisture driven 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°F oven for 8 hours, then reinstall and rewire. Following any of these procedures, the support 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

One important phase in completing hot water heating installations and boiler startup is cleaning the system.

No matter how carefully a system is constructed, certain extraneous materials could find their way into boiler. Pipe dope, thread cutting oils, soldering flux, rust preventatives, soldering compounds, core sand, welding slag, and dirt, sand or clays from the jobsite usually are found.

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

Water treatment is required for satisfactory operation of a boiler to prevent depositing of scale and to prevent corrosion from acids, oxygen and other harmful elements that may be in the water supply. Contact your Cleaver-Brooks local Representative for more information on a water treatment program.

Some objectives of boiler water conditioning are:

1. Prevent the accumulation of scale and deposits in both the boiler and heating system.

2. Remove dissolved gases from the water.

3. Protect the boiler and system against corrosion.

4. Maintain the highest possible heating system efficiency.

5. Decrease the amount of boiler down time for cleaning.

For optimum performance, the following water quality parameters should be maintained:

Hardness:	0-25 PPM
pH Value:	7.5-9.5
Total Alkalinity:	25-700 PPM
Iron Content:	20 PPM maximum
Oxygen Content	.005 PPM maximum
Total Dissolved Solids:	3500 PPM maximum

These recommended guidelines do not include all dissolved minerals. For more infromation 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. Maintenance Schedule
C. Element Replacement Procedure

!WARNING
Make certain all prestart procedures listed in Chapter 3 have been completed prior to reading this chapter. Failure to heed this warning may result in serious personal injury or death.

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

A. Initial Start-Up

1. Fill the vessel and the system with water, open the vent at the highest point in the system to allow air evacuation, and close the valve. Start the system circulation pump. Check to see that the system pressure is within the design range for the boiler and associated equipment.

2. Set the high limit temperature control. (Suggested setting — 20 degrees F. above operating temperature.) The boiler must not exceed a maximum temperature of 250 degrees F. per ASME Code, Section IV.

3. Set the required temperature on the temperature control. (Refer to Figures 4-1 and 4-2.) The temperature control on boilers up to 4 stages (on/off controls) has a 5 degree F. fixed differential. The temperature control on larger boilers has an adjustable proportioning range from 3-30 degrees F., which should be set at 10 degrees F. for the initial start. This proportioning range may require small adjustments later to set the system. The temperature set point is always the center of the proportioning range.

Proportional Temperature Control

Temperature Setting: Turn the knob on the front of the case until the pointer indicates the desired set point temperature. This is the center point of the proportional range.

Range Adjustment: The proportional temperature control may be adjusted to vary the temperature range within which proportional action is

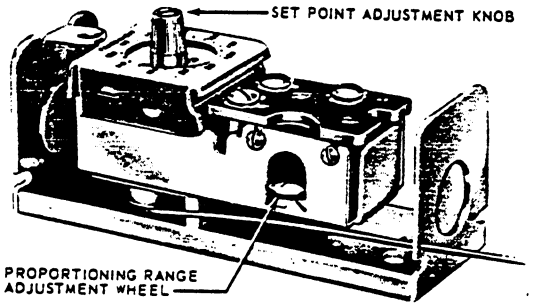


FIGURE 4-1/PROPORTIONAL TEMPERATURE CONTROL

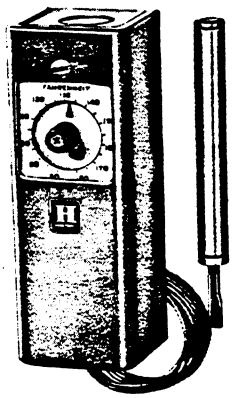


FIGURE 4-2/ON-OFF TEMPERATURE CONTROL

desired. With the cover off, turn the adjustment wheel until the pointer indicates the desired range.

Example: If the temperature of the controlled medium is to be maintained at 130°F., and a proportional action from 125°F. to 135°F. (a range of 10 degrees) is desired — turn the temperature set point indicator 130°F. and the proportional range adjustment wheel to 10.

On-Off Temperature Control

Setting Control Point: Insert a screwdriver in the slotted head visible through the cover, and turn the indicating dial to the control point.

Differential (on adjustable differential models): Remove the cover and move the differential adjustment wheel to a point on the scale corresponding to the desired differential. Replace the cover.

