NORA Technician Certification Silver Review

Bob Hedden

NORA Education Director

NORA Certification

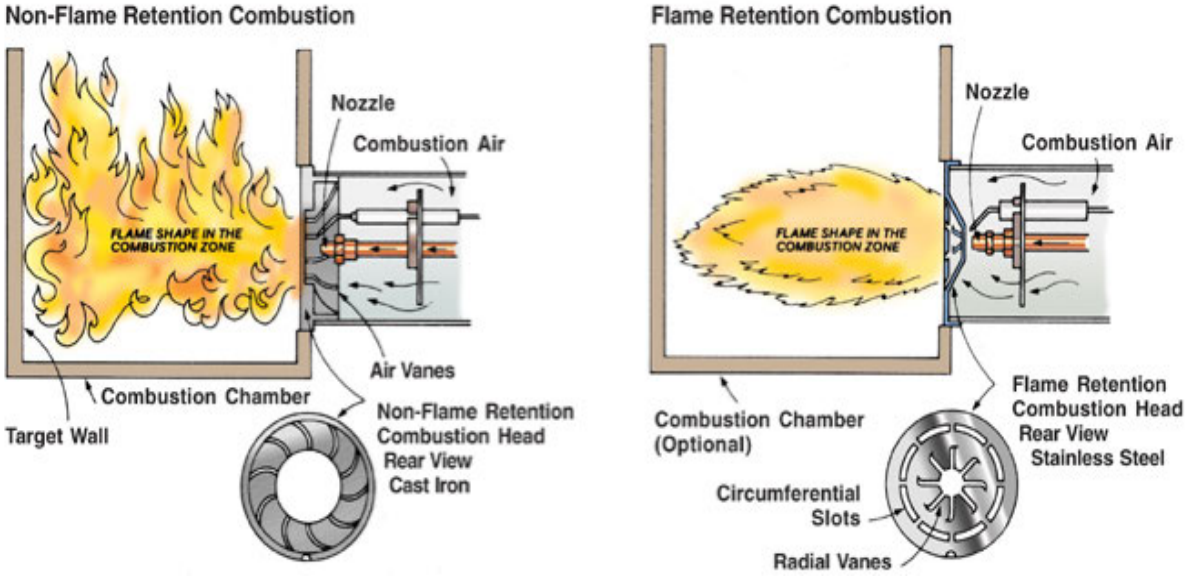
- Bronze- 80 hours of formal training. Bronze to Silver, get 3 years experience and 20 more CEUs
- Silver- 3 years experience & 100 hours of training
- Gold- 5 years experience & 4 of the new 6 hour Gold Certification courses
- National Program, technician is certified not the company, state program for VT & NH
- Test: 75 multiple choice questions, closed book, you can get 17 wrong and still pass.
- Silver and Gold are good for 5 years. To renew you need to get 24 CEUs, or retake the test.

Chapter 1: Oil Burners

- Oil will not burn as a liquid
- We must first vaporize it (turn it into a gas) to get it to burn
- For combustion to take place we need:
  - The vaporized **Fuel**
  - Enough **Heat** to raise the fuel temperature above the ignition point
  - **Oxygen** in the air. Air is the key final adjustment.

High Static Air Pressure (Flame Retention) Burners

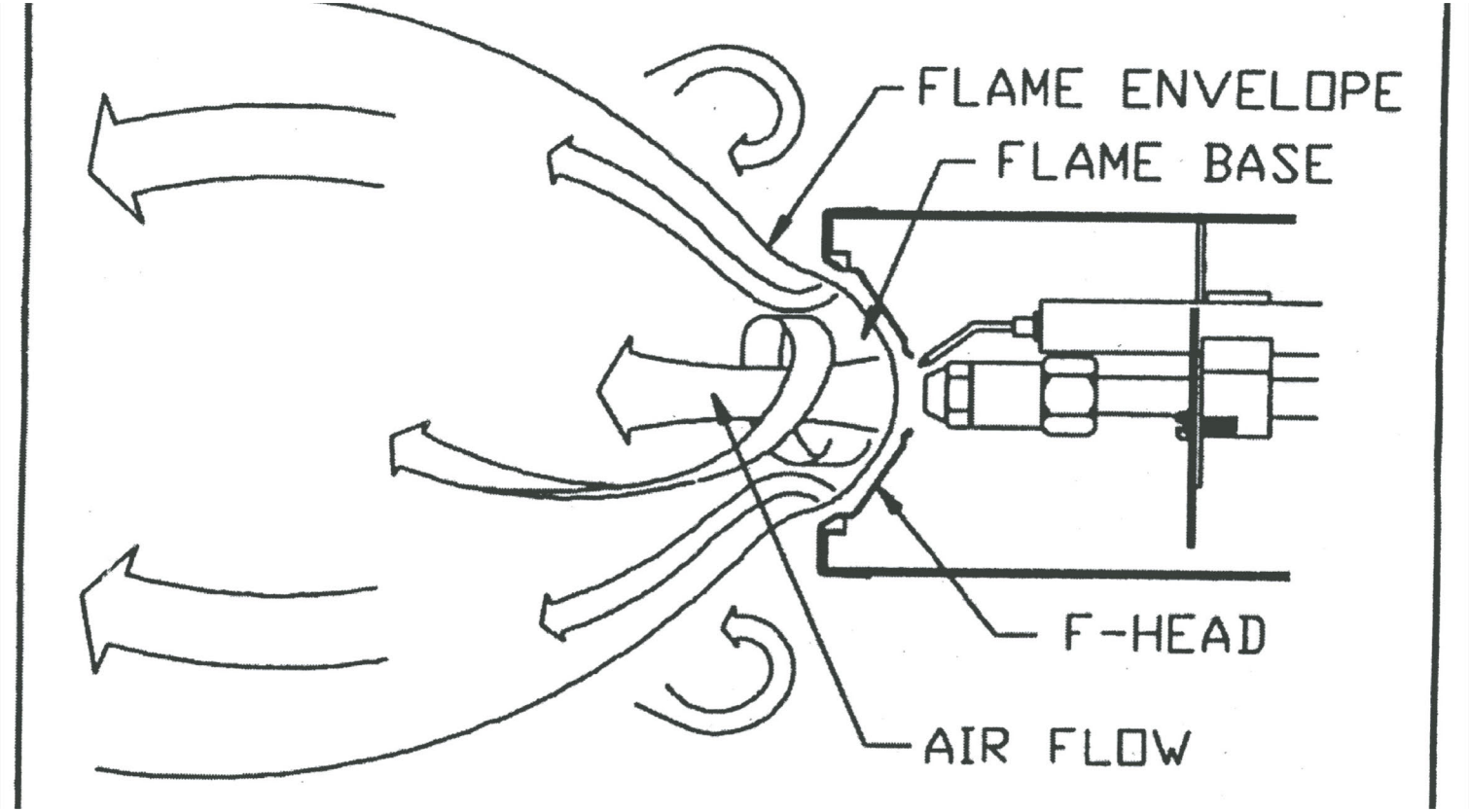
- Better air-oil mixing: Clean Burning and hotter flames with less excess air
- High Static Pressure: more stable flames, able to push through more restrictive heat exchangers
- **Tight heat exchangers lower stack temperatures and reduce idle losses.**



Oil Burner Fan

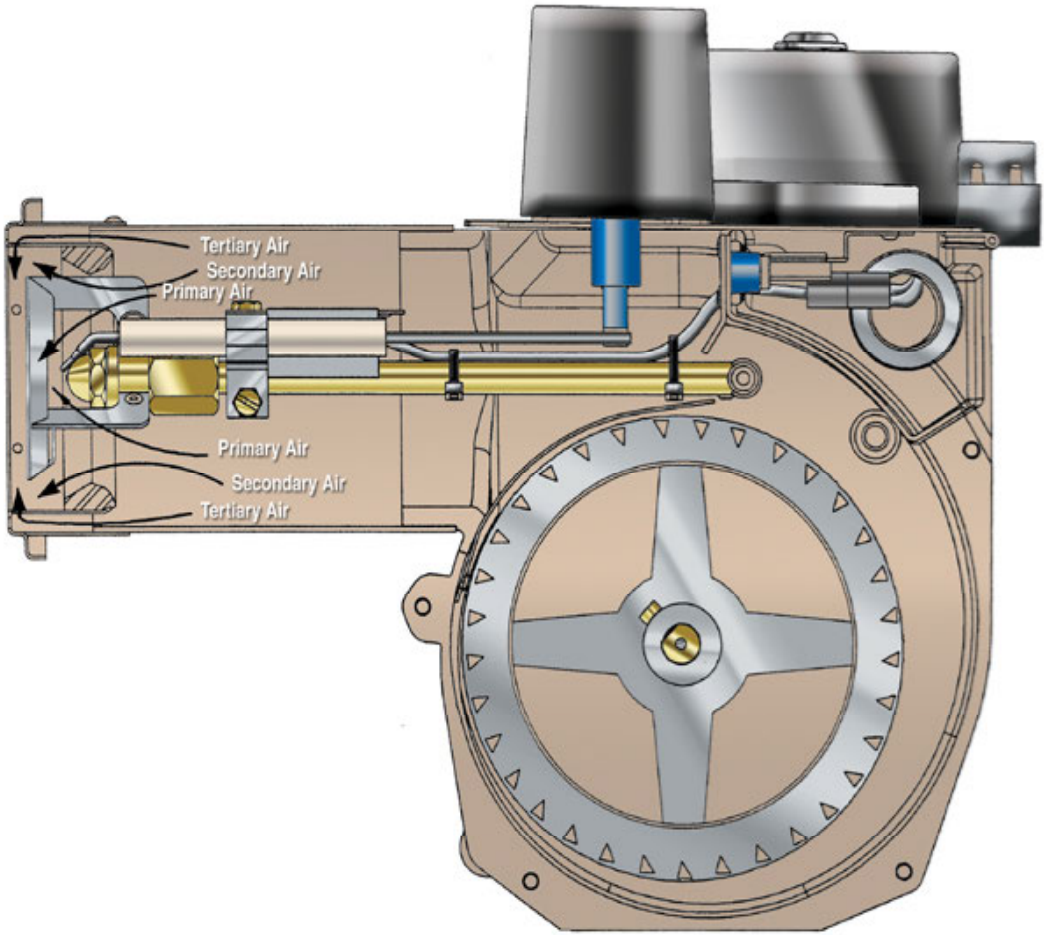
- The beveled blades of the burner fan deliver the air to the air tube.
- Fan must be capable of delivering a minimum of 30cfm plus excess air as required for combustion
- The inside of the bevel must be kept clean to insure proper air delivery

Primary, Secondary, and Tertiary Air



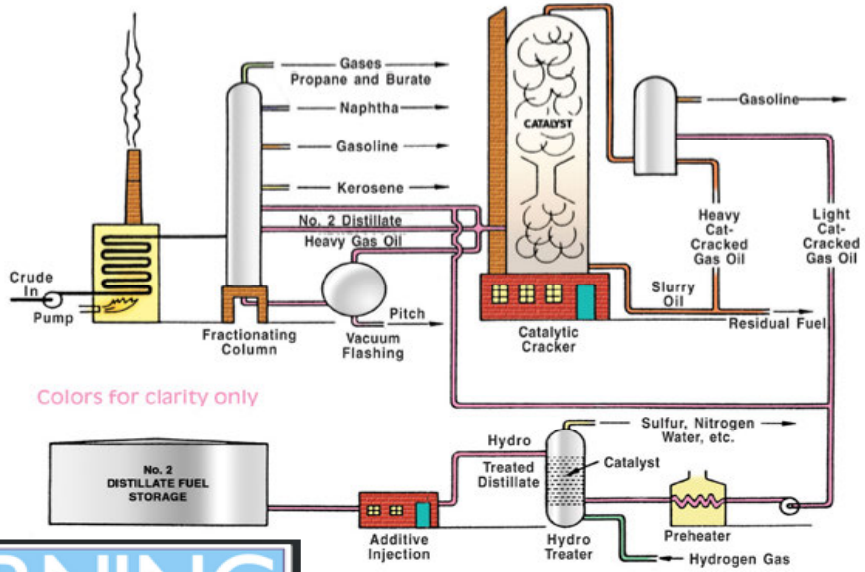
Fixed Head- Air ration set by slots in the head, change firing rate- change head. (Set the drawer assembly to the Z dimension.)

Adjustable Head- Move the head relative to throttle ring to change the air ratio



Chapter 2: Heating Oil

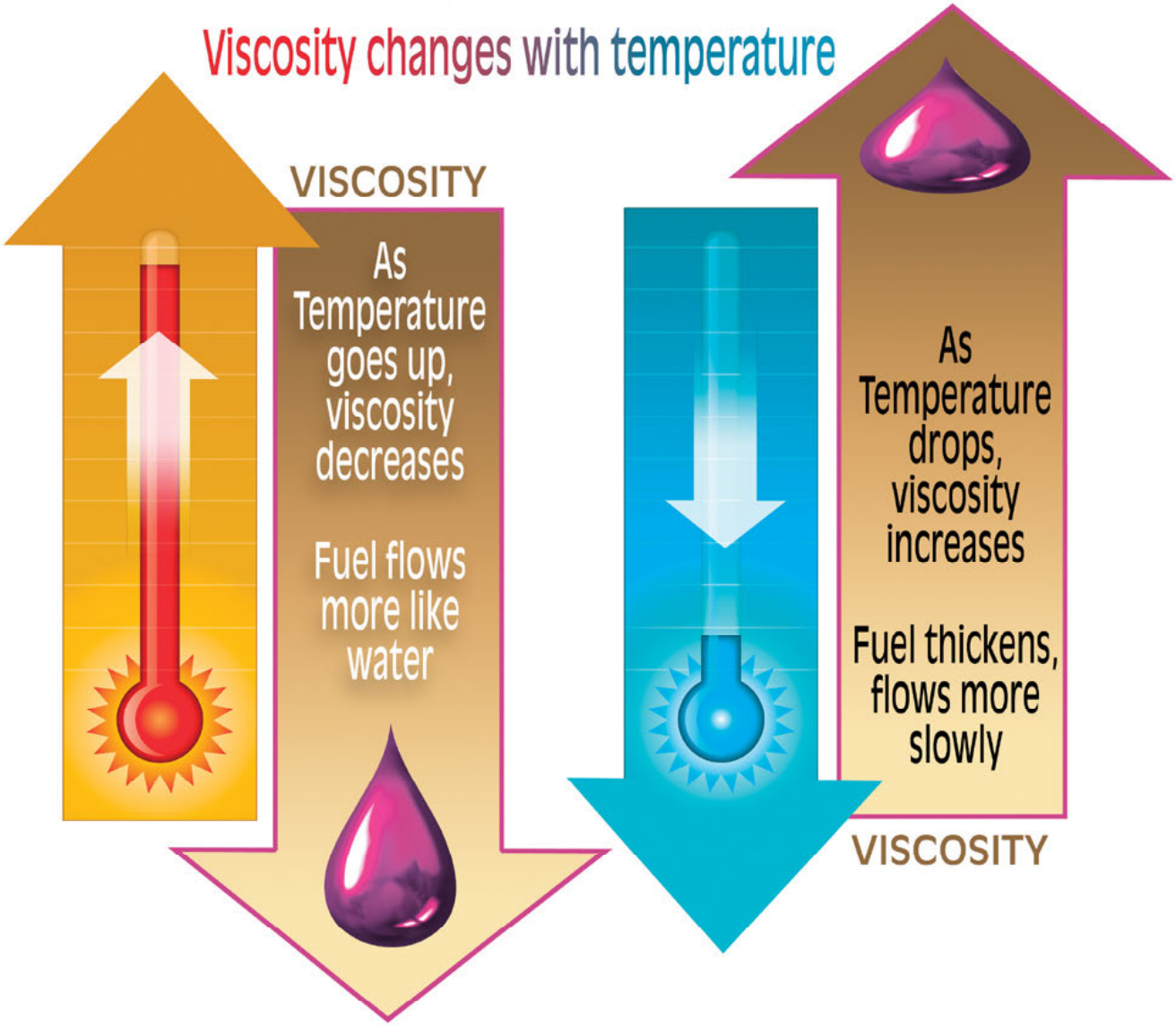
- Heating oil is a hydrocarbon fossil fuel manufactured from crude oil in a refinery. It is made up primarily of Hydrogen and Carbon atoms
- #2 oil contains approximately 140,000 BTU's per gallon



