# BOILER Operation Maintenance and Safety

***TPC is the leader in maintenance training***
***In the virtual and live classroom format***

*Written and presented by* **Gary Xavier**

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# *Webster's Dictionary defines a boiler…*

***Boil-er (n.)*** *1. a closed vessel or arrangement of vessels and tubes, together with a furnace or other heat source, in which steam or other vapor is generated from water to drive turbines or engines, supply heat, process certain materials, etc. Cf. fire-tube boiler, water-tube boiler.*

# *Webster's Dictionary defines a boiler…*

*2. a vessel, as a kettle, for boiling or heating.*

*3. British. A large tub in which laundry is boiled or sterilized.*

*4. a tank in which water is heated and stored, as for supplying hot water.*

***Webster's Dictionary defines a boil***

***Boil-er (n.)*** *1. a* *of vessels and tube* *ther heat source, i* *generated from water to d* *, supply heat, process certain ma* *er. fire-tube boiler, water-tube boiler.*

**PRESSURE**

# Boiler terminology

- **Fireside**

  *The furnace, combustion chamber, or firebox – the burner where fuel is turned into heat.*

- **Waterside**

  *The pressure vessel – where water is heated or turned into steam.*

# Boiler terminology

- **Boiler trim**

*The controls, valves, and fittings that make a pressure vessel a boiler:*

Safety or Relief valve

Low-water cutout (LWCO)

Water column

Pressure and temperature controls

Burner management system

# Boiler classification

- Pressure
- Type
- Medium
- Use
- Fuel
- Capacity


3-pass Scotch marine packaged boiler
*Courtesy Hurst Boiler and Welding Co., Inc.*

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# **M**aximum **A**llowable **W**orking **P**ressure

| ASME BOILER PRESSURE DESIGNATIONS | | |
|---|---|---|
| ***Media*** | ***Heating Boilers*** | ***Power Boilers*** |
| **Steam** | **Less Than or Equal To 15 PSIG** | **Greater Than 15 PSIG** |
| **Water** | **Less Than or Equal To 160 PSIG or 250°F at or near boiler outlet** | **Greater Than 160 PSIG or 250°F at or near boiler outlet** |
| **State or local jurisdictions may modify pressure designations for purposes of operator licensing** | | |

# **M**aximum **A**llowable **W**orking **P**ressure

*Original stamps were retired January 1, 2013*



S

*New stamps were introduced in 2012, became mandatory January 1, 2013*

**S Stamp**


Power Boilers (over 15 p.s.i. steam, 160 p.s.i. water and temperature exceeding 250 F) shall be stamped ASME (S) and National Boiler (N.B.) The "S" stamp by virtue of its description, also covers the "PP" area or pressure piping.