4. Replace all access panels that were removed for the pre-start check out. Close the control cabinet doors.

5. Close the main power switch. Turn the pilot switch on to energize the boiler control circuit. The white pilot light will light. If both temperature and water level are within limits, the red pilot light or lights will not light and you will hear the contactors begin to close.

6. To assure all limit circuits are operational, individually test each high temperature limit control by lowering its setting momentarily. All contactors should drop out and the red "high temp" light should light. Then return the setting to the desired limit setting.

7. Monitor the temperature rise through the boiler. If a bypass piping arrangement is used, adjust the flow through the boiler to obtain the desired temperature rise detailed in Chapter 3.

8. Monitor the boiler operation to see that the control functions at the desired temperature setting. If the control cycles on and off on the

proportional type controller, widen the proportional range (about 5 degrees at a time) until the system is stable.

9. 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, depending on the step control supplied.

B. Maintenance Schedule

NOTE: Only personnel who have a working knowledge and understanding of this equipment should have access to the control cabinet.

Weekly Procedure

!WARNING

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

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

Quarterly Procedure for First Year

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

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

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.

CAUTION!

When checking the element terminal connections, use wrenches on both nuts to avoid twisting the terminal stud and damage to the equiment.

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

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

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 element(s) 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 startup procedure is otherwise identical with the aforementioned monthly and quarterly procedure.

C. Element Replacement Procedure

Heating Elements (See Figure 4-3)
The smaller, individually replaceable Cleaver-Brooks 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.

Element Replacement (See Figure 4-4)

> **!WARNING**
> Before element replacement, make certain the main power to boiler is disconnected and locked out, and that the boiler is drained below the element opening to avoid hazard of electrical shock, which could result in serious personal injury or death.

1. Make a sketch or a drawing of the element bussing and tag wires 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 remove the brass ferrule nuts.

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 wet side.

6. Inspect and clean the thread and the seat of the steel flange where the new ferrules will seal. If seats are pitted or rusted, it may not be possible to seal the new elements; therefore, a new flange may be required.

7. Screw the new ferrule nuts (furnished with a 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 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.

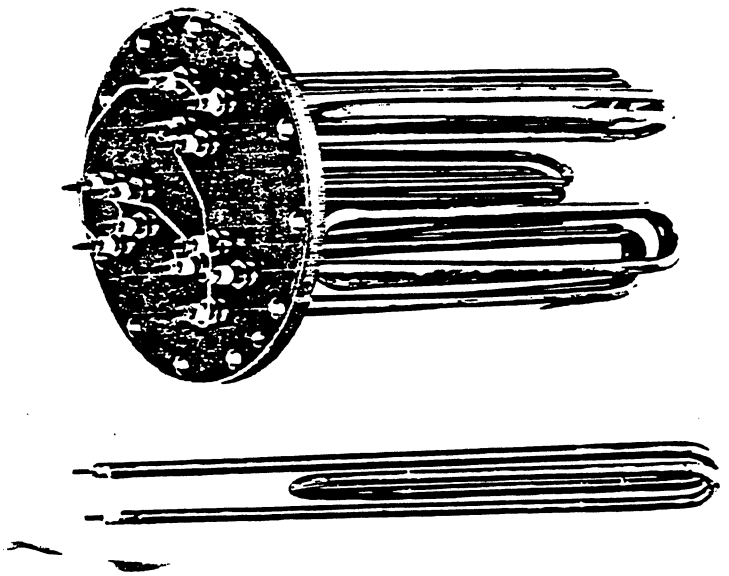
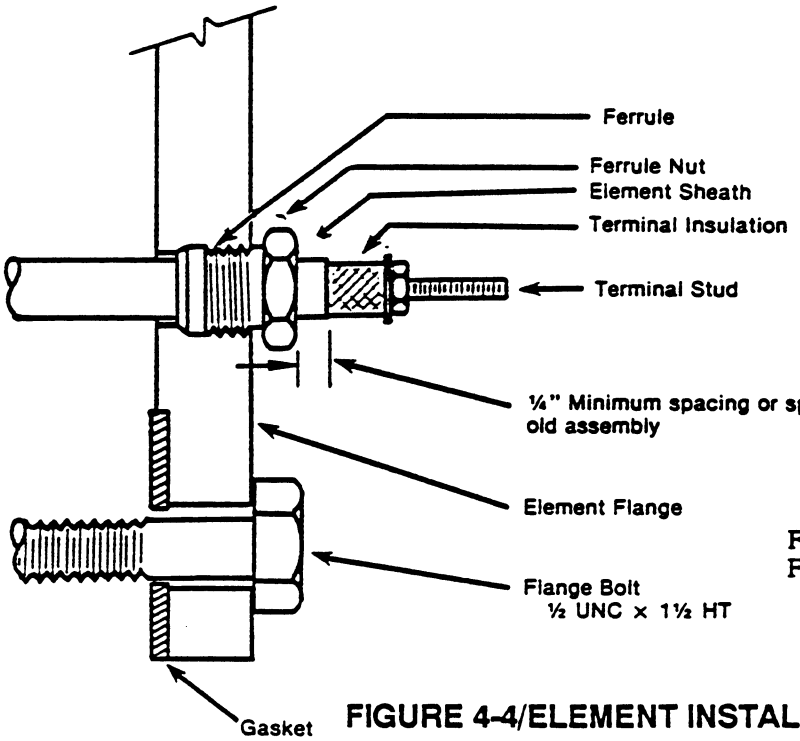