Hydrogen and Carbon

Properties of Heating Oil

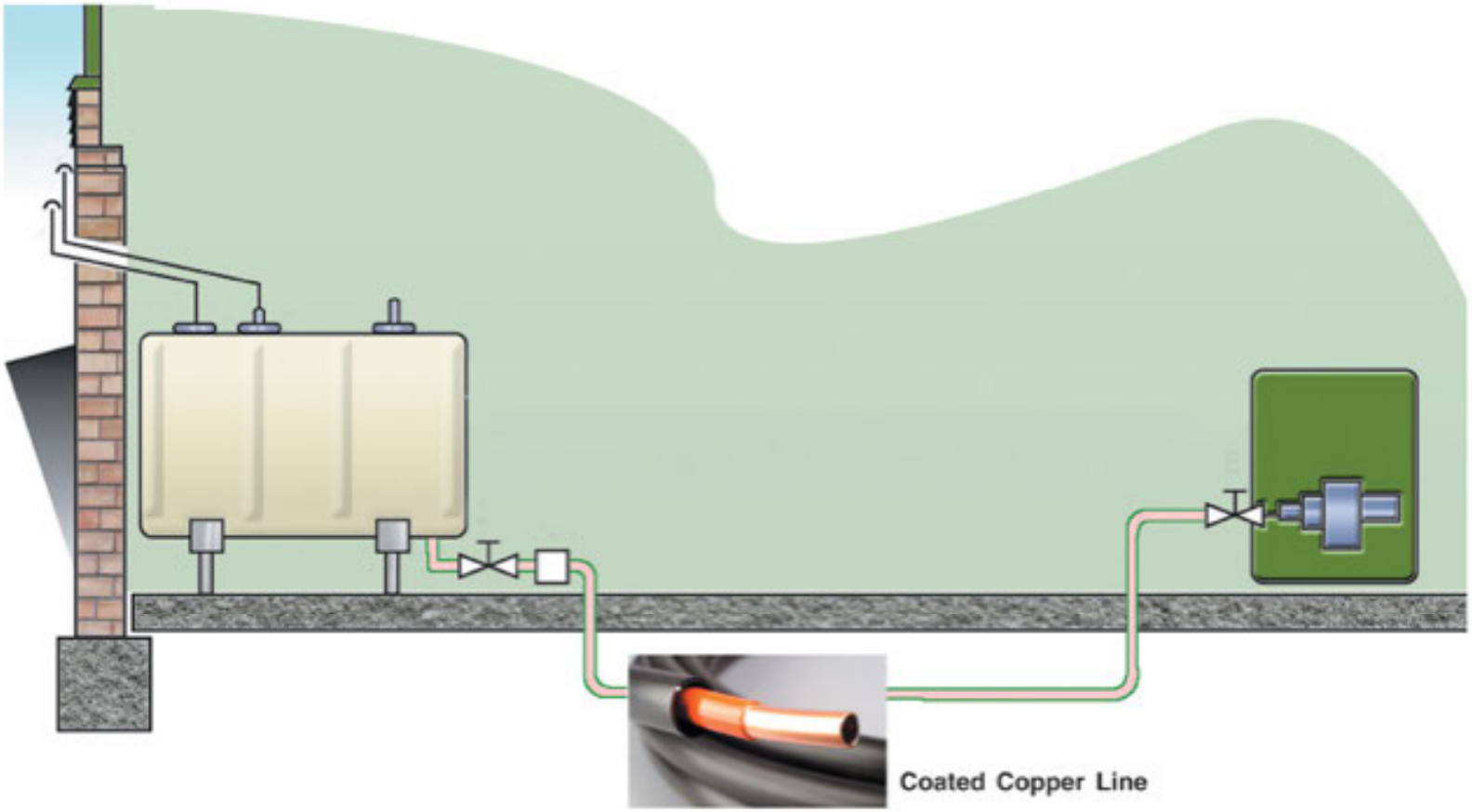
- **Flash Point:** the lowest temp. that the fuel will flash but not continue to burn- over 100. The highest temperature fuel can be safely stored
- **Ignition Point:** the lowest temperature when rapid combustion of the fuel takes place in air- over 500
- **Pour Point:** lowest temperature at which it will flow. Can be lowered by blending with kerosene or additives.


Viscosity changes with temperature
VISCOSITY
As Temperature goes up, viscosity decreases
Fuel flows more like water
As Temperature drops, viscosity increases
Fuel thickens, flows more slowly
VISCOSITY

Tank Bottom Sediment

- Sludge is a combination of bacteria, mold, yeast, slime, acid, dirt, rust, and hydrocarbons
- It grows in the water at the bottom of the tank
- Water comes from condensation, loose or missing fill or vent caps, broken gauges, new tanks
- Install a quality oil filter
- Never Pump Over!

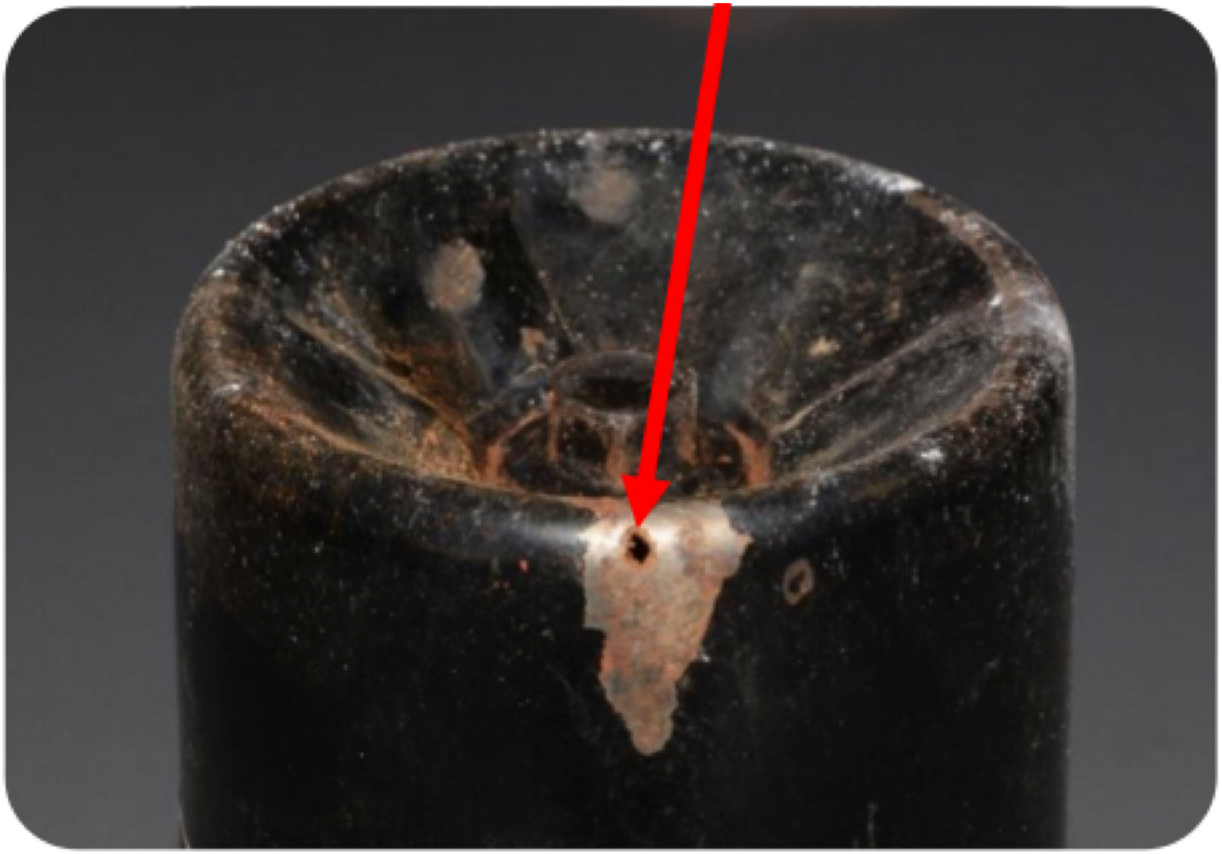
Chapter 3- Oil Tanks & Piping



Proper Tank Installation

- Locate indoors if possible, on solid base, fill & vent piped outdoors
- Pitch fill and vent toward tank, swing joints, steel pipe, malleable fittings, 1 ¼” fill and vent.
- Vent alarm (no whistle- no fill!), gauge, filter, 5 feet from burner
- Draw from bottom of tank, pitch 1/4” for every 1 foot
- Sleeve and protect oil lines, no compression fittings, fusible valves, no Teflon, no fittings below floor

Check the filter can!!

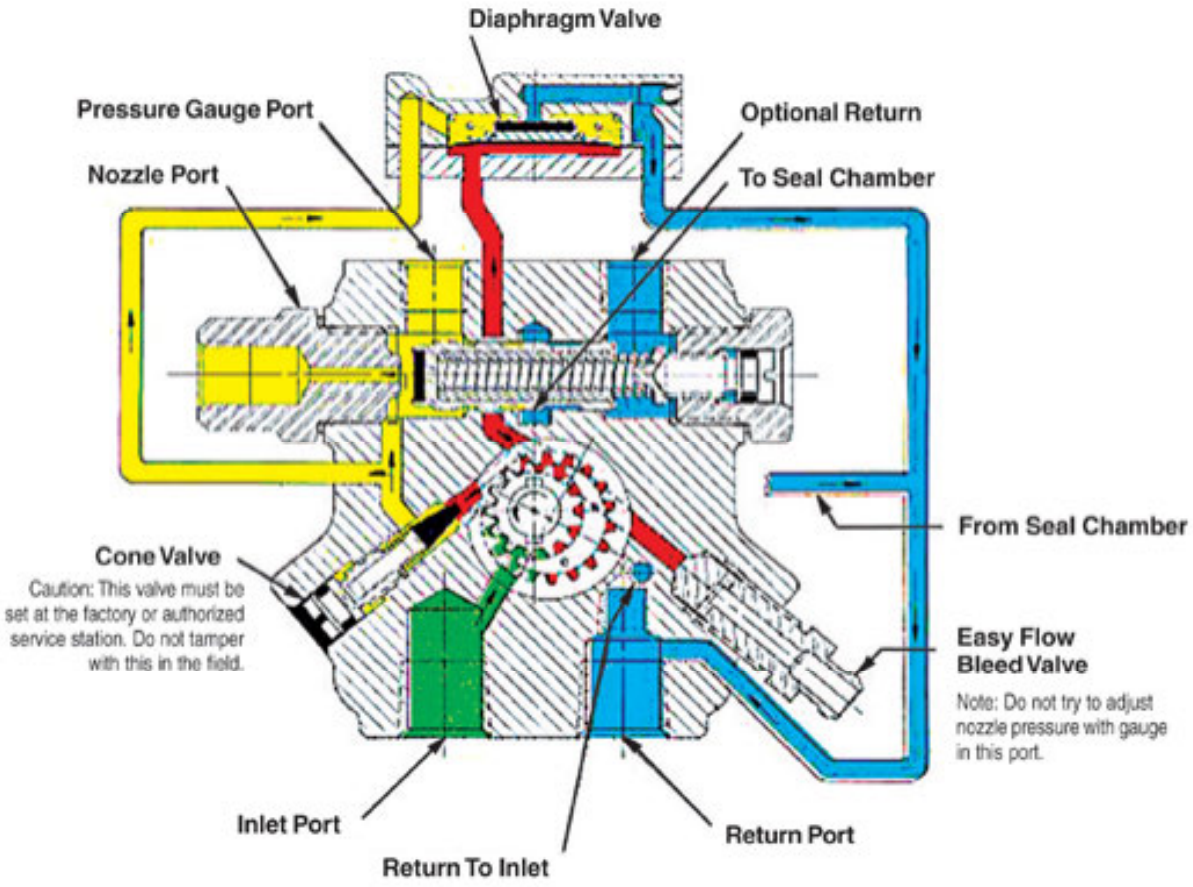


Chapter 4- Fuel Units, Oil Valves

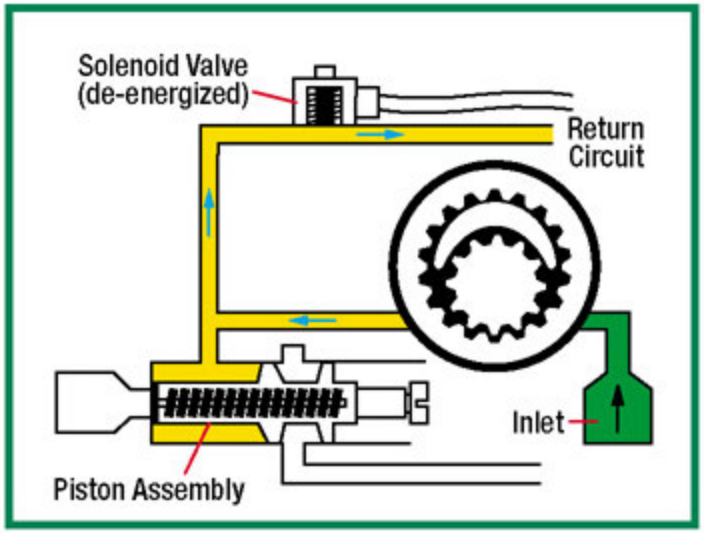
Function:

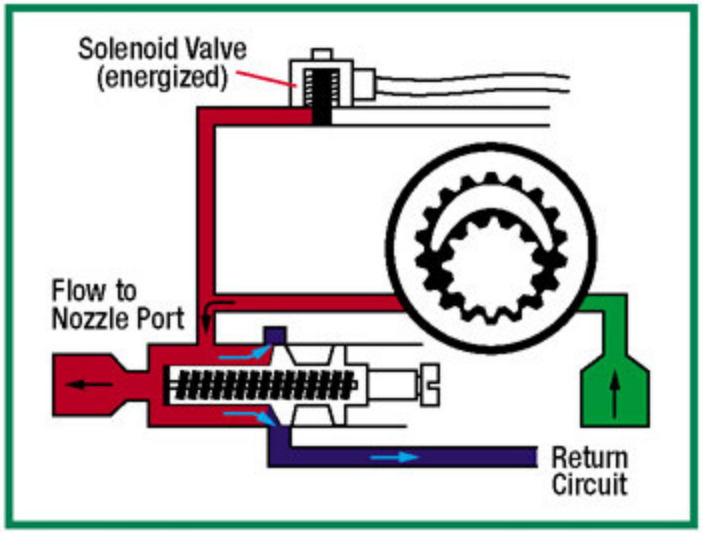
- lift the oil from the tank
- deliver oil at a constant and regulated pressure to the nozzle
- provide clean cut-off that stops gravity flow of fuel to nozzle

Suntec A Pump

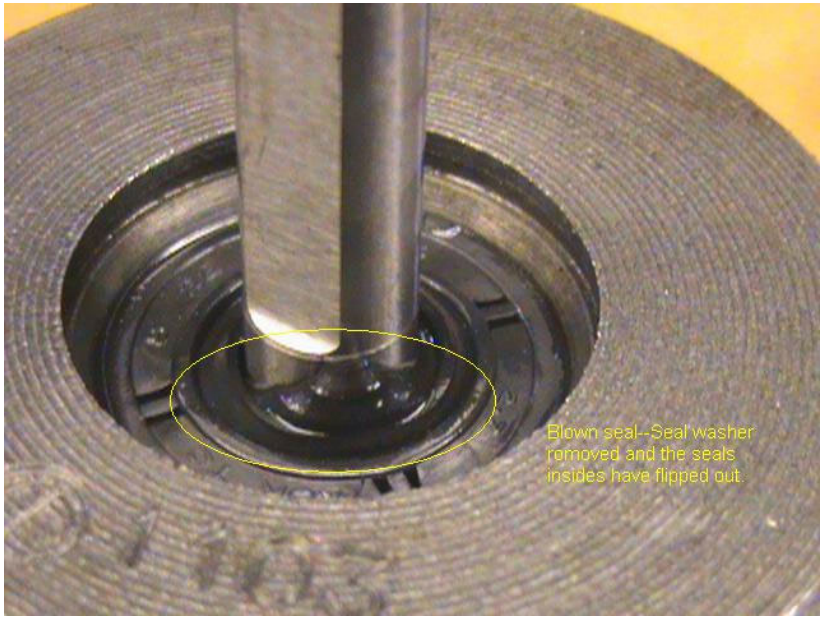


Clean Cut Pump





Pump Seal

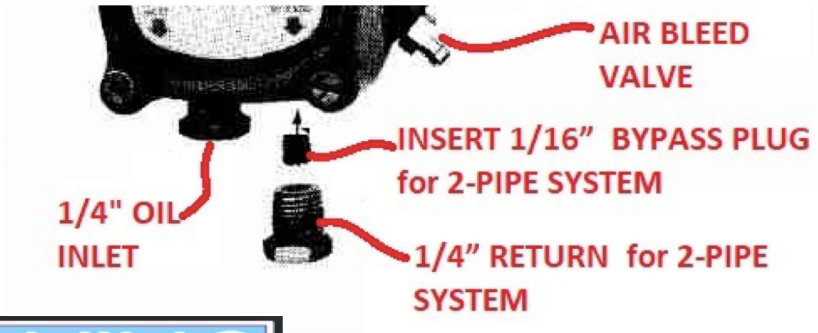


- Pump seals keep the oil in the pump and the air out.
- To avoid burning up from friction they allow a little oil to leak around the shaft
- This is called seal wetting
- So, it is OK if the fan is a bit damp.
- If the fan is soaked with oil and it is dripping out of the burner on to the floor replace the pump.