# **M**aximum **A**llowable **W**orking **P**ressure

*Original stamps were retired January 1, 2013*

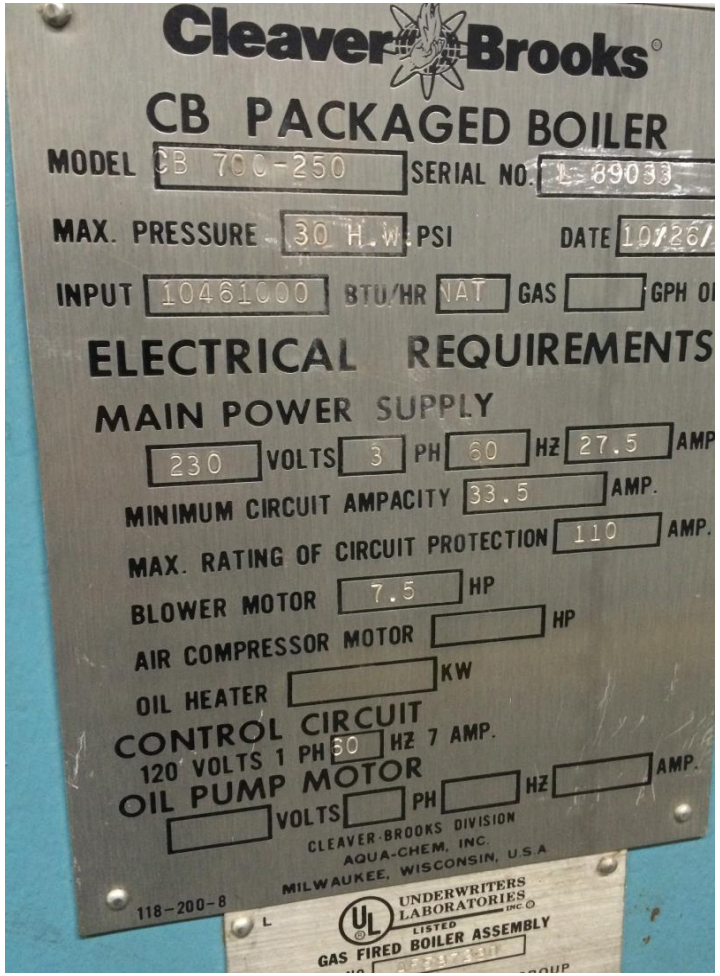


*New stamps were introduced in 2012, became mandatory January 1, 2013*

## H Stamp

**Heating boilers not to exceed 15 psi steam or 160 psi water or 250°F at or near the boiler outlet.**

# **M**aximum **A**llowable **W**orking **P**ressure




# **M**aximum **A**llowable **W**orking **P**ressure

# Boiler Type

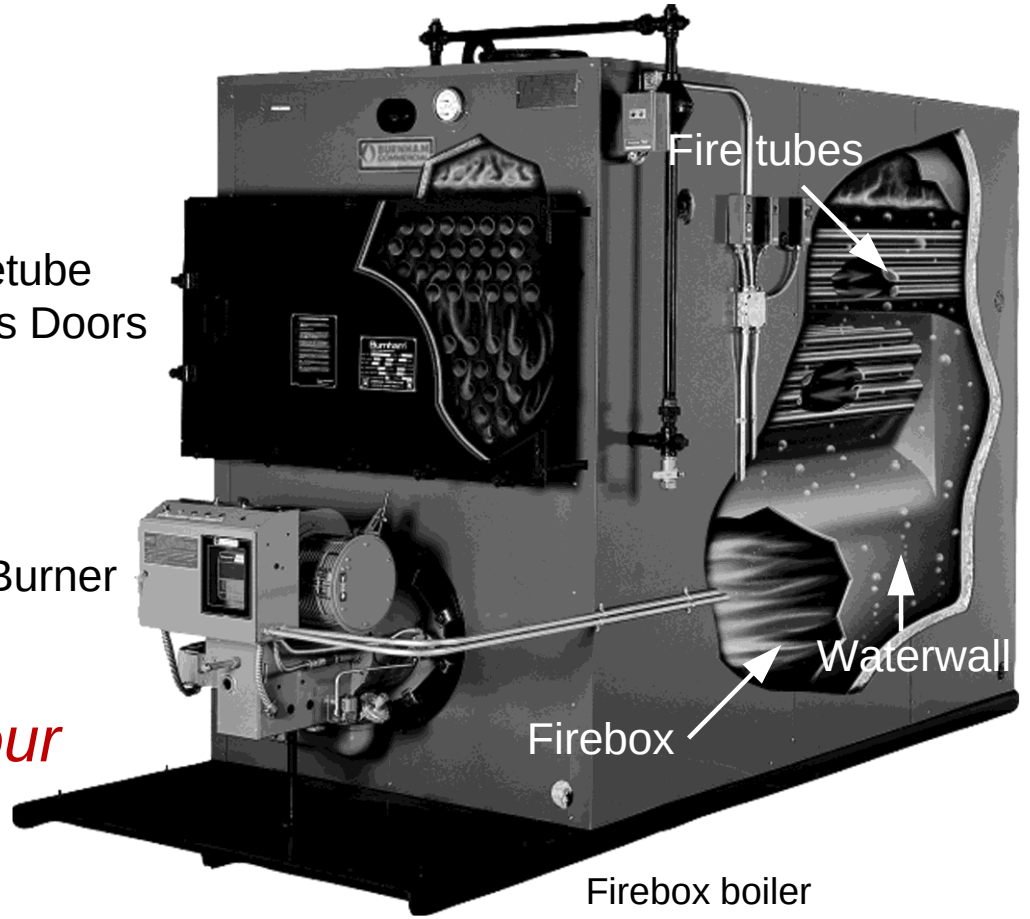
***Boiler Type*** is determined by the relationship of the water to the fire.

- **Firetube boilers:** *fire in the tubes and water around the tubes.*
- **Watertube boilers:** *water in the tubes and fire around the tubes.*
- **Sectional boilers:** *water in the sections and fire around the sections.*

# Firetube Boilers

- Firebox
- Scotch marine
- Vertical
- Locomotive
- Horizontal return tube

- *Saturated steam*
- *Hot water*
- *Capacities ≤ 30,000 pounds per hour*
- *Pressures ≤ 250 psig.*