FIGURE 4-3/HEATING ELEMENTS/INDIVIDUALLY REPLACEABLE



Ferrule is attached to ferrule nut until installation. Ferrule separates from nut when tightened.

FIGURE 4-4/ELEMENT INSTALLATION DETAILS

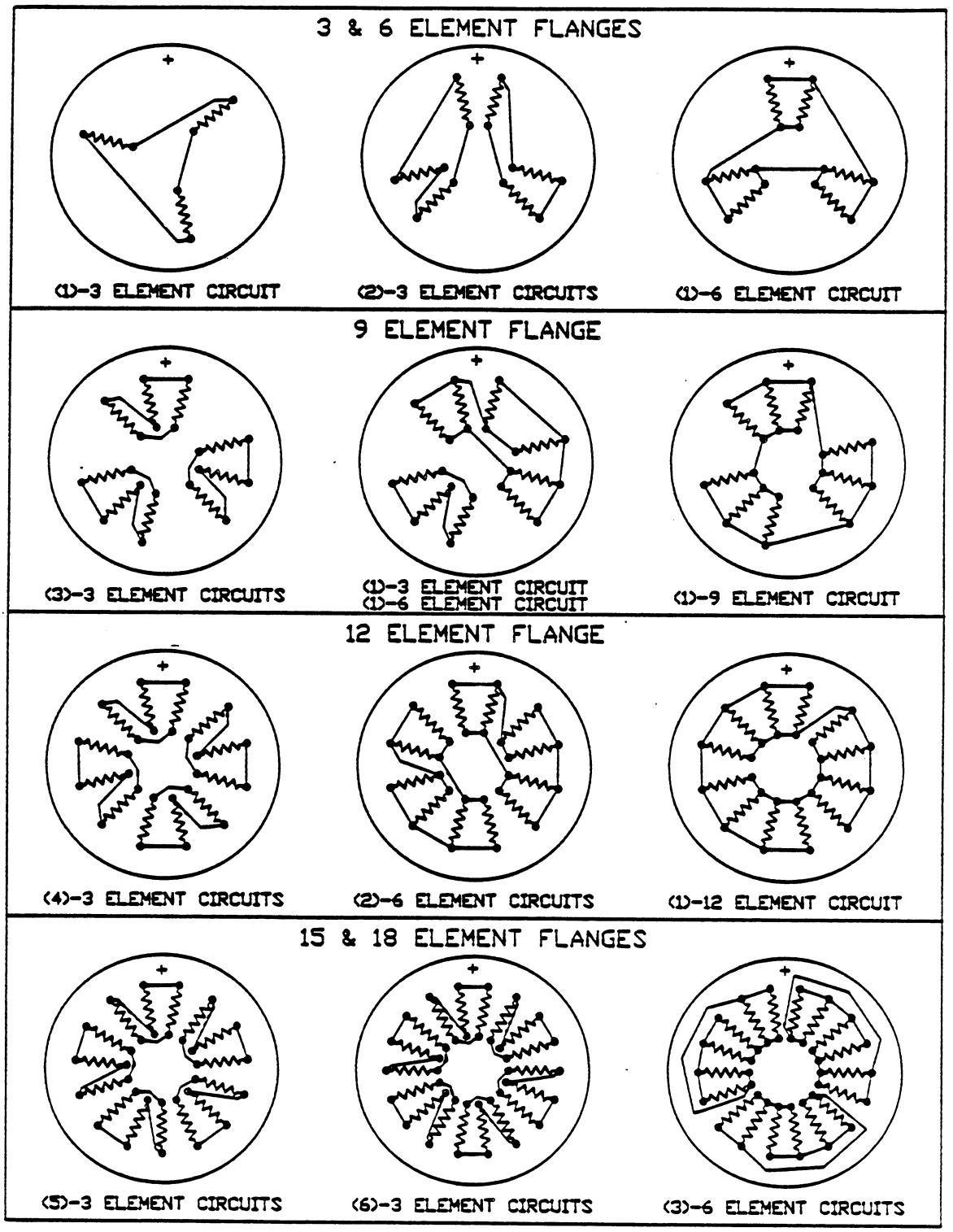


FIGURE 4-5/BOILER ELEMENT BUSSING DETAILS

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	POSSIBLE CAUSES	ACTIONS
Pilot switch on: "power on" pilot light off	Main power supply not on	Energize power supply
	Control transformer fuse is blown	Check for loose connections, then replace fuse
	Control transformer inoperative	Check for proper wiring/loose connections; replace transformer
	Pilot light burned out	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

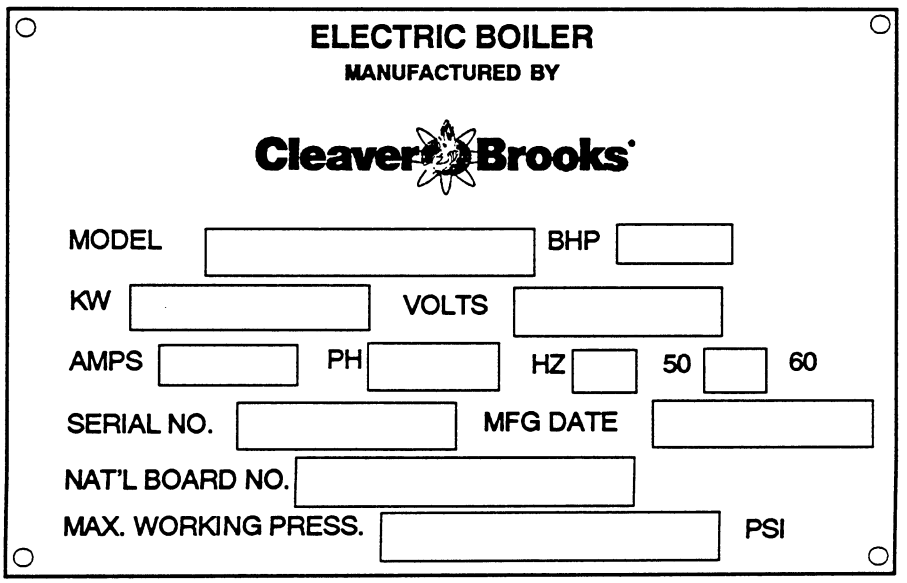
PROBLEMS	POSSIBLE CAUSES	ACTIONS
Control power pilot light on, alarm pilot lights off, contactors not energized	Alarm pilot light(s) burned out	Replace pilot light(s)
	Step control fuse blown	Replace fuse
	Pressure/temperature control improperly wired to step control	Check that wiring is per control literature and per unit wiring diagram
Steps do not all energize	Step control faulty	Replace step control
	Contactor coil inoperative	Check for loose coil connection; replace contactor.
	Step control relay(s) faulty	Check that relay is tight in socket; replace relay
Steps do not draw rated current	Step control faulty	Replace step control
	Branch circuit fuse(s) blown	Check element(s) for proper ohms and resistance to ground then replace fuse(s).
	Element bussing improper	Check that element bussing is per wiring diagram
Contactors noisy (chatter)	Element(s) open	Replace faulty element(s)
	Contactors damp/dirty	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.



CB PARTS LIST

CWB and HW
Models Electric Hot Water 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	
817-400	A/R Limit Control	170-240°F
817-1050	M/R Limit Control	110-250°F
817-2183	2-Stage Control	160-260°F
994-1915	2-Stage Control	55-175°F
817-1244	Mod Controls	160-260°F
817-1424	Mod Controls	55-175°F
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 Fuses 1.5 amp	600V
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	
833-2525	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	

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