One Pipe Versus Two

- 2 pipe is self bleeding
- Problems:
  - Pumps deliver over 15 gph, cleaning the tank thru the filter
  - Return lines are at 2 psi, leaking return does not effect burner performance
  - Copper is a catalyst that destabilizes oil
- Remember: One pipe: by-pass plug out,

Two pipe: by-pass plug in!



De-Aerator: Eliminates need for return line

At 7” of vacuum oil foams

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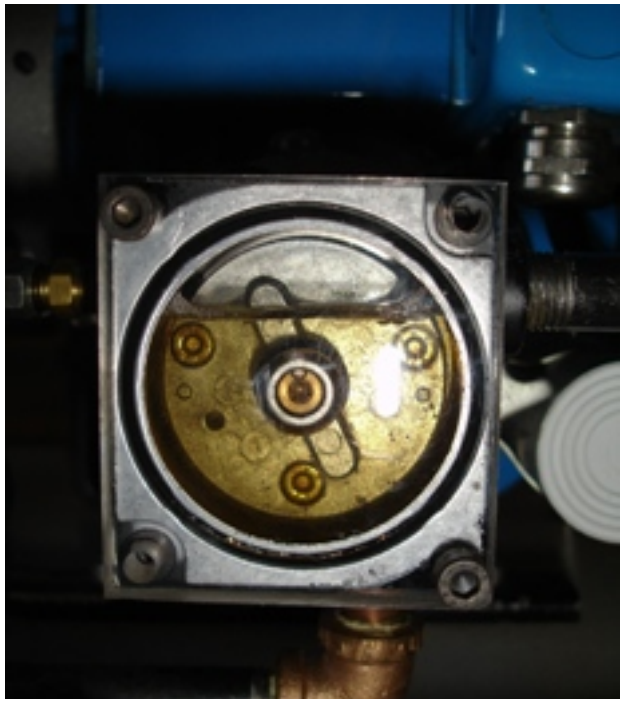
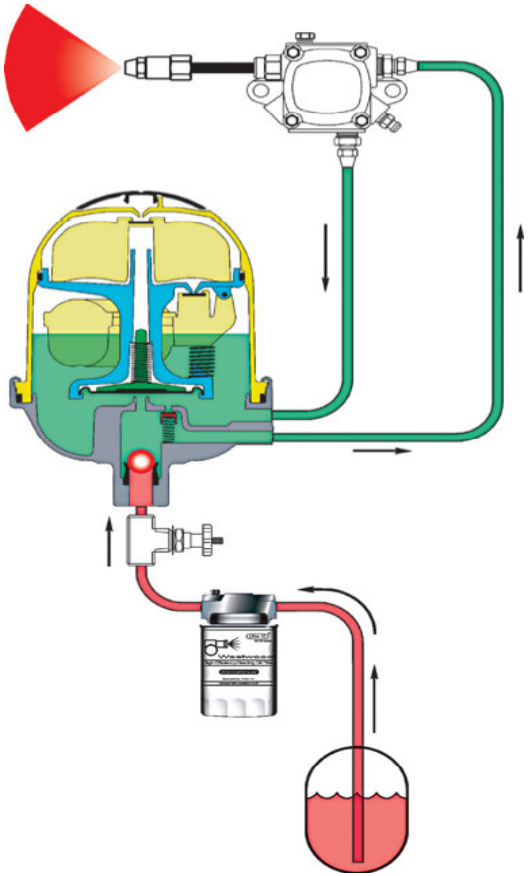
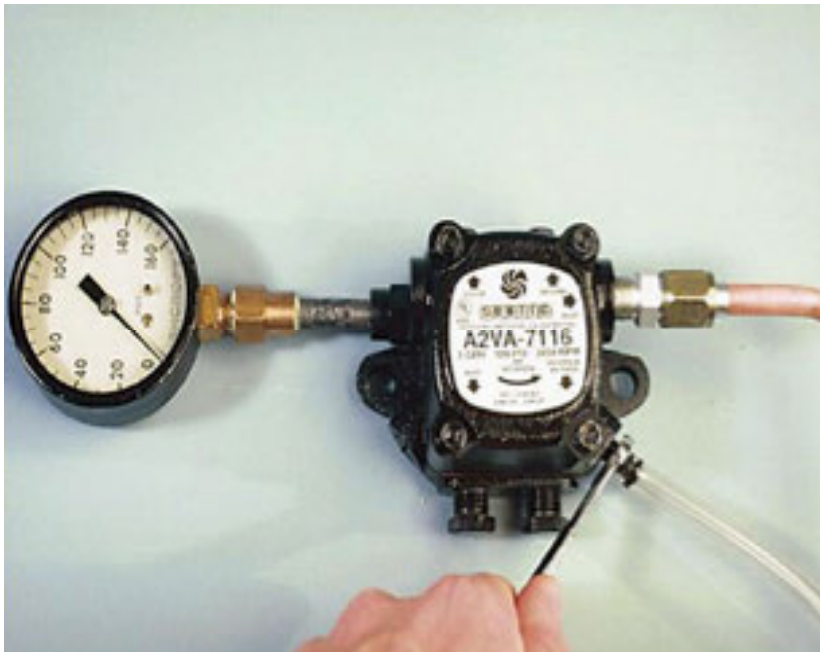




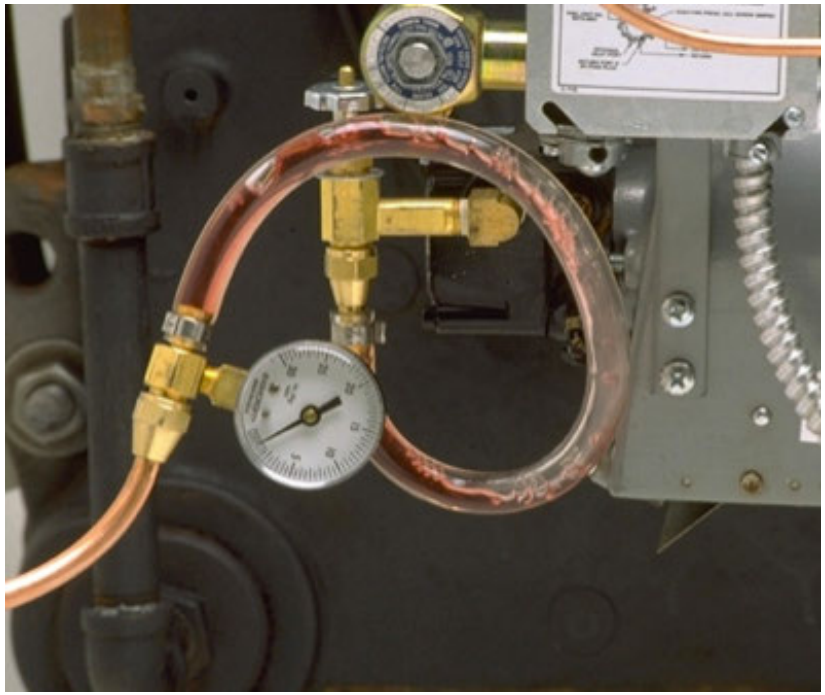
Pressure



- Pump pressure is factory set at 100 psi. To adjust pressure and check cut-off install pressure gauge in nozzle port.
- On shut down pressure should drop and hold.
- Pulsating pressure caused by: air leaks, dirty strainer, worn gear set
- Pump noise caused by: high vacuum, air leaks, worn gears

Vacuum

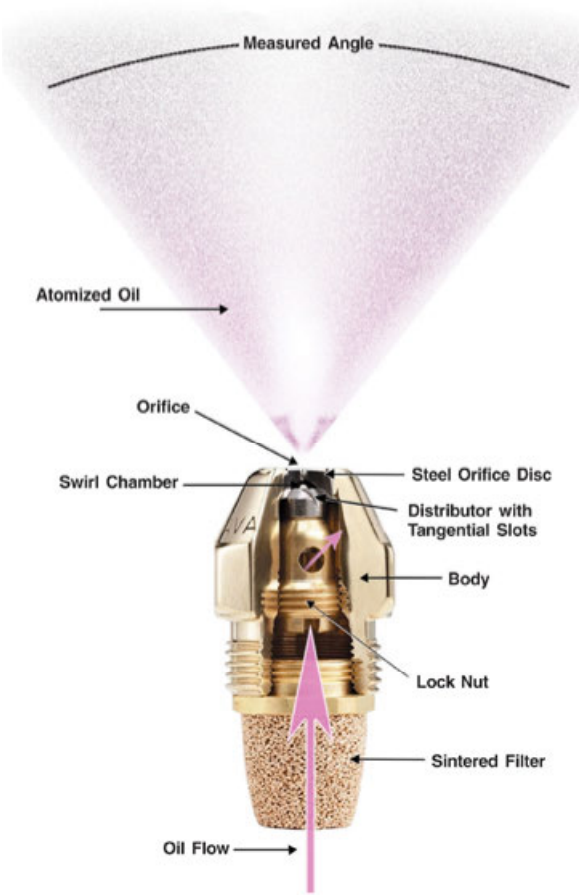
- Operating vacuum should equal calculated vacuum
- To calculate vacuum: allow 1” for every foot of lift, 1” for every 10 ft. of run, 1/2” to 1” for the filter
- If operating vacuum is above calculated it means: plugged filter, kinked or plugged suction line, check valve sticking. (not a plugged strainer)
- If operating is below calculated you probably have a leak in the suction line, fittings, or filter gasket.



High vacuum, plugged oil lines

- If a line is plugged with sludge, ice, or gelled oil
- The best way to clear it is to suck it out with a hand pump. Do not use a CO2 gun!
- If the line is really badly plugged, it should be replaced.

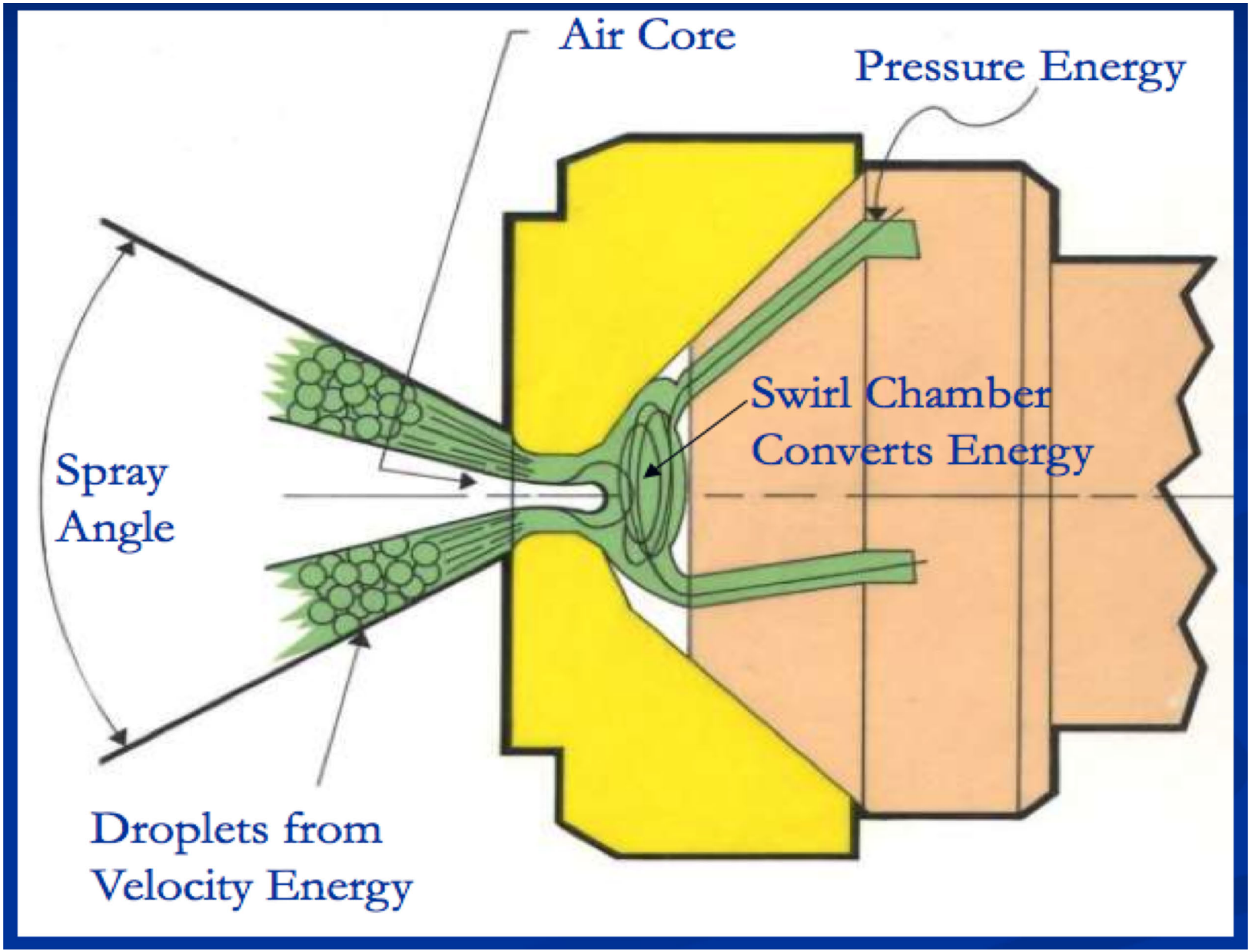
Chapter 5- Nozzles & Chambers



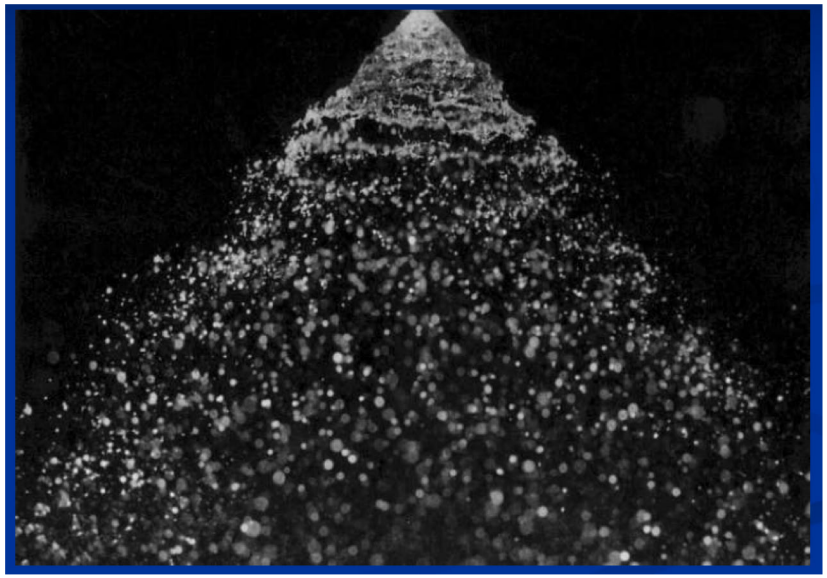
Purpose:

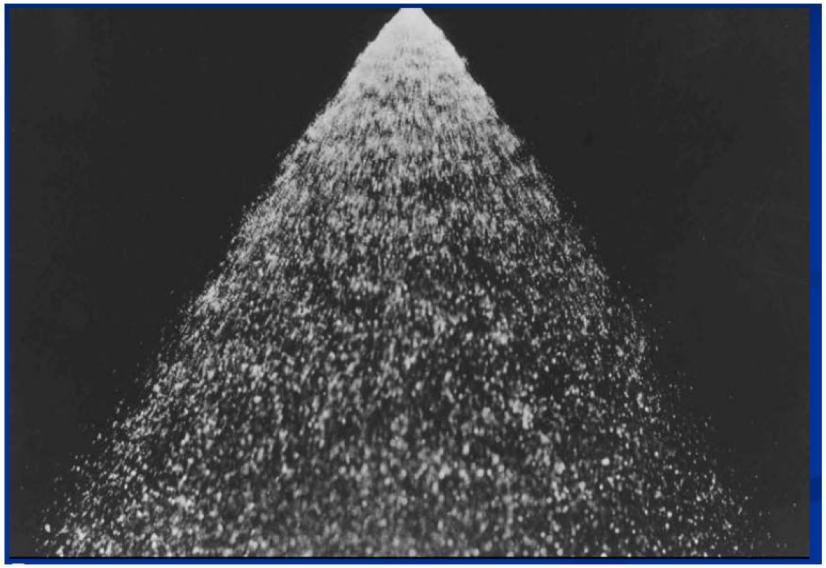
- Atomize the oil
- Patterns the spray
- Meter the amount of oil

- When replacing a nozzle:
- Size according to mfg. Recommendations
- Work clean
- The flow rate is based on 100 PSI.
- **If you increase the pressure you increase the flow**