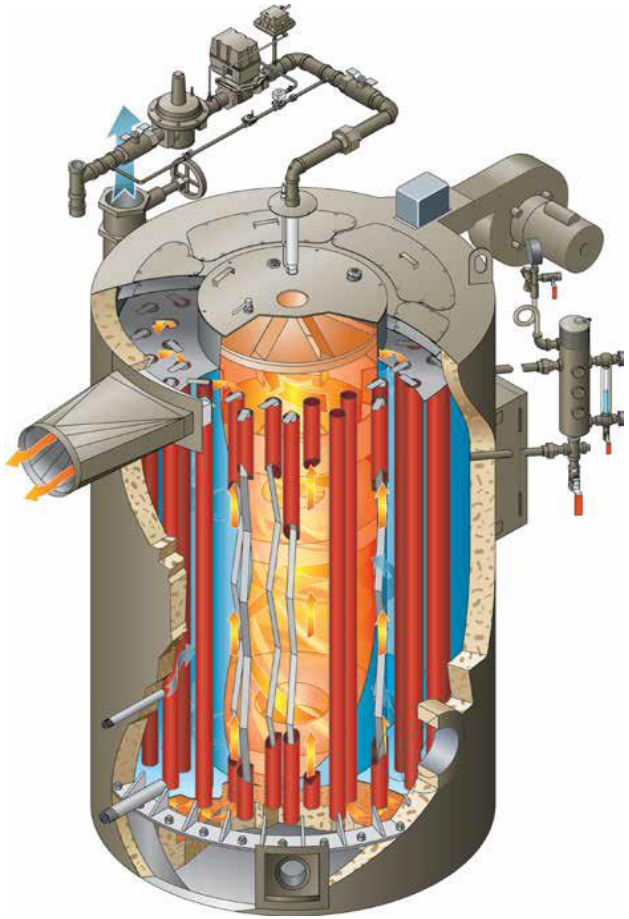

Firebox boiler
*Courtesy Burnham Commercial ®*

# Firetube Boilers

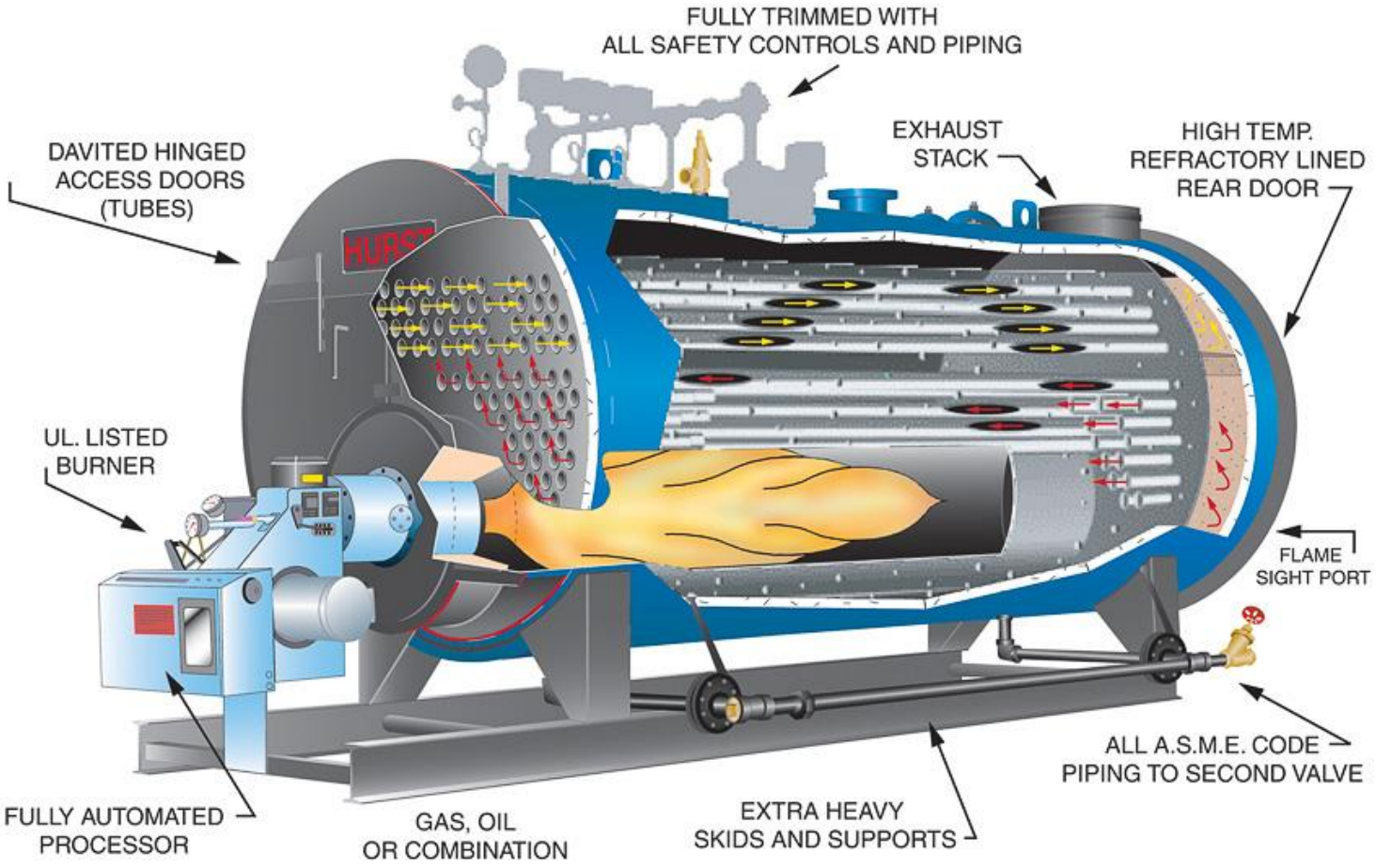

Vertical tubeless boiler
*Courtesy Fulton Companies*


Scotch marine wetback firetube boiler
*Courtesy Hurst Boiler and Welding Co., Inc.*

# Firetube Boilers



*Courtesy Fulton Companies*




*Courtesy Hurst Boiler and Welding Co., Inc.*

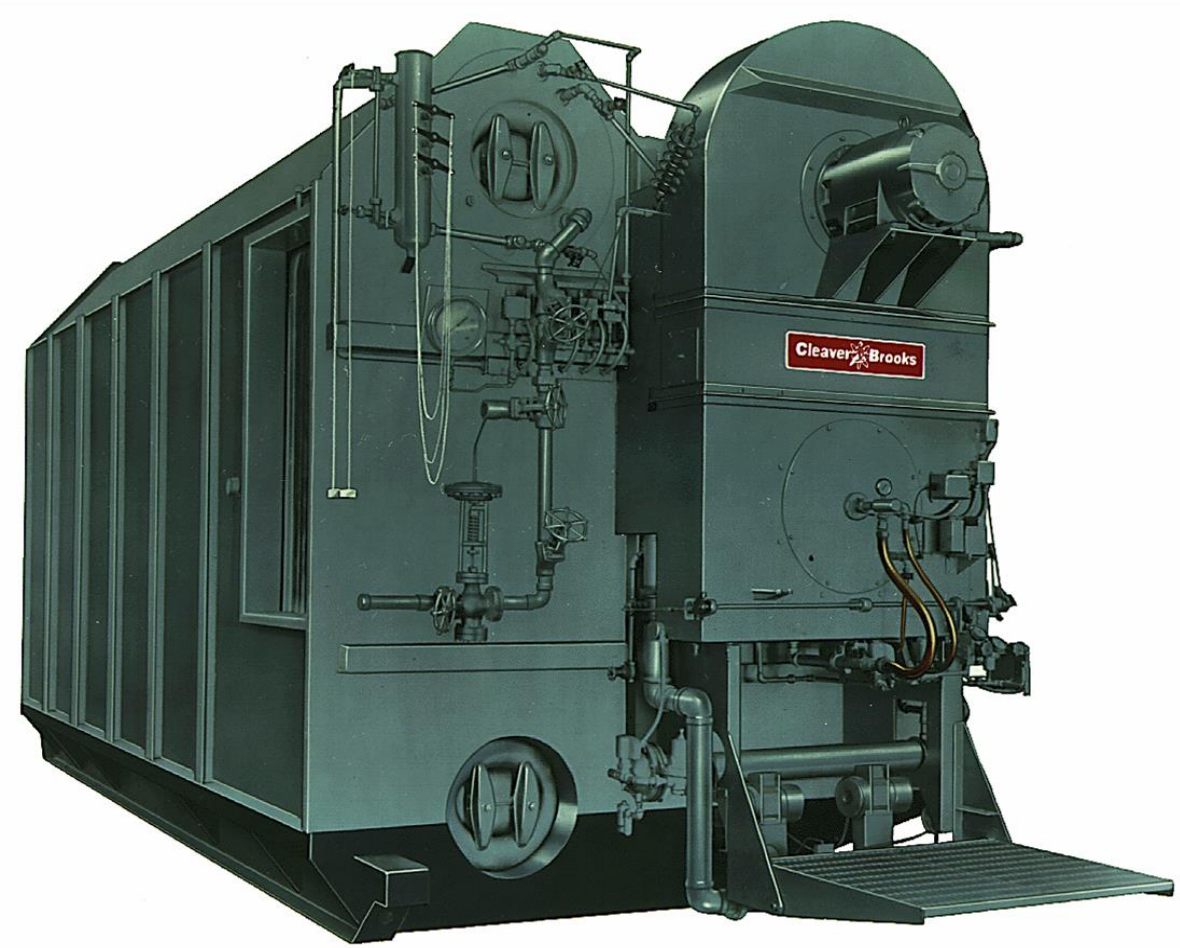
# Watertube Boilers

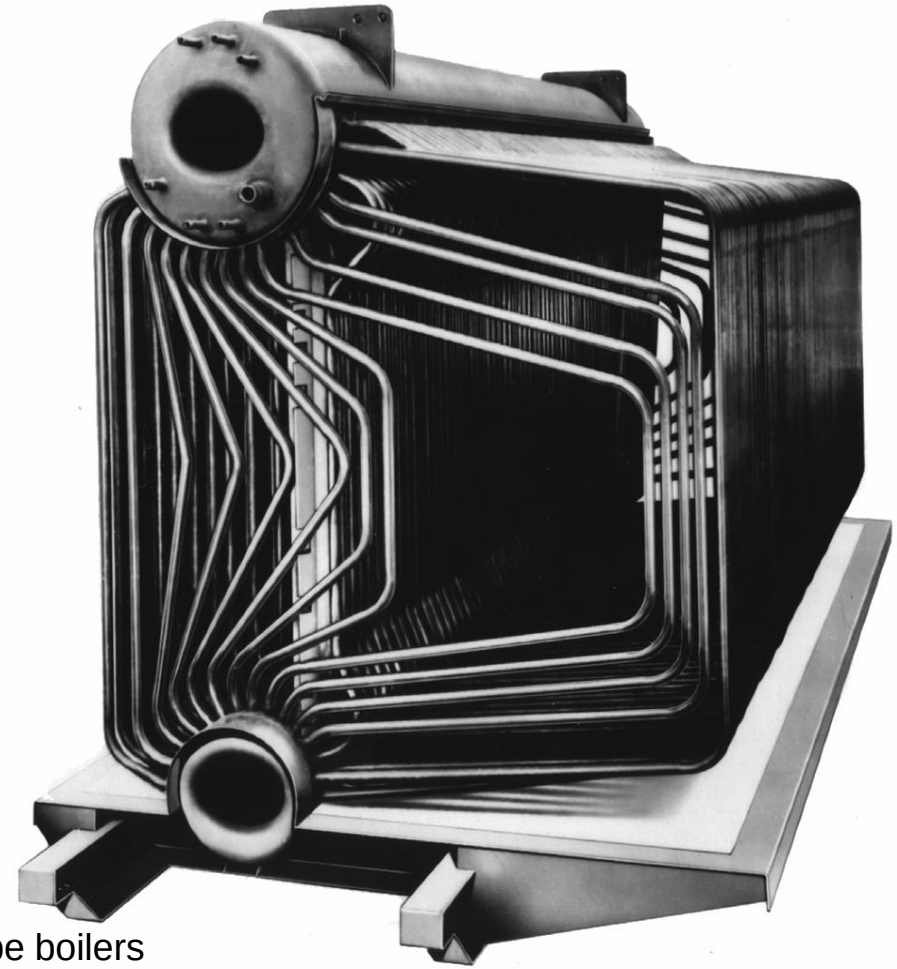
- Industrial O,A,D,M types
- Commercial O,D and flexible
- Helical-coil boilers
- Steam generators