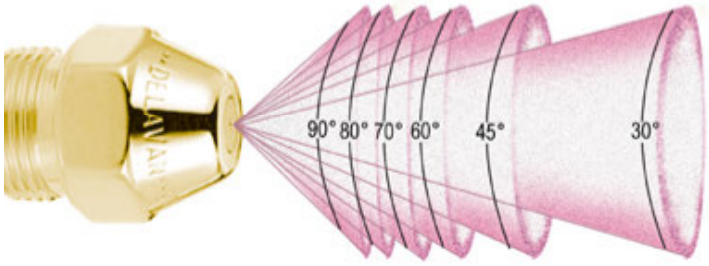

Air Core
Pressure Energy
Swirl Chamber
Converts Energy
Spray
Angle
Droplets from
Velocity Energy

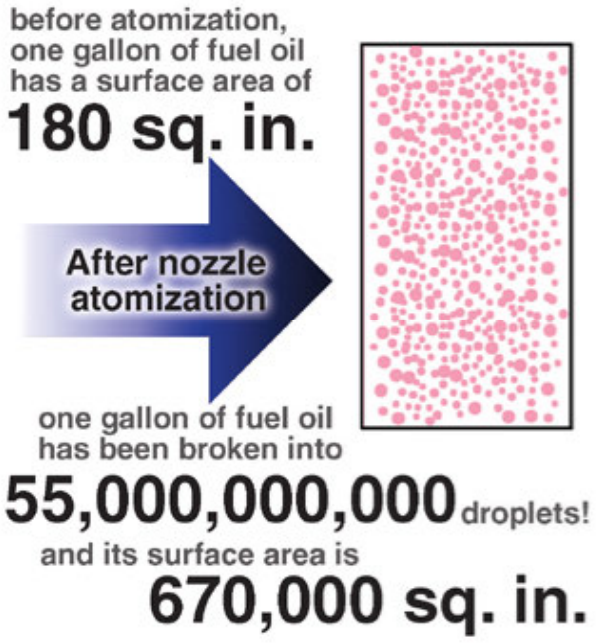
50 and 100 pounds pressure



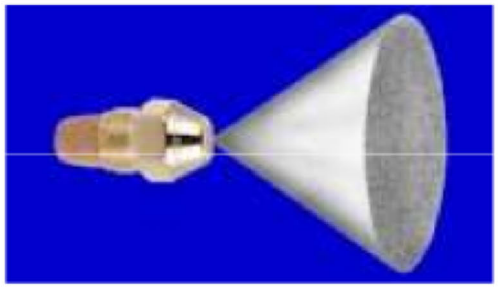


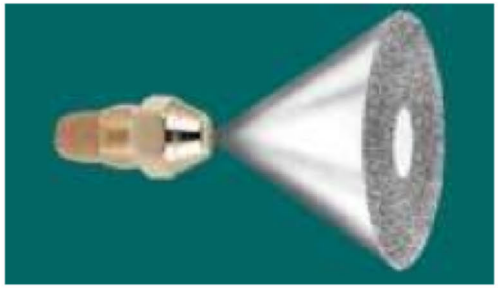
Nozzles


90° 80° 70° 60° 45° 30°


before atomization,
one gallon of fuel oil
has a surface area of
180 sq. in.
After nozzle
atomization
one gallon of fuel oil
has been broken into
55,000,000,000 droplets!
and its surface area is
670,000 sq. in.

Spray patterns





- A - Hollow
- B - Solid
- W – all purpose
- MH – mobile homes

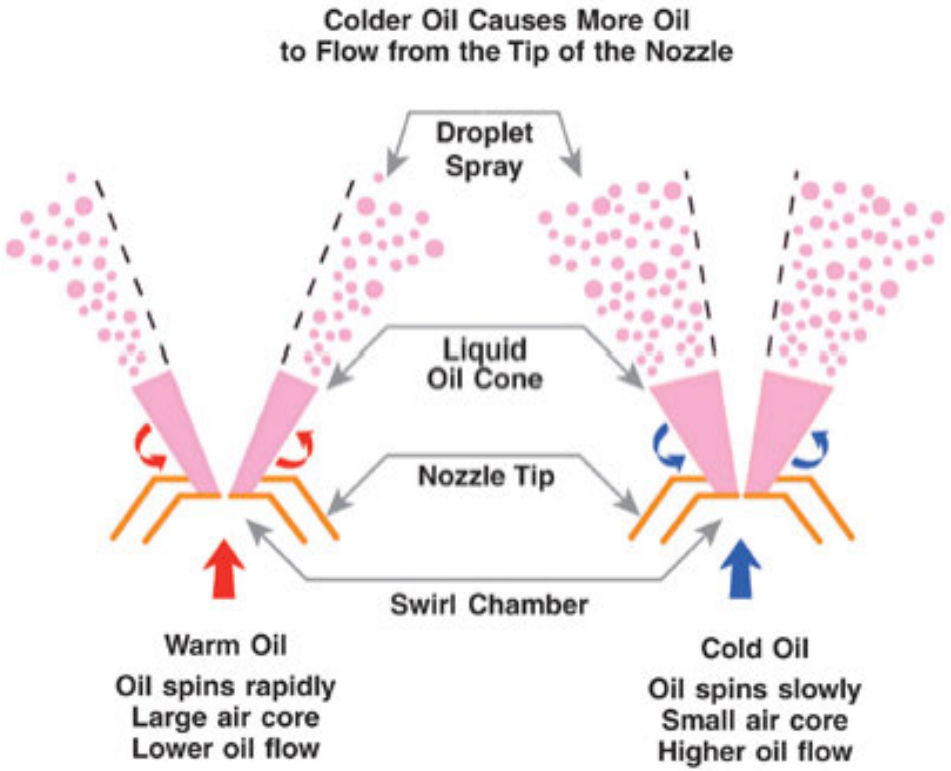
Cold Oil Increases Viscosity

To minimize effects:

Increase the pump pressure (reduce the nozzle firing rate)

Install a nozzle line pre-heater

Use additives or kerosene to reduce viscosity



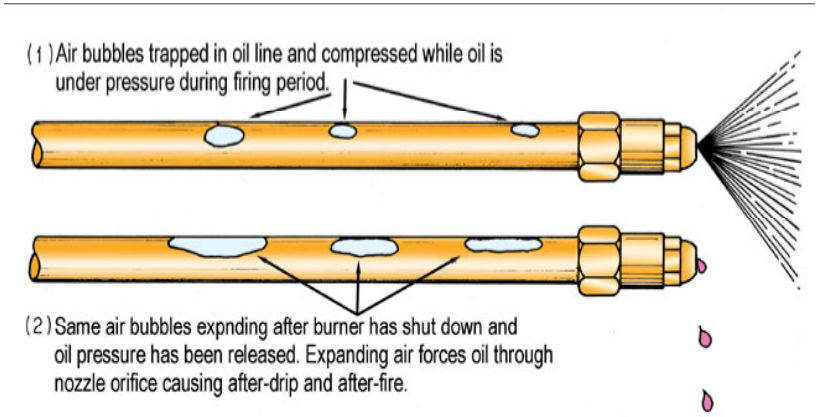
After Drip

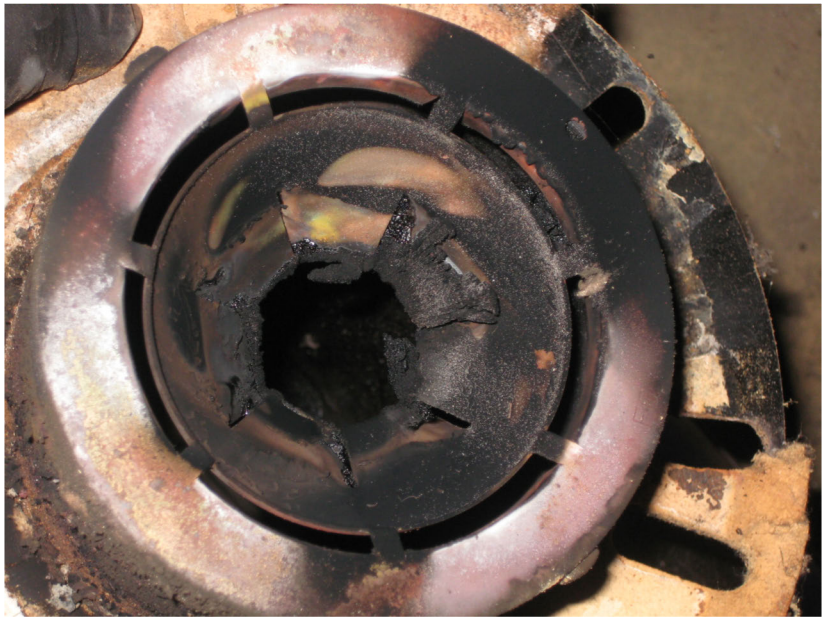
Causes: defective pressure regulating valve, air in the nozzle line, oil expansion due to heat

Solutions: pump pressure cut-off test, check for air leaks,

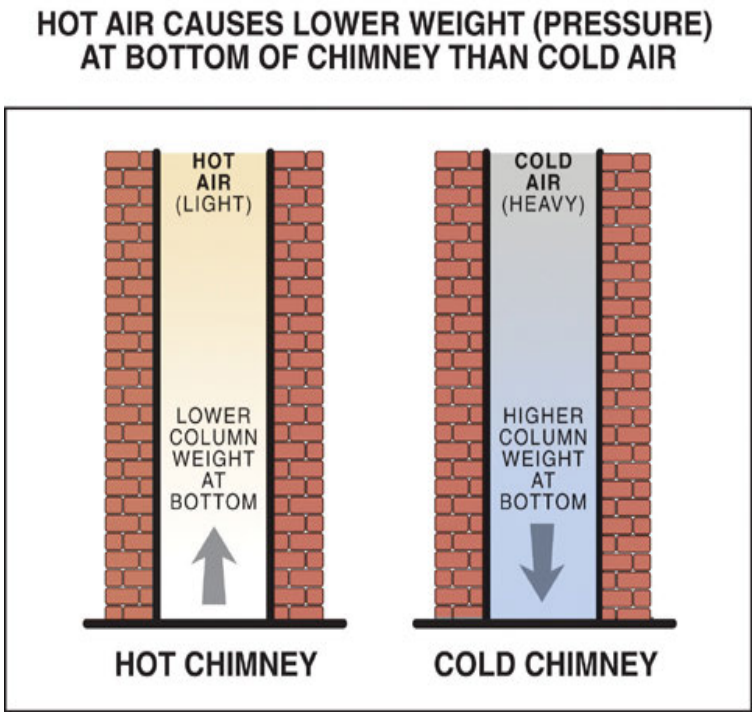
de-aerator,

motor delay-off (post purge)





Chapter 6- Draft & Venting



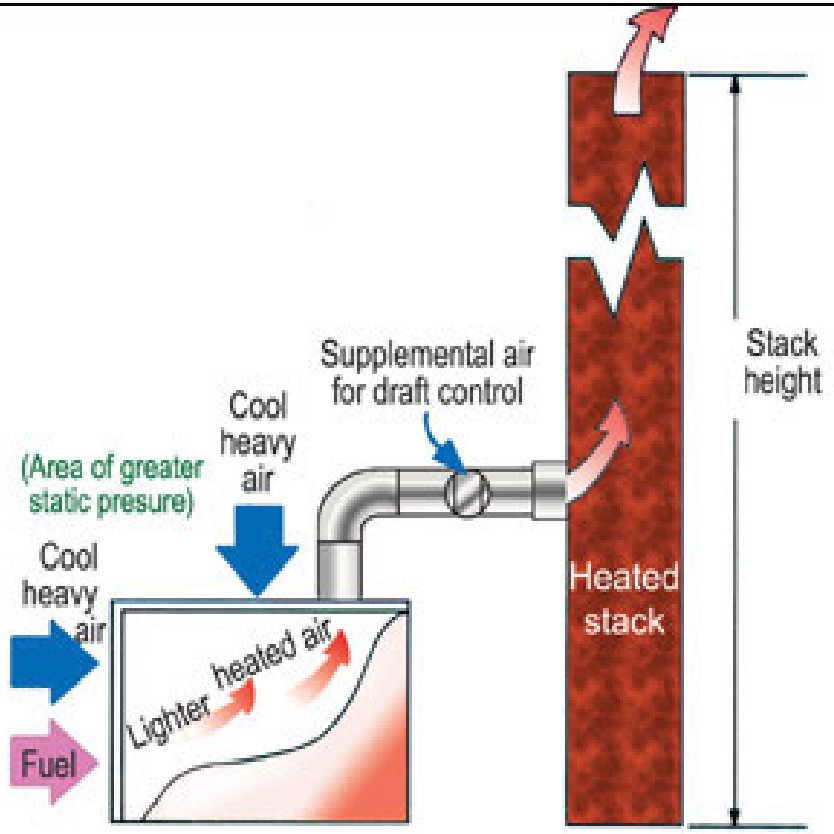
- Combustion gasses must be vented from the building
- Draft is the flow of air into the burner to the fire and the flow of the combustion gasses created by the fire through the heat exchanger into the flue pipe and up the chimney.
- This flow (draft) is created by a difference in pressure.
- High pressure flows to low pressure.
- Hot air rises thru cold air.

Draft Facts

- **Natural draft in a chimney is created by heat (thermal draft) and wind (currential draft).** Draft is measured in inches of water column, -.02”wc.
- Key measurement is draft over the fire

(-.01 to-.02”wc). We also measure draft at the breech. The difference between the two is draft drop. A large draft drop indicates soot and scale buildup

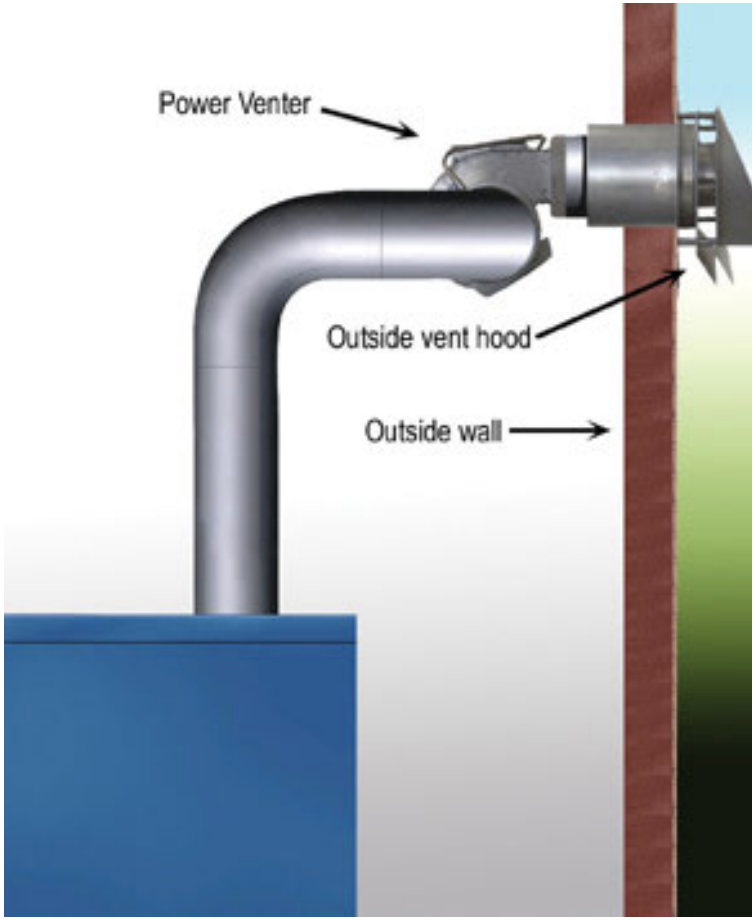
- Draft is effected by the temperature difference between outside air and flue gasses, the barometric pressure, the wind blowing over the chimney, and the humidity levels, so draft needs to be controlled.
- Draft regulators decrease overfire draft to steady low draft
- Flue pipe: each section must be secured with 3 screws, use 45 degree elbows if possible, locate the draft regulator as close to the chimney as possible.