- *Saturated and superheated steam*
- *High temperature hot water*
- *Capacities to > 1,000,000 pph*
- *Pressures  to > 3200 psig*


D-Type packaged watertube boiler
*Courtesy English Boiler Inc.*

# Watertube Boilers



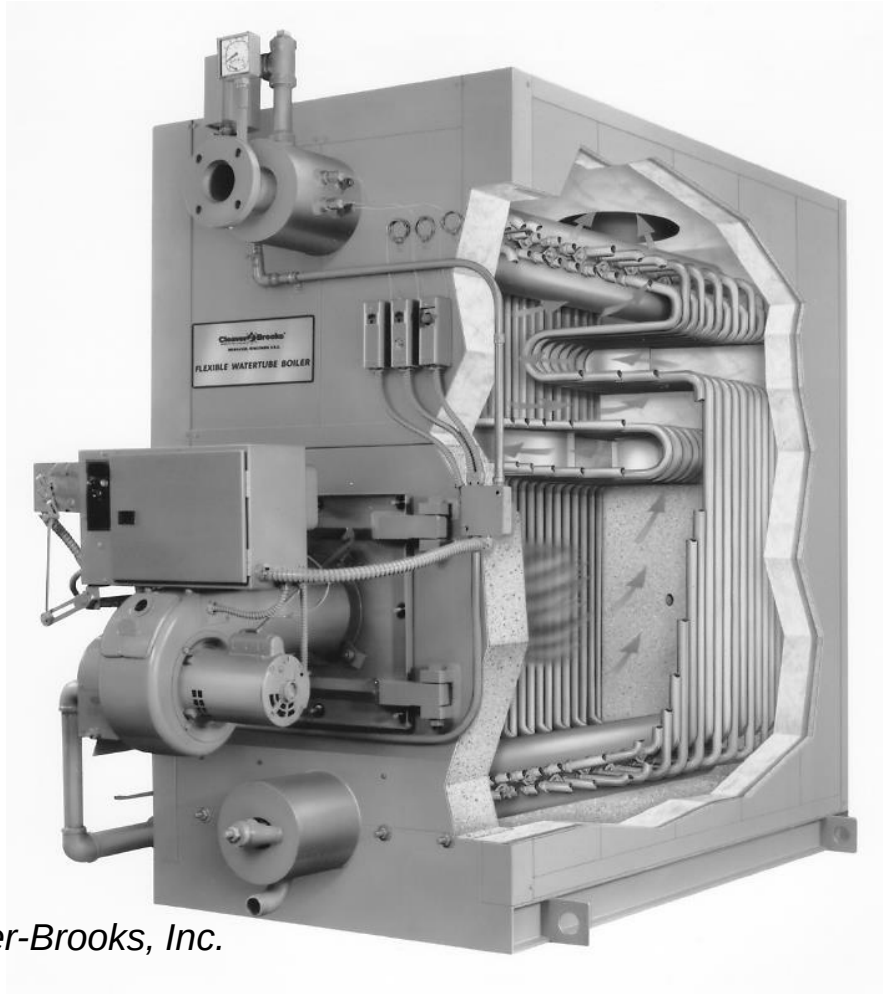



D-Type industrial watertube boilers
*Courtesy Cleaver-Brooks, Inc.*

# Watertube Boilers

*Courtesy Bryan Boilers*

Commercial flexible tube watertube boilers




*Courtesy Cleaver-Brooks, Inc.*

# Watertube Boilers

1. Outer Heater Cover
2. Inner Heater Cover
3. Clamp Band
4. Outer Shell
5. Burner Base
6. Burner Manifold
7. Burner Volute
8. Refractory Insulation
9. Cap Screws
10. Castable Insulation
11. Water Air Passage
12. Air Passage
13. Heating Coil
14. Coil Insulation
15. Cap Screws
16. Lifting Lug