Currential Draft

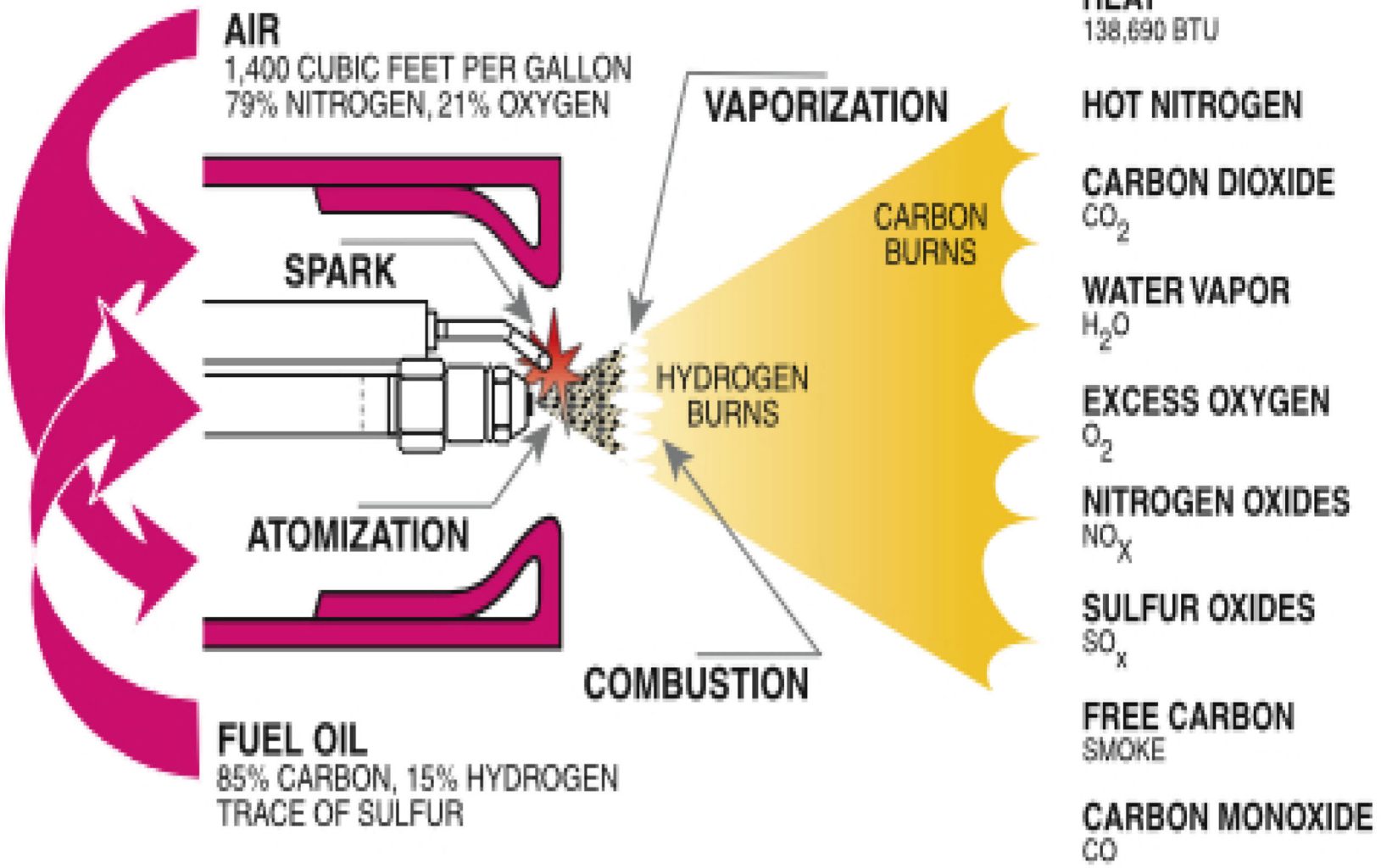
- Caused by suction created as wind rushes over the chimney top creating a negative pressure in the chimney the same way water rushing from a showerhead causes a negative pressure that sucks the shower curtain into the shower so it sticks to your leg.
- Because wind is gusty and variable currential draft is unpredictable and must be controlled.
- Occasionally wind will blow down the chimney. We call this down draft. It causes rumbles and pulsations in the fire

Power Venters and Direct Vent



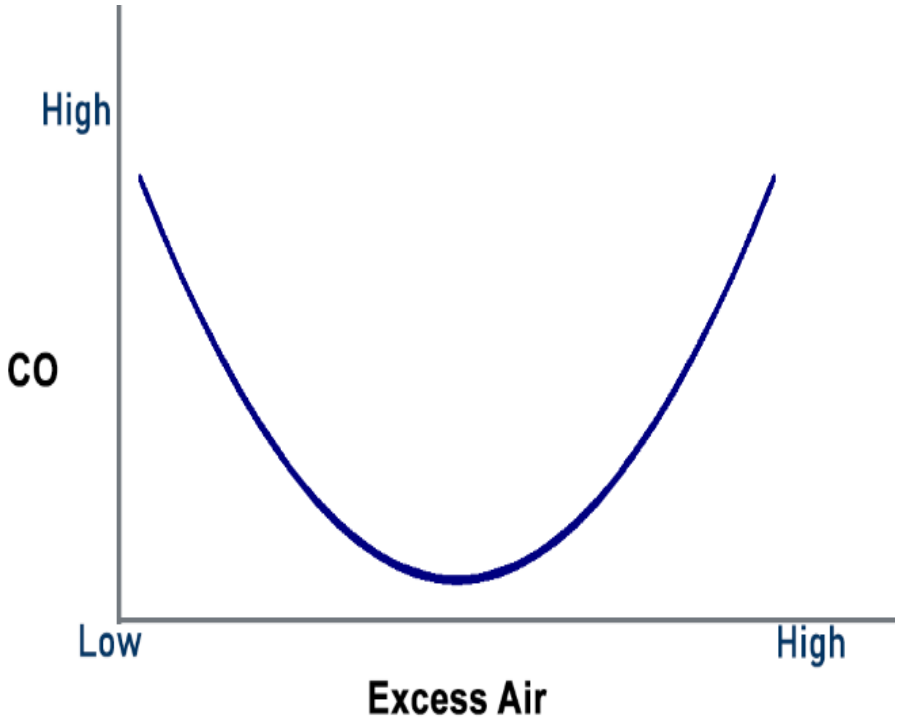
Chapter 7- Combustion

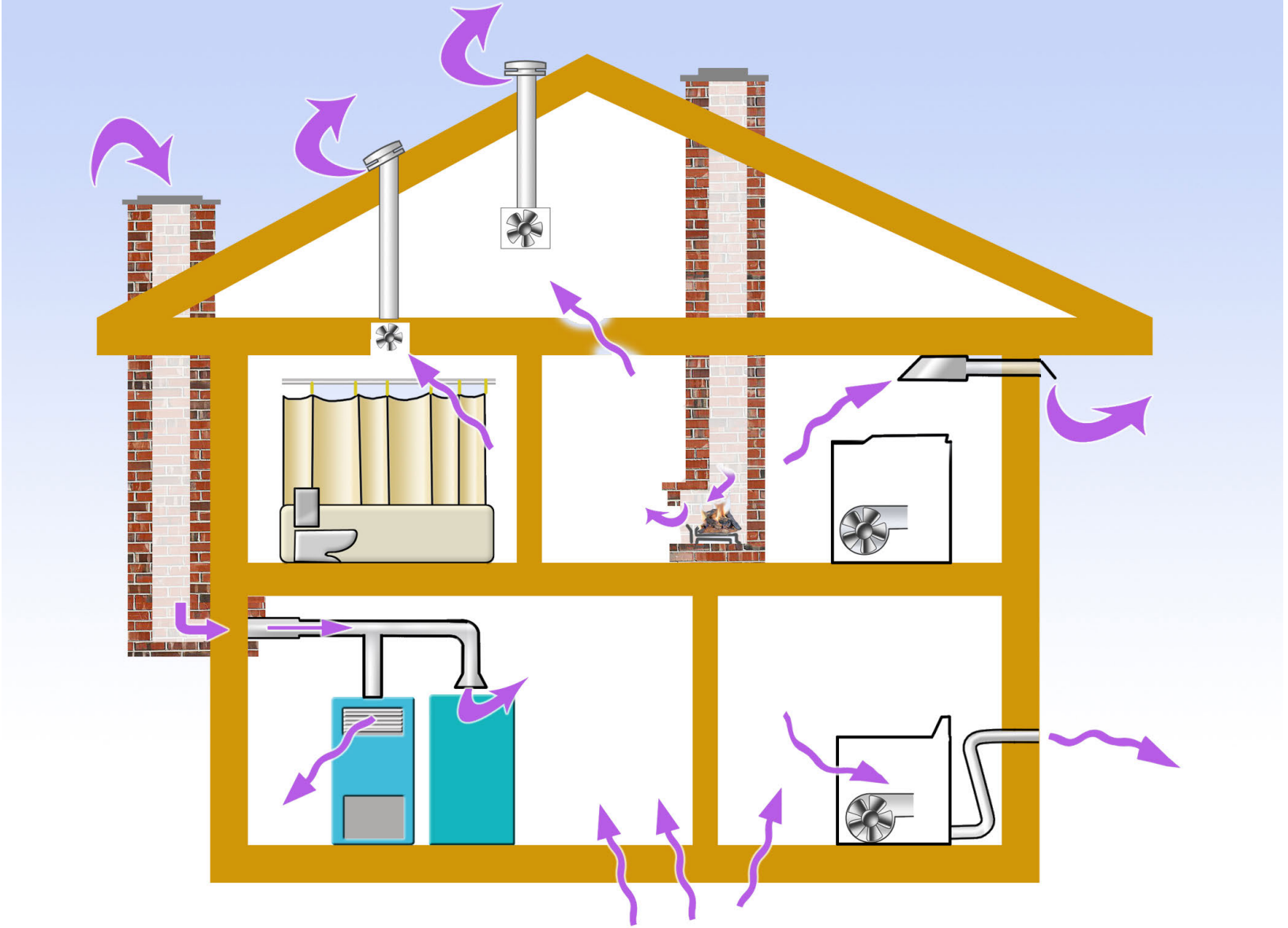
COMBUSTION


AIR
1,400 CUBIC FEET PER GALLON
79% NITROGEN, 21% OXYGEN
SPARK
ATOMIZATION
VAPORIZATION
CARBON BURNS
HYDROGEN BURNS
COMBUSTION
FUEL OIL
85% CARBON, 15% HYDROGEN
TRACE OF SULFUR
HEAT
138,690 BTU
HOT NITROGEN
CARBON DIOXIDE
CO_2
WATER VAPOR
H_2O
EXCESS OXYGEN
O_2
NITROGEN OXIDES
NO_X
SULFUR OXIDES
SO_x
FREE CARBON
SMOKE
CARBON MONOXIDE
CO

Carbon Monoxide Causes

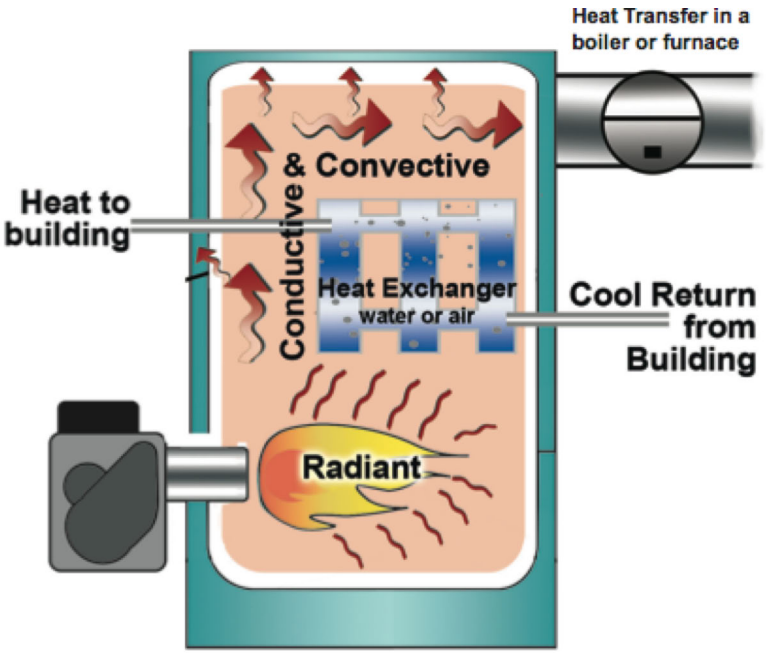
- Not enough combustion air.
- Adding too much air to clean up a smoky fire
- Flame impingement also results in lower flame temperature and CO production.
- A CO event in the building is caused by improper combustion and a venting failure
- Carbon monoxide is released into homes by vent blockage, flue pipe damage, heat exchanger cracks, and restricted air supply into the house.





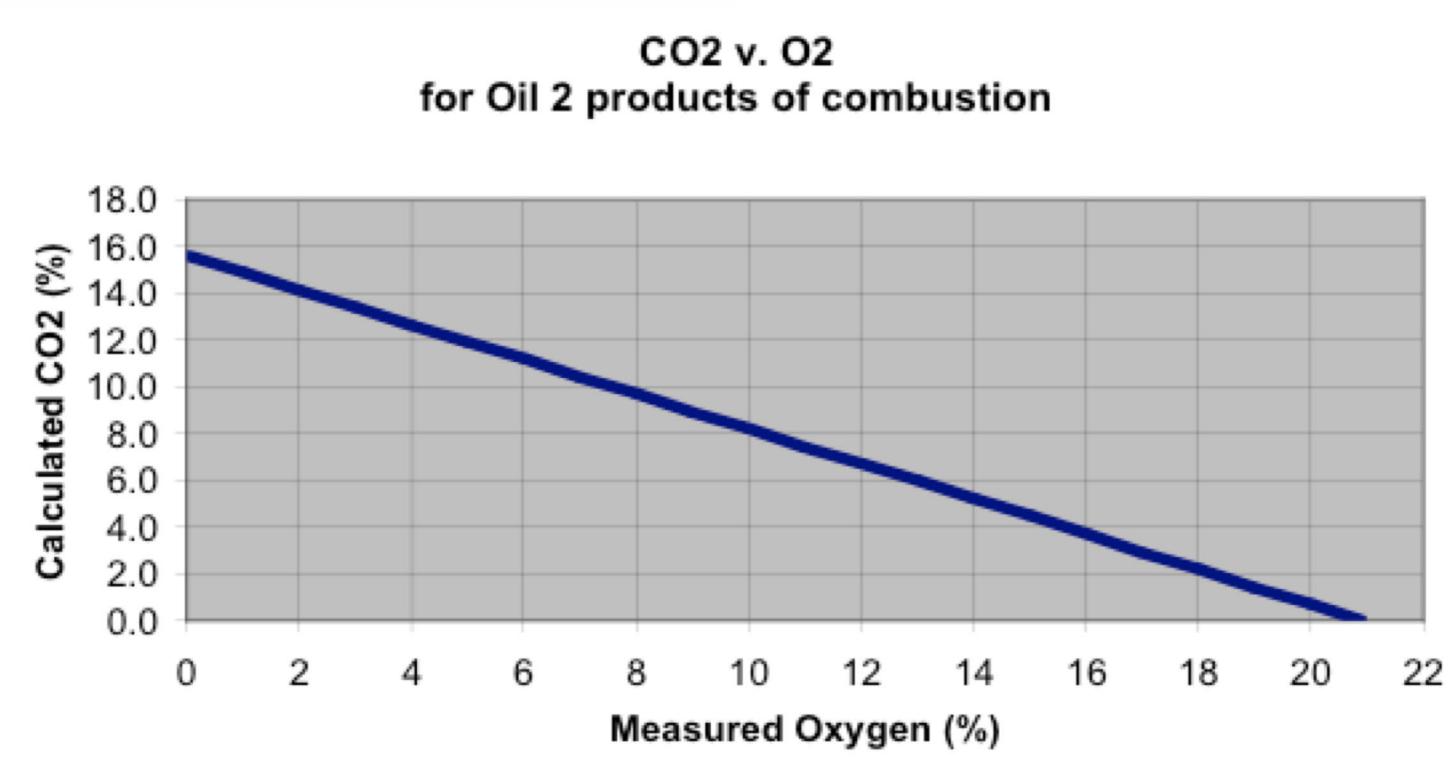
Ventilation problems raise carbon monoxide hazard

Daniel Bernoulli, 1738



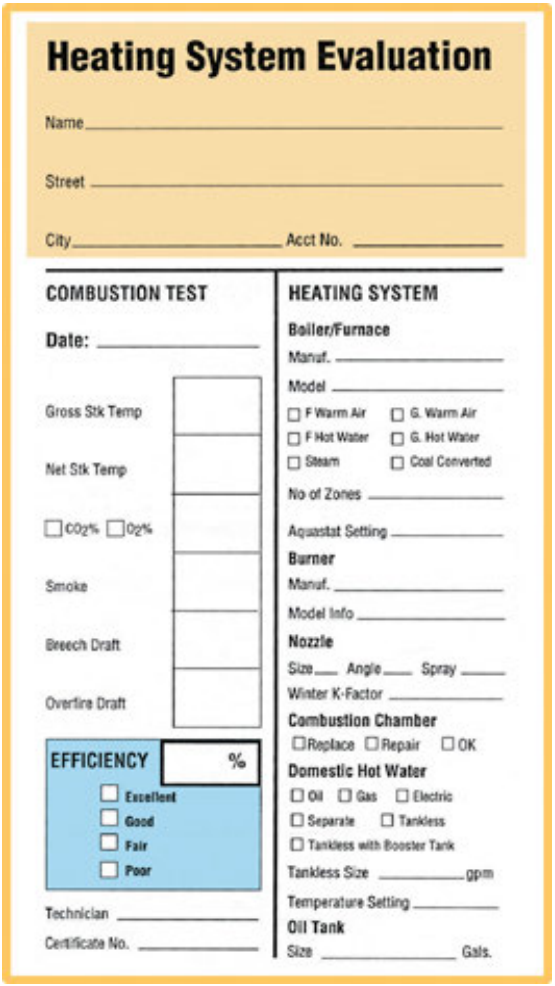
- The longer the combustion gasses are in the heat exchanger, the more heat it pulls from them, the lower the stack temperature will be.
- As the excess air increases so does the volume of combustion gasses.
- The greater the volume, the faster it goes, and the less time the exchanger has to suck the heat out of the gasses.
- Therefore, as the excess air goes up the stack temperature does too
- As stack temperatures go up, efficiency comes down, and our customers heating costs increase.

Wet Kit versus Digital



Combustion Testing

- Combustion tests: measure temperature of the flue gasses, draft over the fire, smoke in the flue gasses, and amount of excess air
- **Steady state** efficiency is the net stack temperature and the amount of excess air (CO2 or O2)
- The hole for testing must be between the breech and the draft regulator, not in an elbow
- Before using a draft gauge zero out the scale to adjust for barometric pressure



Heating System Evaluation

Name_____

Street _____

City_____ Acct No. _____

COMBUSTION TEST

Date: _____

Gross Stk Temp	
Net Stk Temp	
☐ CO_2% ☐ O_2%	
Smoke	
Breech Draft	
Overfire Draft	

EFFICIENCY %

☐ Excellent
☐ Good
☐ Fair
☐ Poor

Technician _____

Certificate No. _____

HEATING SYSTEM

Boiler/Furnace

Manuf. _____

Model _____

☐ F Warm Air ☐ G. Warm Air
☐ F Hot Water ☐ G. Hot Water
☐ Steam ☐ Coal Converted

No of Zones _____

Aquastat Setting _____

Burner

Manuf. _____

Model Info _____

Nozzle

Size___ Angle___ Spray ___

Winter K-Factor _____

Combustion Chamber

☐ Replace ☐ Repair ☐ OK

Domestic Hot Water

☐ Oil ☐ Gas ☐ Electric
☐ Separate ☐ Tankless
☐ Tankless with Booster Tank

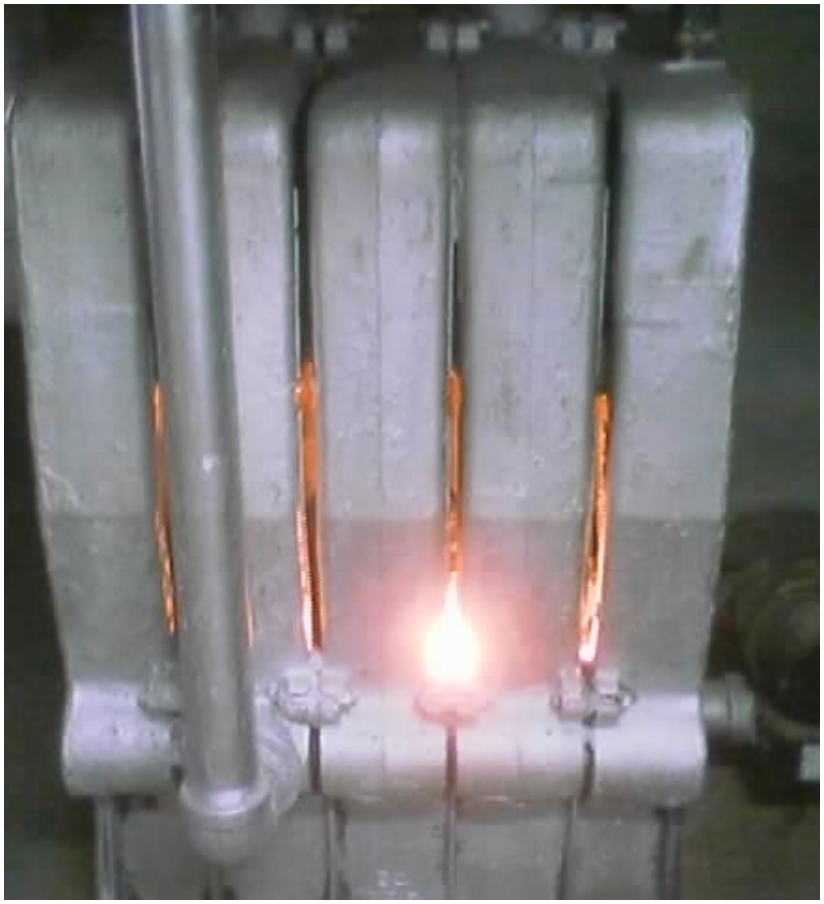
Tankless Size _____ gpm

Temperature Setting _____

Oil Tank

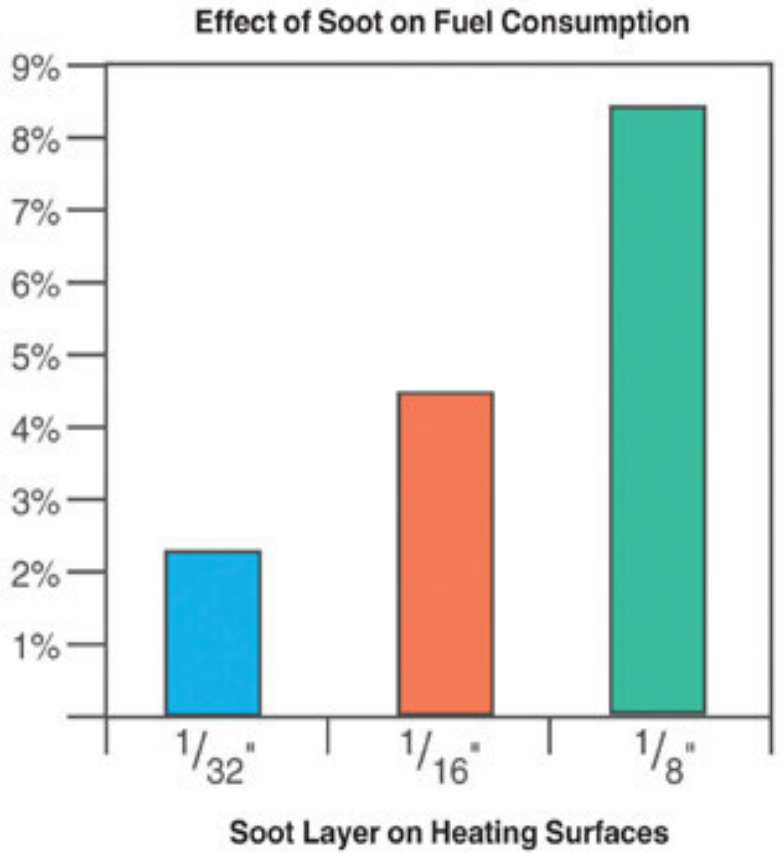
Size _____ Gals.

Air Leaks into the Heat Exchanger



- Leaks: Excess air at breech greater than over the fire
- Air leaks into the appliance increase volume and velocity of air flow
- Reducing heat exchanger effectiveness
- Increasing on-cycle, off-cycle, and infiltration losses
- To test compare excess air over-fire to the breech
- If CO2 over the fire is more than at the breech- you have a leak.

Smoke



Causes of smoke:

- Flame impingement
- Insufficient combustion air
- Inadequate air-oil mixing
- Dirty air handling parts
- Poor atomization, low pressure, worn nozzle, cold oil
- Overfiring
- Worn out burner

Soot increases stack temperatures and draft drop through the unit

Smoke Tester

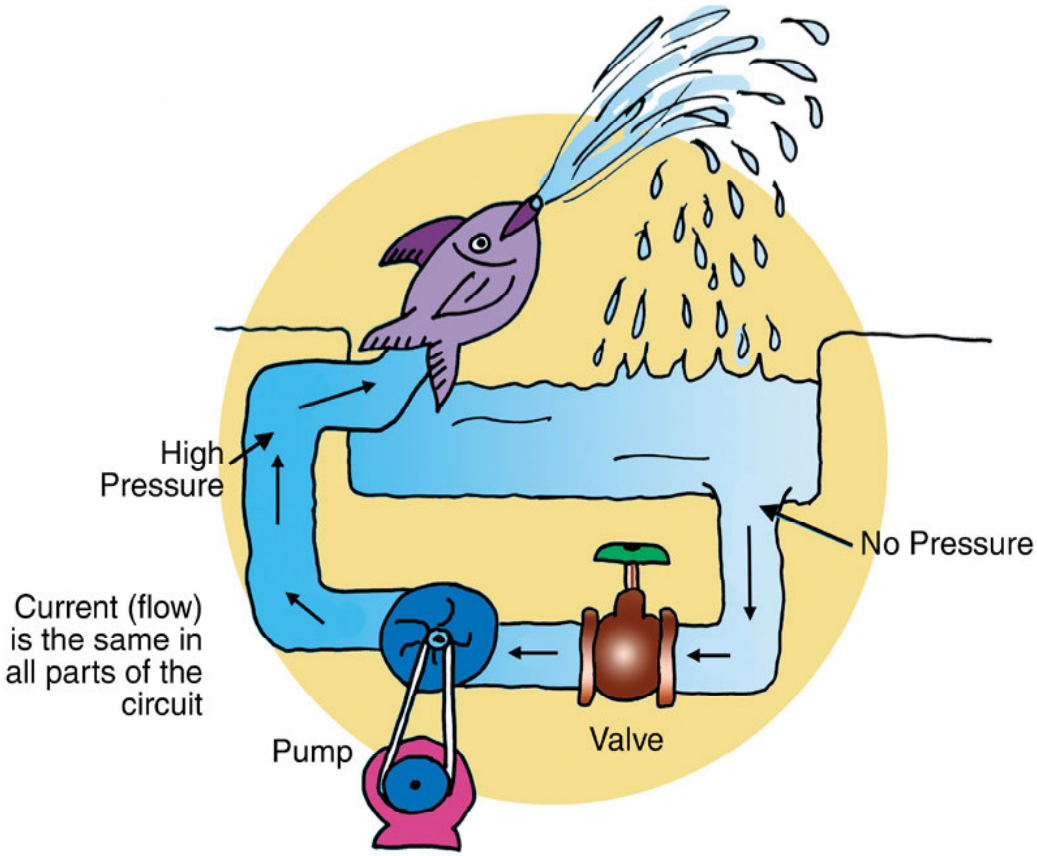
- Smoke becomes soot that insulates the heat exchanger surfaces and lowers efficiency
- 10 full strokes are needed to draw the proper amount of flue gas through the paper
- Adjust to zero, trace first then add a bit more air

Digital Electronic Analyzers

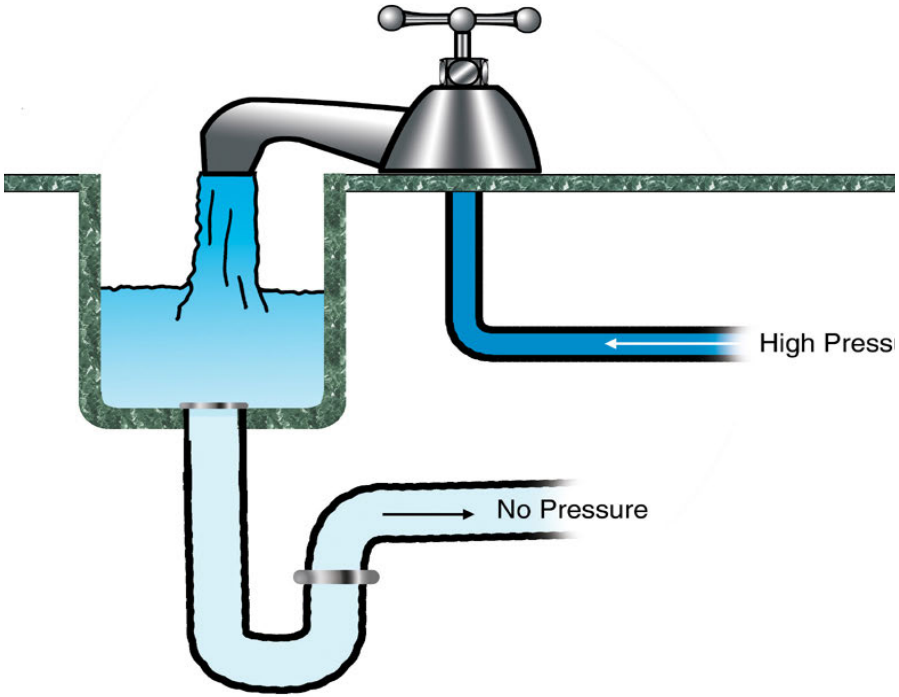
- Faster, more accurate, and created a printed record
- Perform a smoke test first and be sure it is a trace or less before using analyzer
- Do not leave in the cold
- O2 sensors must be replace periodically
- Calculate combustion efficiency by comparing the net stack temperature and excess air

Chapter 8- Basic Electricity

- Water and Electricity are similar.
- The pump and power source add energy
- The water and electricity flow at high pressure to a thing doing work
- Then they flow back to the power source under no pressure



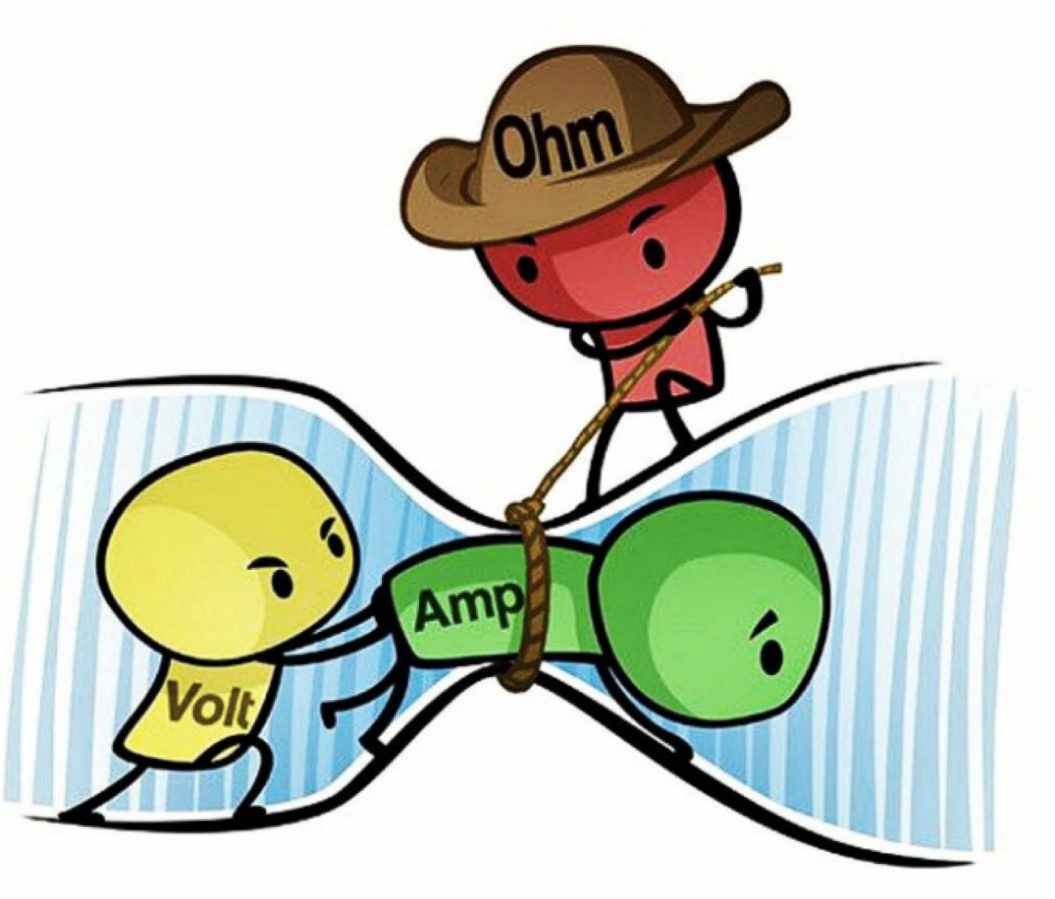
Volts- Electric potential, like water pressure- pounds per square inch