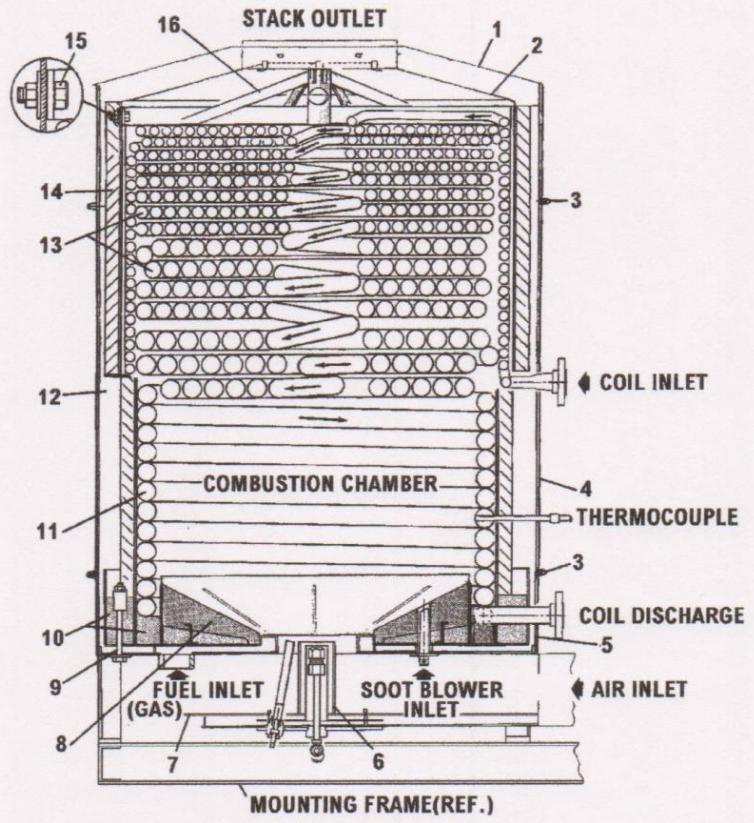


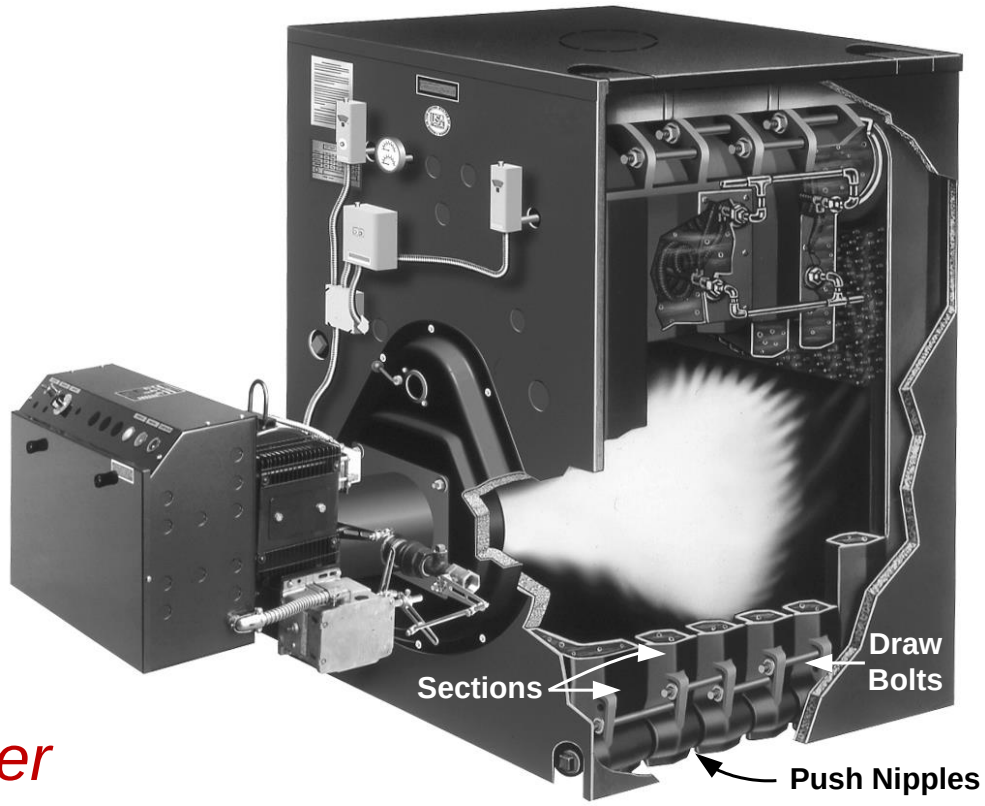

**Fig. 7-9.** Heating Unit (typical)

Helical-coil steam generator
*Courtesy Clayton Industries*

# Sectional Boilers

Assembled of sections of cast iron or aluminum that provide steam or hot water for heating purposes only

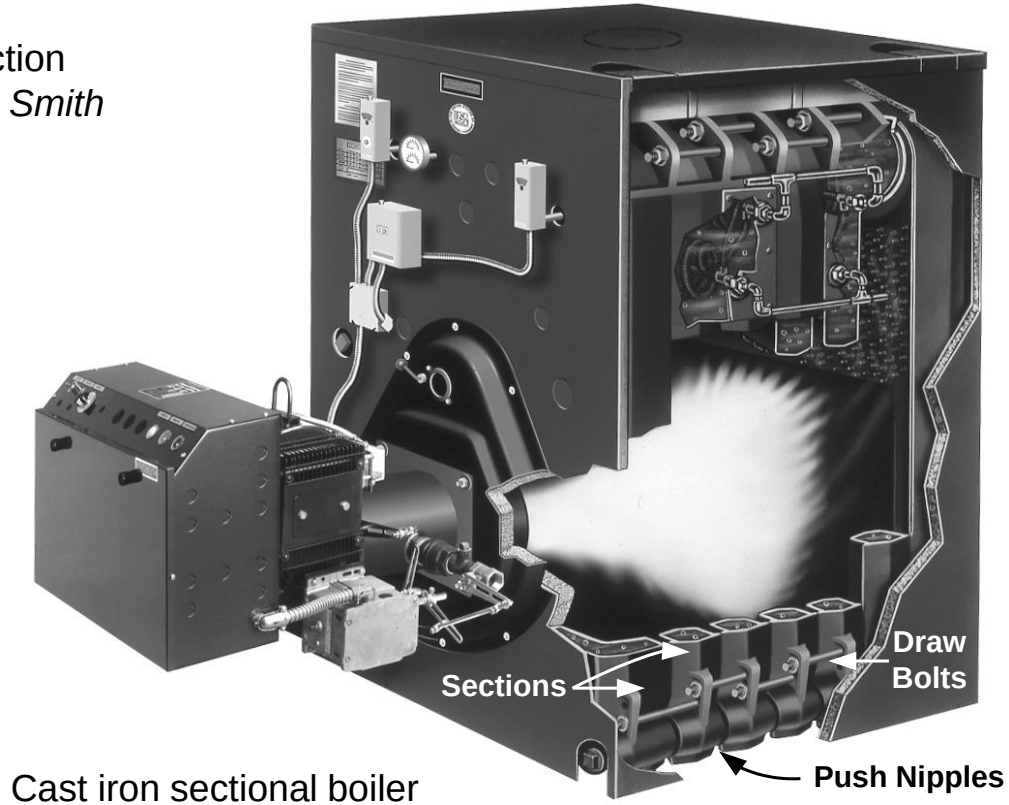
- *Saturated steam*
- *Hot water*
- *Capacity based on number of sections*
- *Pressures up to 15 psi steam, 30 psi water*




Cast iron sectional boiler
*Courtesy Burnham Commercial ®*

# Sectional Boilers

Cast iron section
*Courtesy HB Smith*




Cast iron sectional boiler
*Courtesy Burnham Commercial ®*

# Boiler classification

***Use:*** *heat or process.*

- **Heating boilers** *provide steam or hot water for building heat.*
- **Power boilers** *provide steam or high temperature hot water for uses in manufacturing or power generation.*