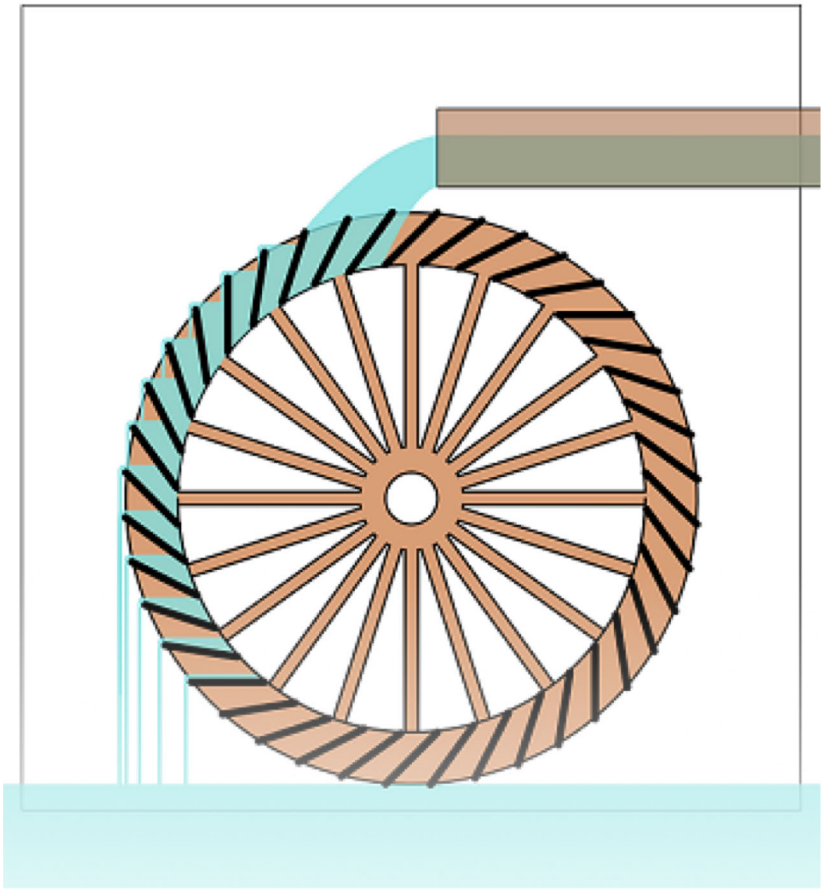
Amps- the amount of electric current flowing in the wire- like gallons per hour

Ohms- the resistance to flow, heat is created by resistance

Ohm's Law: Volts = Amps times Ohms

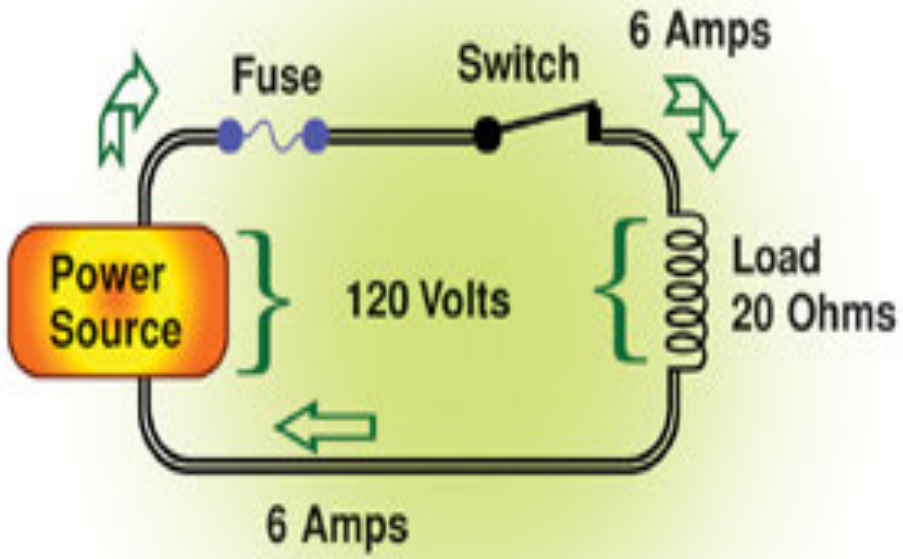


Watts- Amount of work being done, Watts = Volts times Amps



- A 100 watt light bulb pulls .83 amps at 120 volts and 144.57 ohms.
- At 90 volts it pulls 1.11 amps and 81.08 ohms.

Electric Flow and Circuits



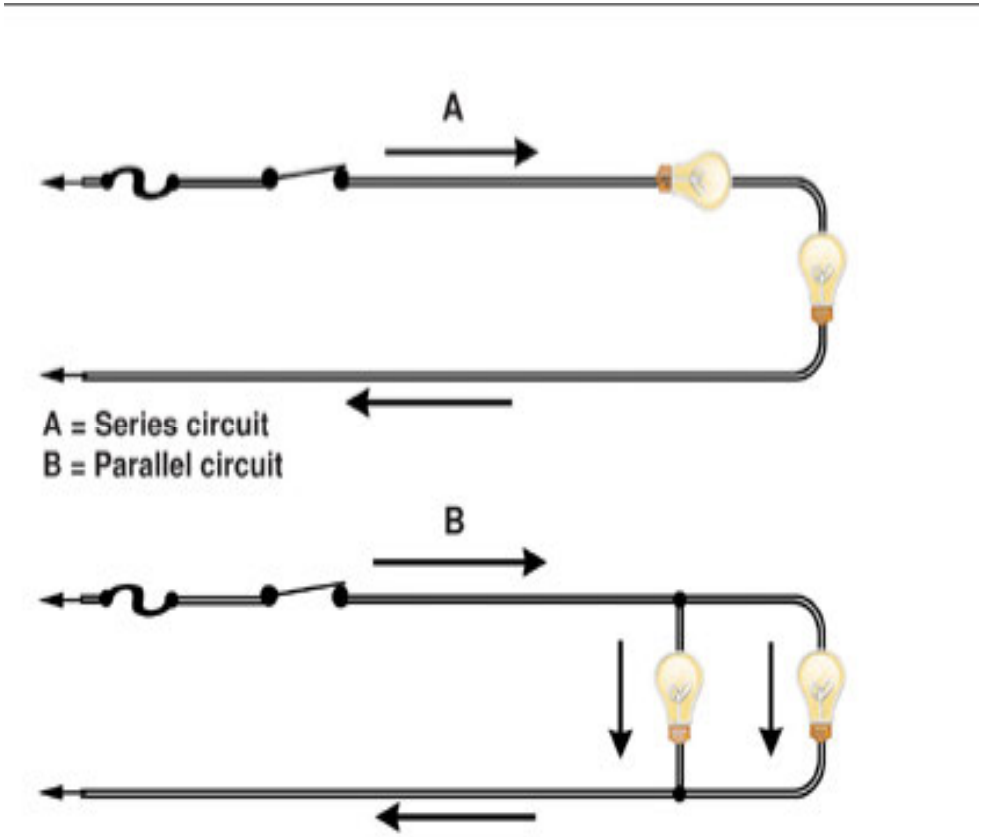
- **Conductors**- allow electricity to flow easily. Gold, copper, silver, and aluminum are good conductors
- **Insulators**- high resistance to flow. Air is a good insulator. So is glass, porcelain, plastic, & rubber.

Load- a device that uses electricity to perform work, the work is measured in watts.

PSC motor

Circuits

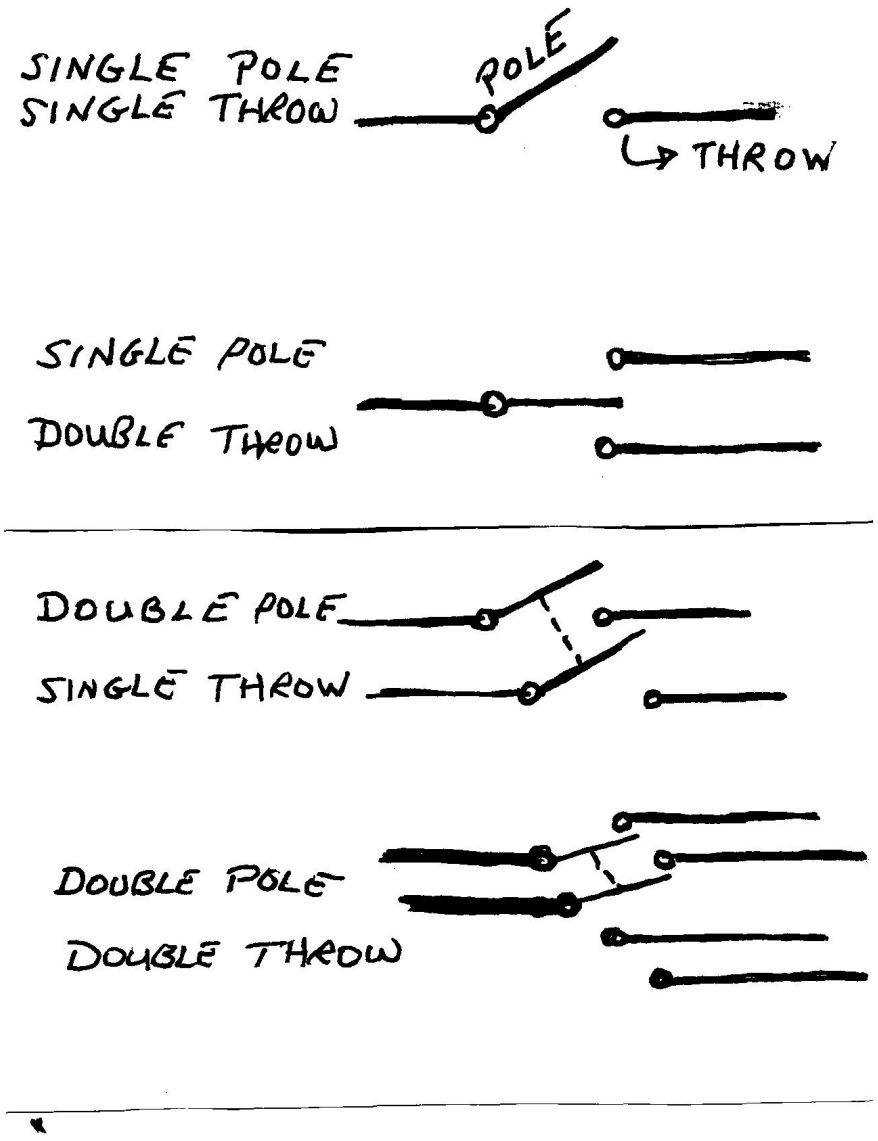
- **Circuit**- a conductor runs from a power source to a switch, a load, and back to the power source. A short circuit has no load.
- **Series**- only one path for the current through the loads
- **Parallel**- each load has its own branch
- Oil heating systems are a combination of both and should be wired on a their own circuit

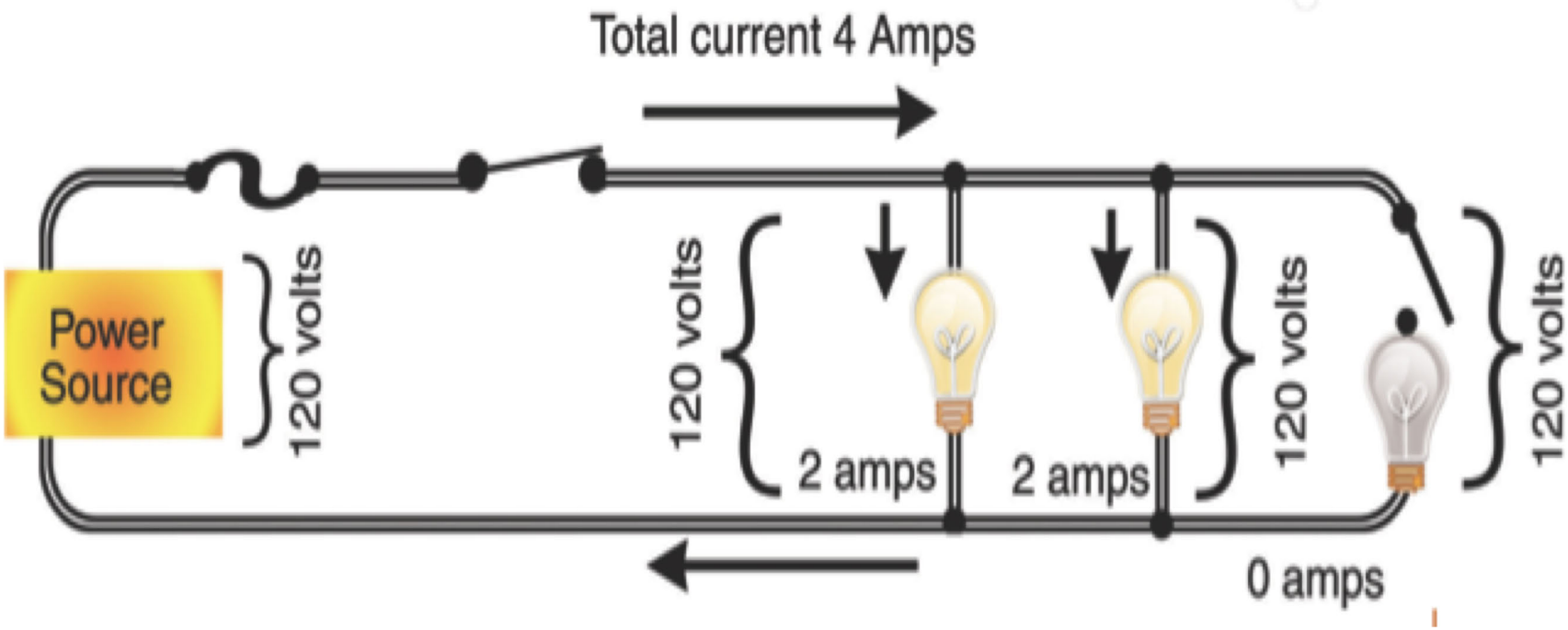


Alternating and Direct Current- AC/DC

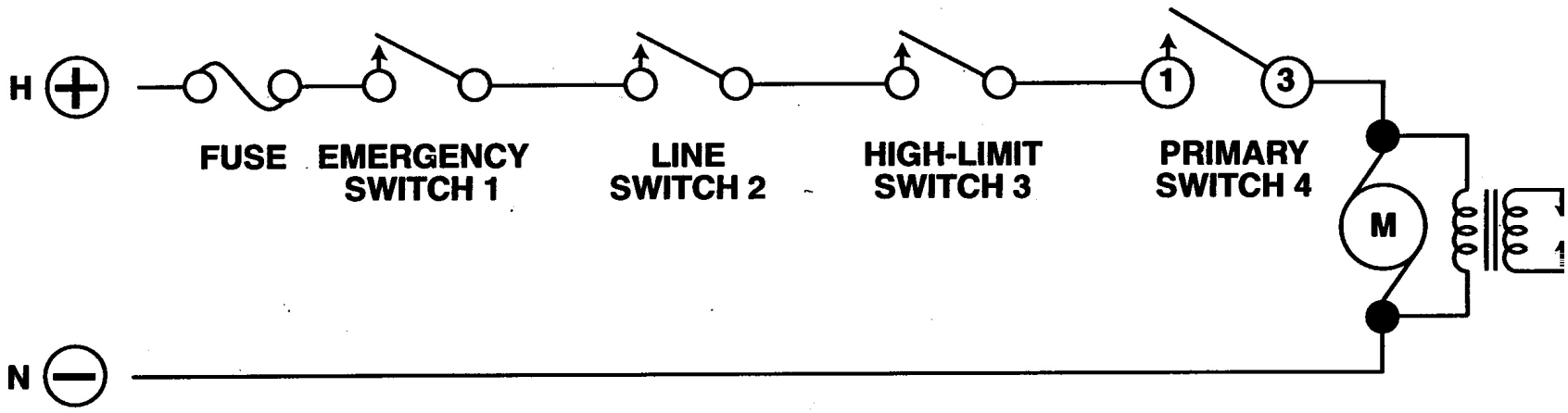
- Direct current comes from a battery. Only flows in one direction
- Alternating current changes direction, flowing back and forth in the wire. Each back and forth change is a cycle. In North America, the electricity cycles 60 times a second, 120 changes of direction.
- The current delivers power to the load no matter which way it is flowing. The power goes from zero to the required number of watts and back to zero 120 times a second.