*Courtesy Fulton Companies*

# Boiler classification

**Media used to transfer heat:**

- *Steam*
- *Water*

**Type of fuel:**

- *Coal*
- *Wood*
- *Gas*
- *Oil*
- *Biomass*
- *Electricity*


ClearFire ® condensing boiler
*Courtesy Cleaver Brooks, Inc.*

# Boiler classification

**Size or capacity:**

*the amount of work done by the boiler.*

| BOILER ROOM CONVERSION FACTORS | | |
|---|---|---|
| ***Multiply*** | ***by*** | ***To Obtain*** |
| Boiler HP | **34.5** | pounds of steam/hour |
| Boiler HP | **33,475** | Btu/hour output |
| Boiler HP | **33.4** | Mbh (1000 btu per hour) |

# Boiler capacity

**Horsepower**

*the amount of work the boiler can do, based on 34.5 pounds of water turned into steam in one hour, from and at 212°F.*

***Webster's Dictionary defines a boil***

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**PRESSURE**

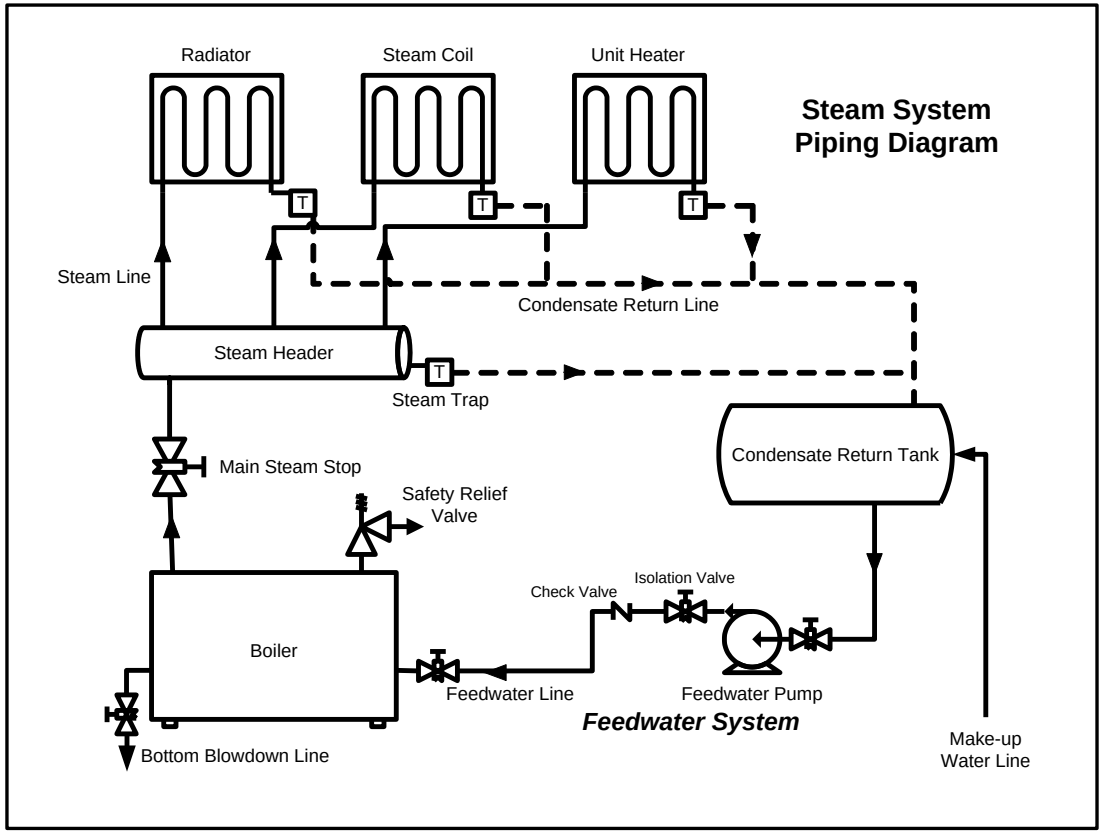
# Steam boiler systems

**Feedwater system**

**Steam system**

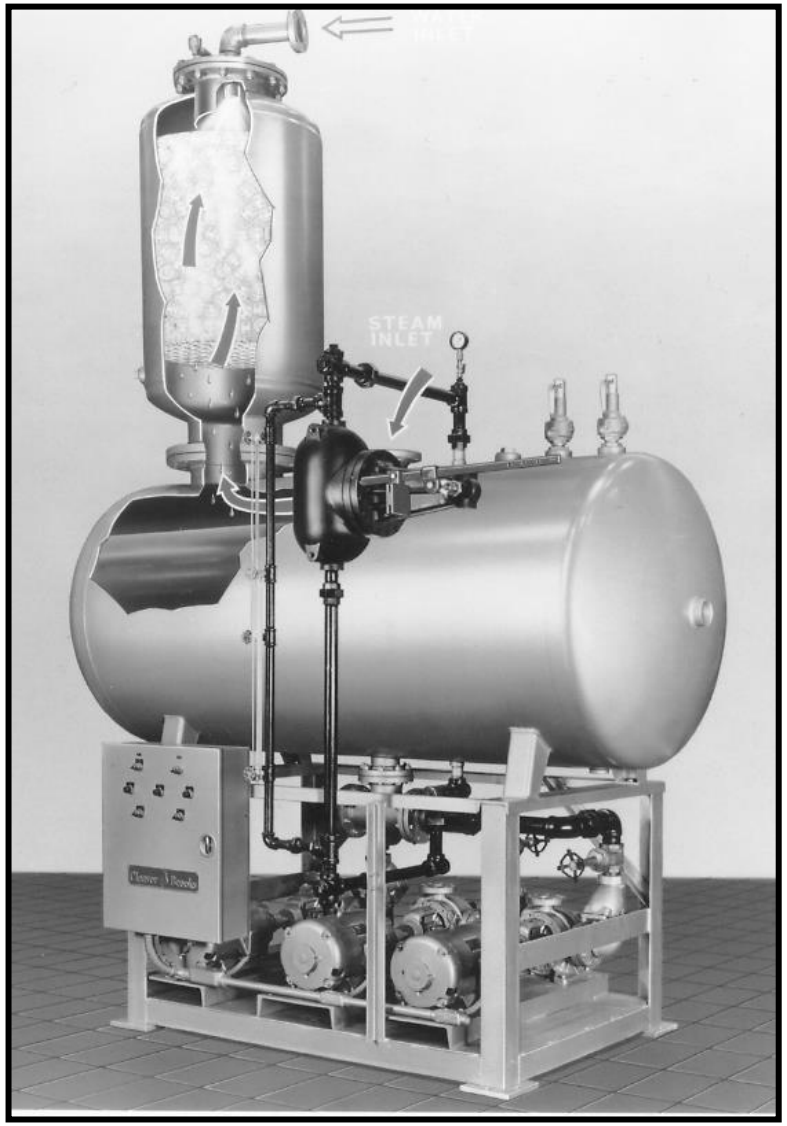
**Fuel system**

**Draft system**



# Feedwater system

- *Brings water to the boiler*
- *Consists of make-up water, pre-treatment equipment, chemical feed*




Deaerator
*Courtesy Cleaver-Brooks*

# Steam and condensate system

- *Carries steam from the boiler to the point of use*
- *Returns condensate to the boiler*
- *Consists of piping, valves, fittings, steam traps, heat exchangers*

OS & Y Valve

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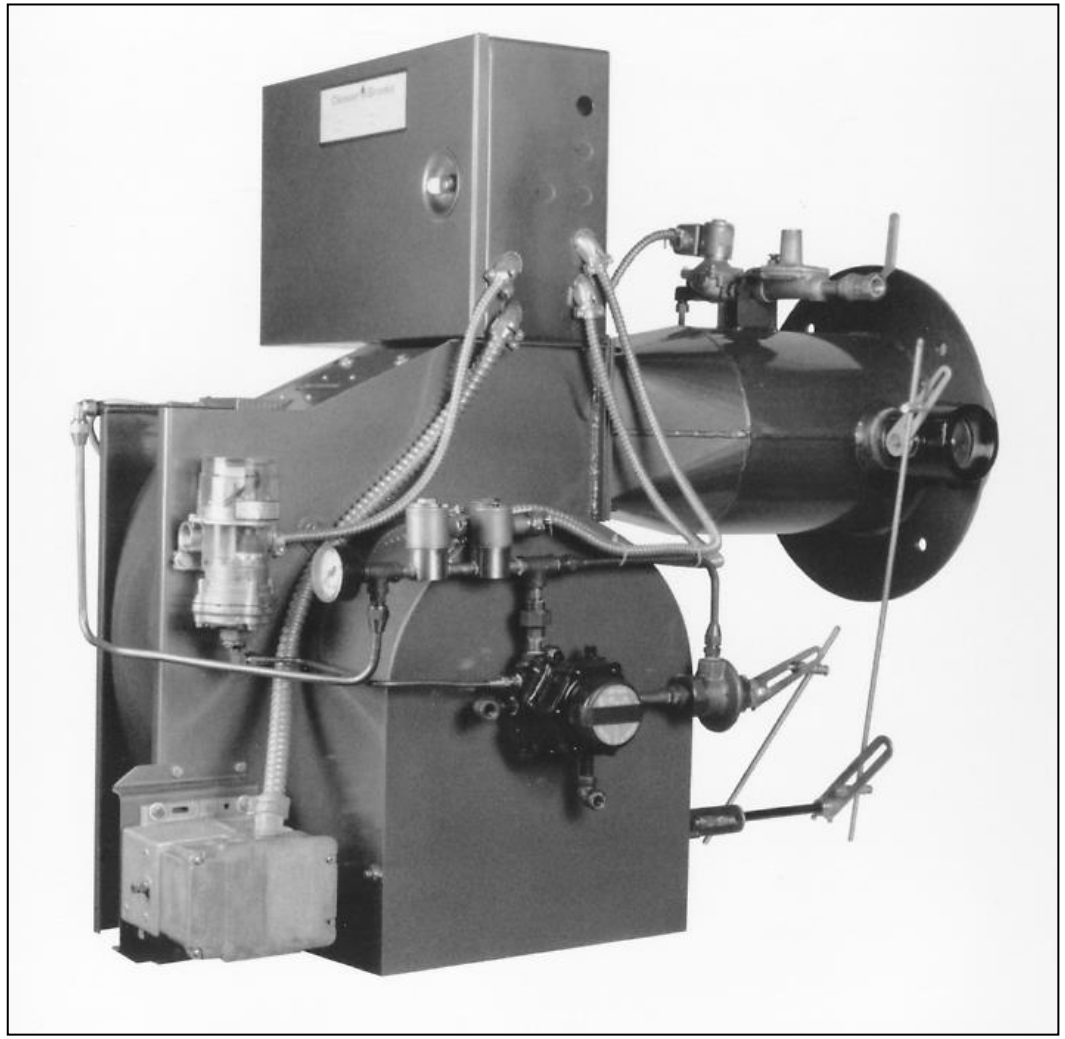
# Fuel system

- *Delivers fuel to boiler burner*
- *Consists of tanks, piping, valves, controls, and burner*



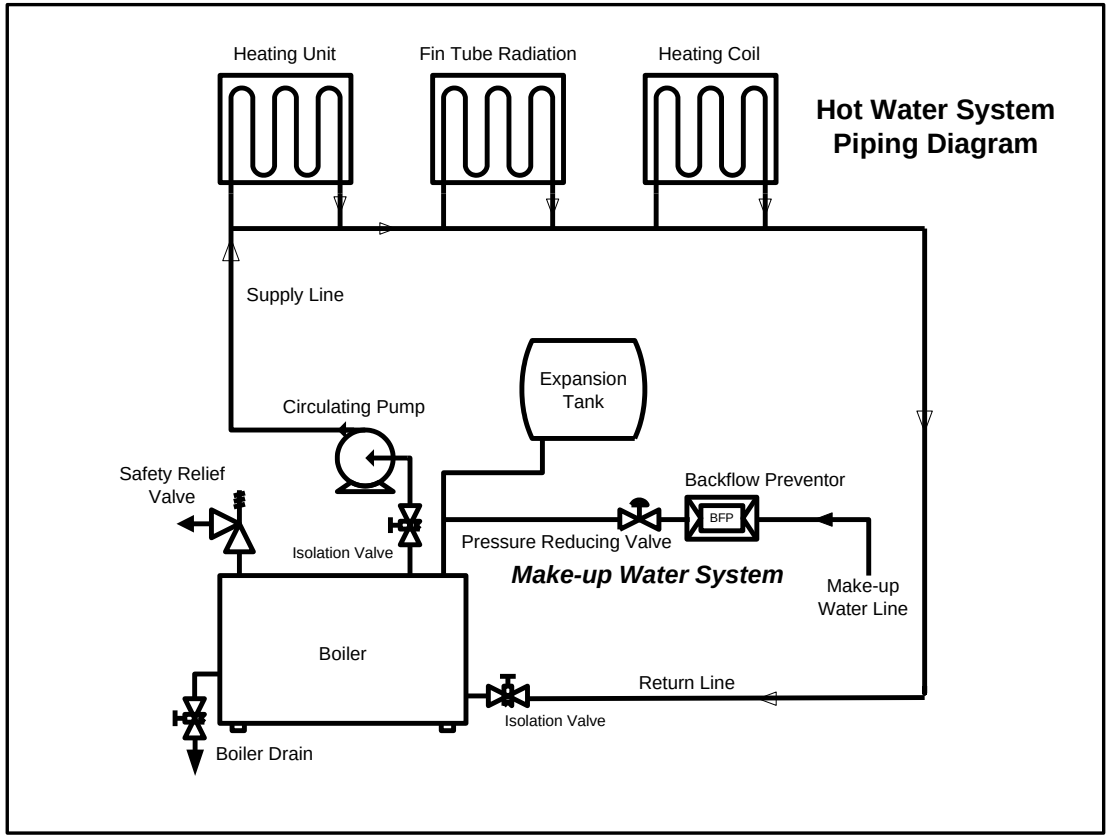
Power boiler burner *Courtesy Cleaver-Brooks*

# Draft system

- *Brings air to the furnace*
- *Removes flue gases from the combustion chamber*
- *Consists of stack, dampers, fans*
- *Natural, forced, induced, or balanced draft*

# Water boiler systems

- Make-up water system
- Recirculating water system
- Fuel system
- Draft system



# Make-up water system

- *Brings water to the boiler*
- *Consists of pressure reducing valve, backflow prevention*

Pressure reducing valve
*Photo Courtesy Bell and Gossett, Division of ITT*
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# Recirculating water system

- *Carries water from the boiler to the point of use and returns water to the boiler*
- *Consists of pumps, piping, valves, fittings, heat exchangers, expansion or compression tanks, air separators, air vents*

Water pump
*Photo Courtesy Bell and Gossett, Division of ITT*
.

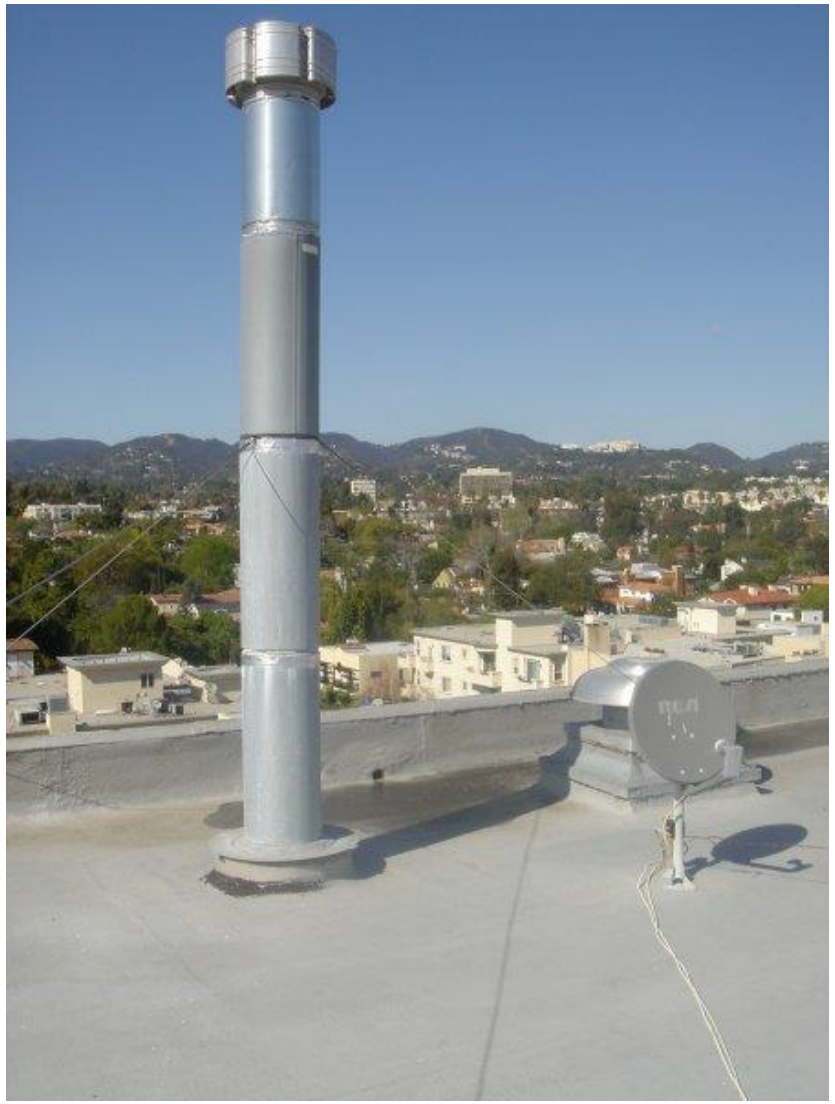
# Fuel system

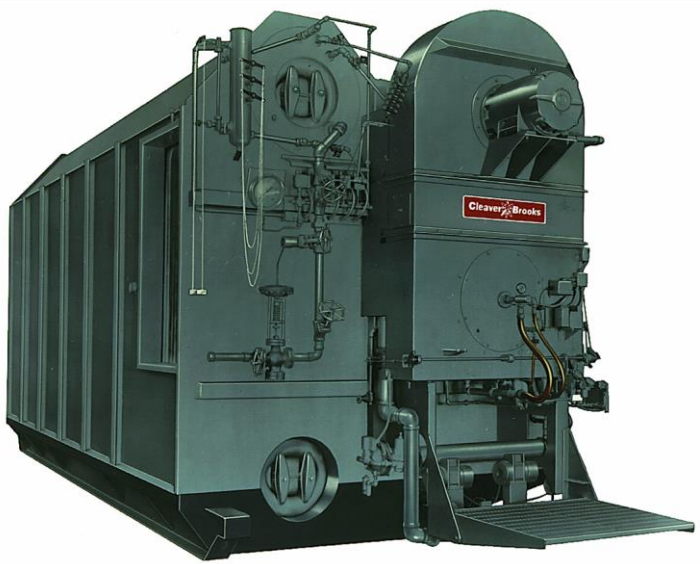
- *Delivers fuel to boiler burner*
- *Consists of tanks, piping, valves, controls, and burner*

Atmospheric boiler burner
*Photo courtesy Ajax Boiler, Inc.*

# Draft system

- *Brings air to the furnace*
- *Removes flue gases from the combustion chamber*
- *Consists of stack, dampers, fans*
- *Natural, forced, induced, or balanced draft*









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**PRESSURE**

# Boiler safety

- **The Number 1 cause of boiler failure is low water.**
- **NEVER add water to a hot boiler if you don’t know where the water level is.**
- **The Number 1 responsibility of a boiler operator is to maintain the Normal Operating Water Level (NOWL) at all times!**

**Regardless of your job title… if you have the authority to walk into a boiler room and touch the boiler – YOU are an OPERATOR!**

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# Respect the pressure!

# Thank you for attending!

**The 2-day virtual “Boiler Operation, Maintenance, and Safety” course, happening every Wednesday and Thursday**

**Register at:**

**TPC Training (877) 978-7246**

**live.tpctraining.com**