Switches

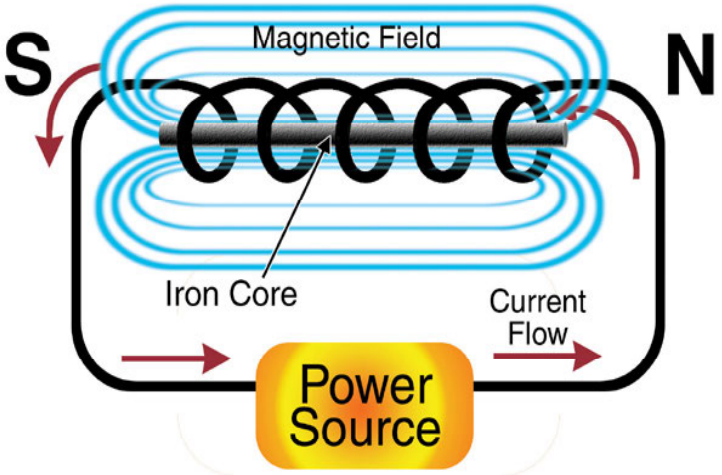

SINGLE POLE
SINGLE THROW
POLE
THROW
SINGLE POLE
DOUBLE THROW
DOUBLE POLE
SINGLE THROW
DOUBLE POLE
DOUBLE THROW

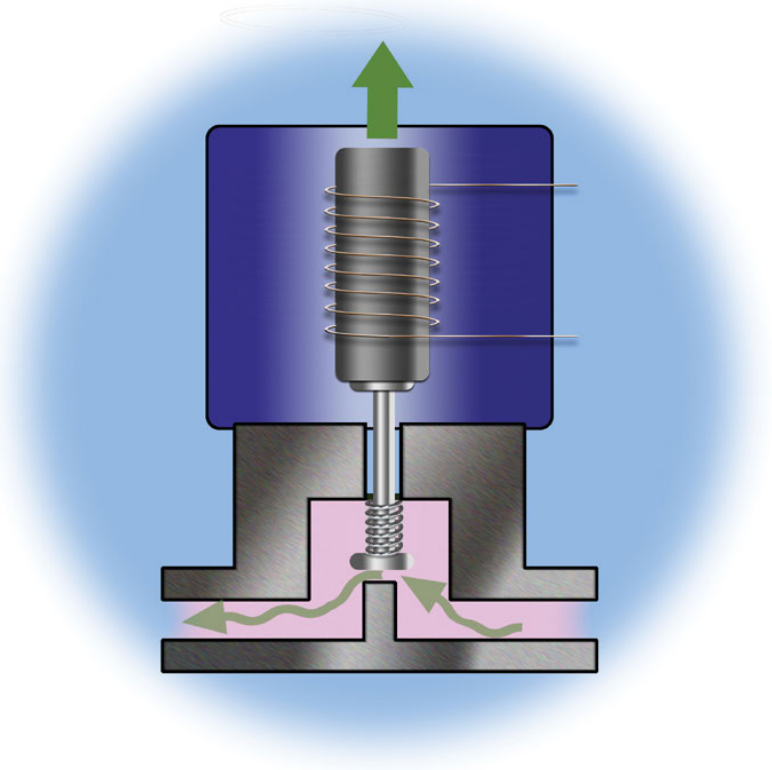

Total current 4 Amps
Power Source
120 volts
120 volts
2 amps
2 amps
120 volts
120 volts
0 amps

BASIC OIL BURNER CIRCUIT SHOWING SWITCHES, MOTOR, AND IGNITION TRANSFORMER

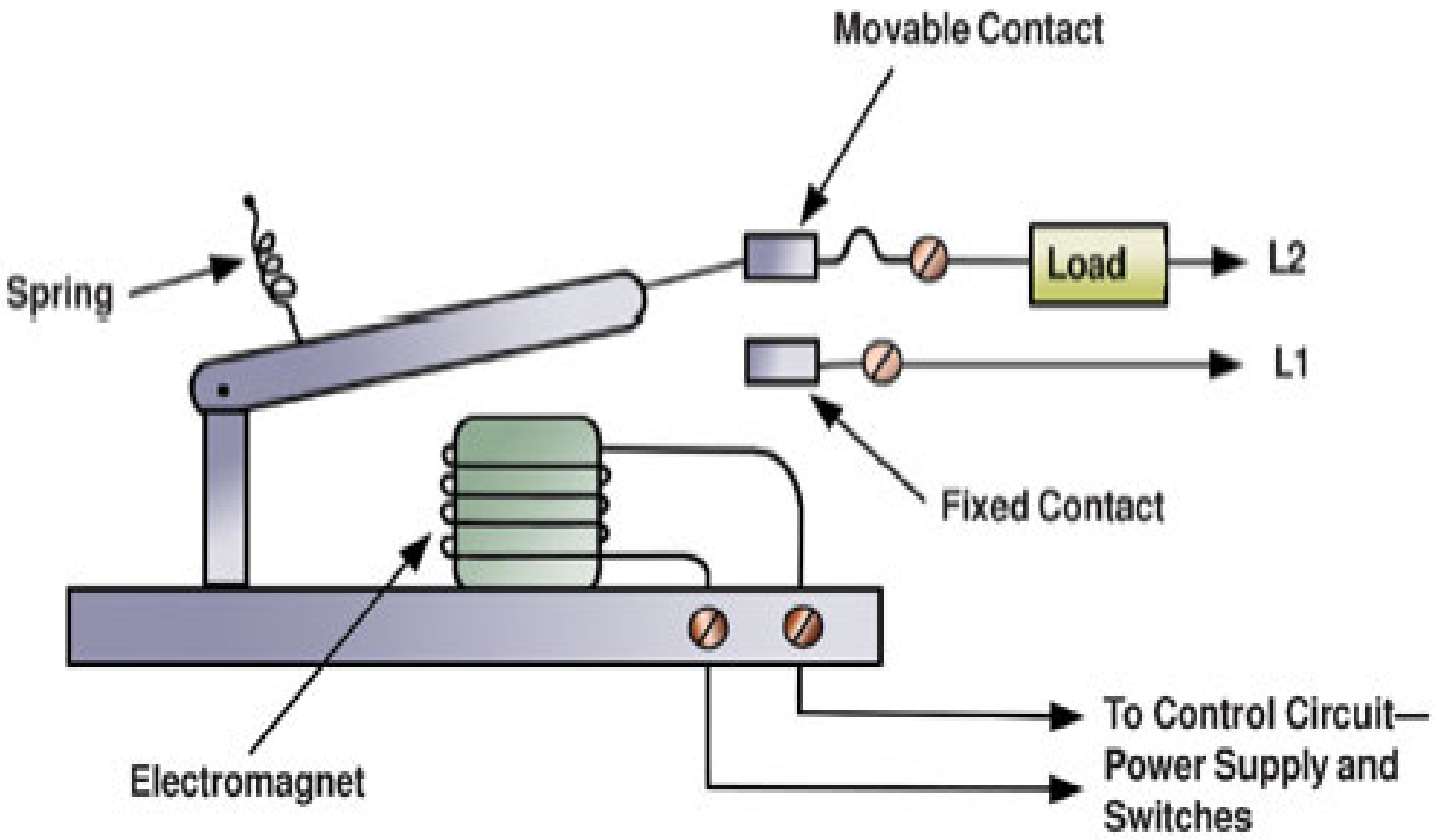


Electromagnet, Solenoids

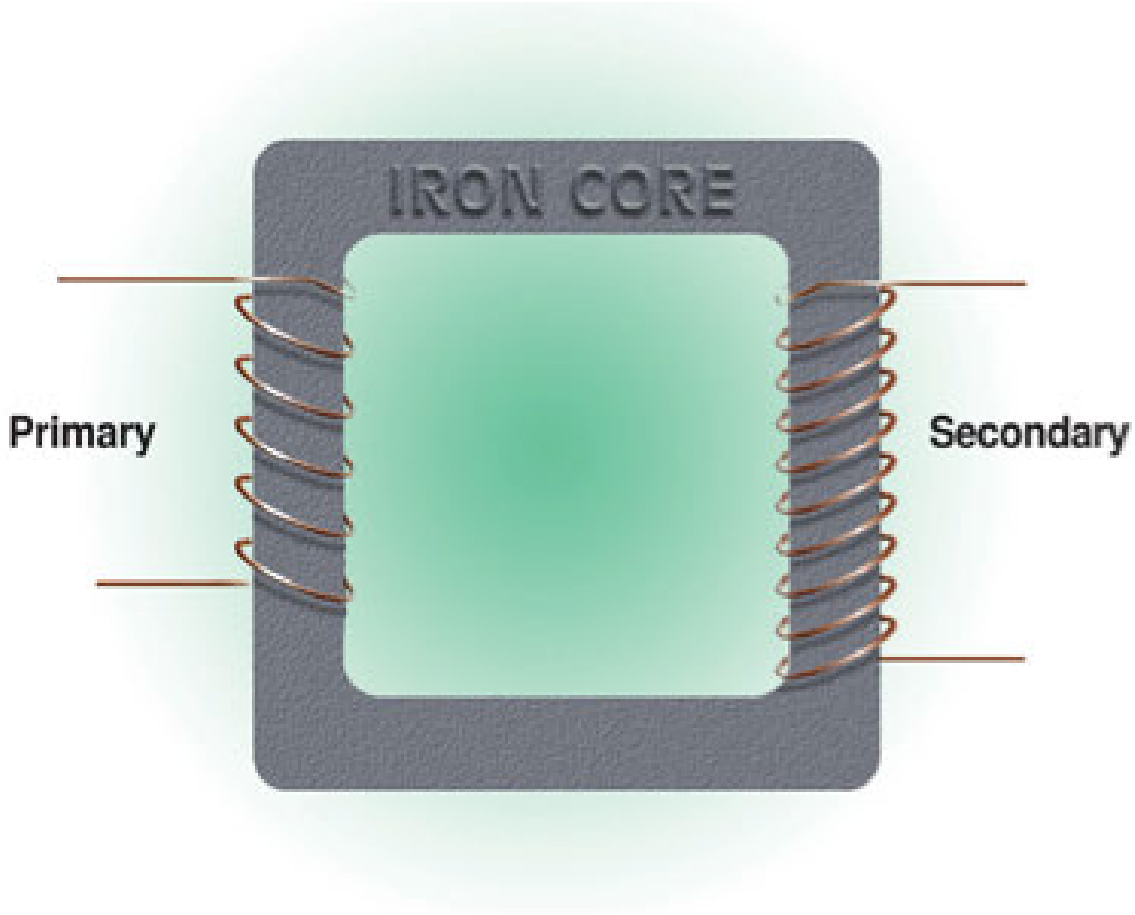




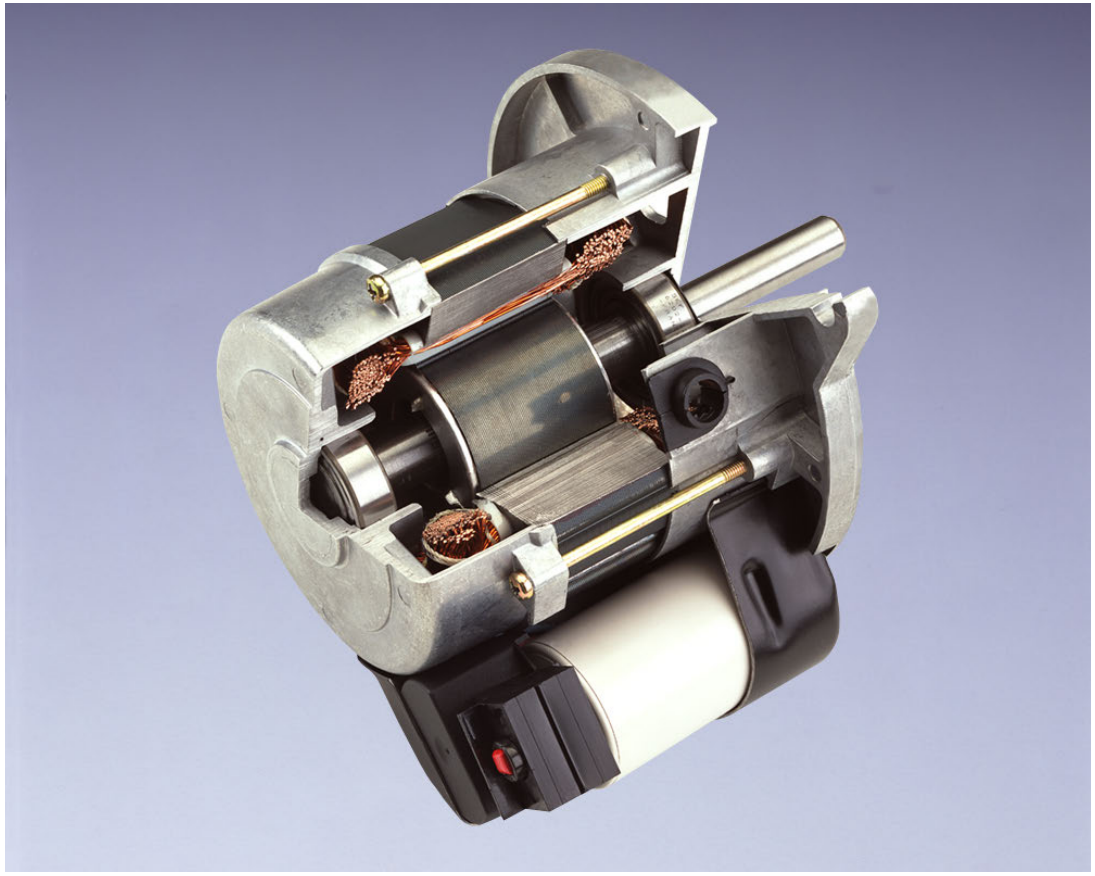
Relay Switch



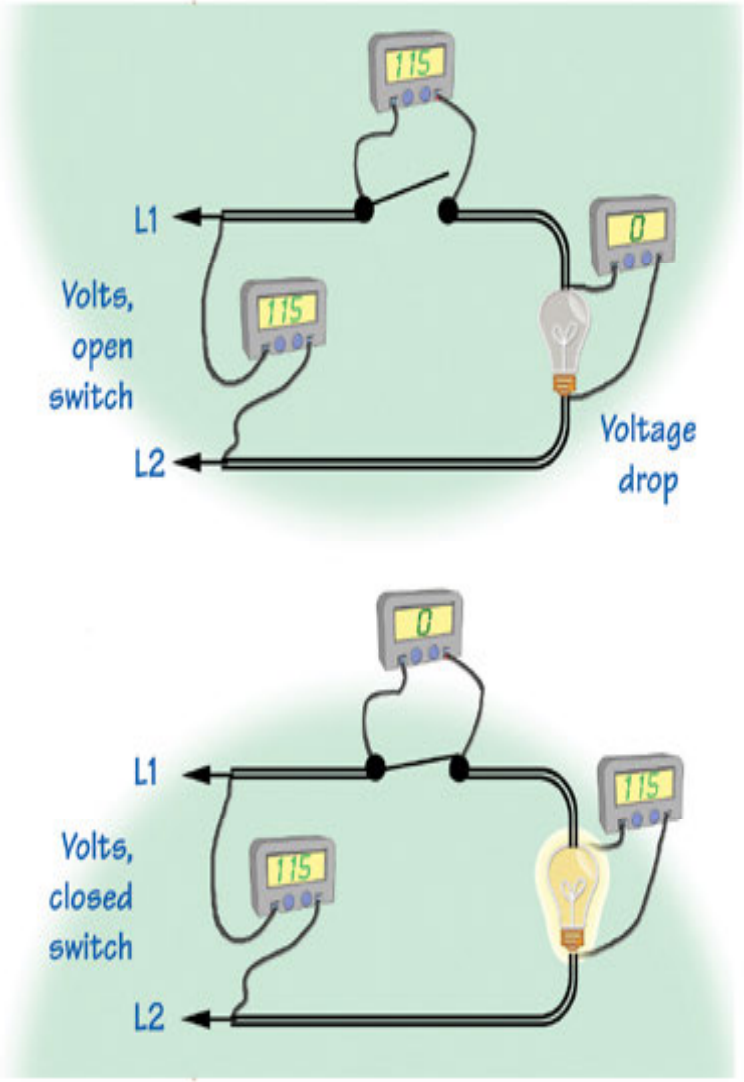
Transformer



Motor



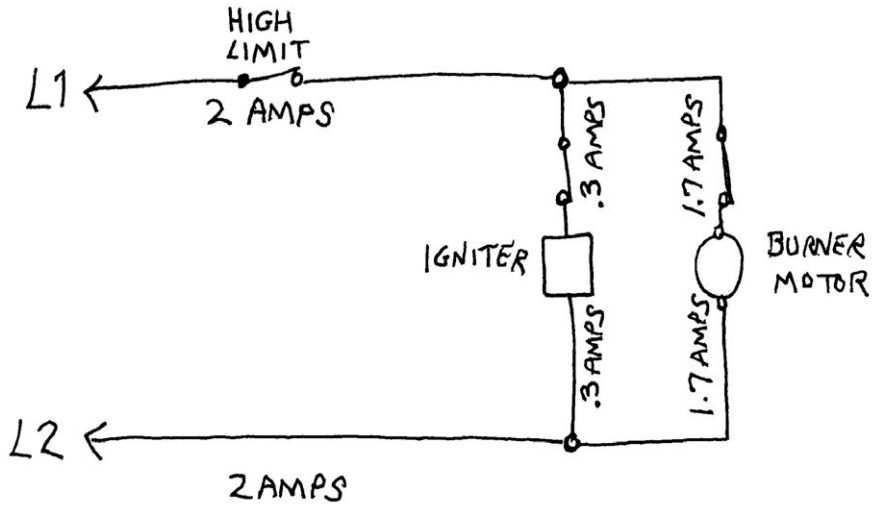
Voltmeter



- Measures the difference in electric pressure between two points in the circuit
- Volts applied are volts used
- Parallel to the load being measured
- Allows very little electricity to flow through them

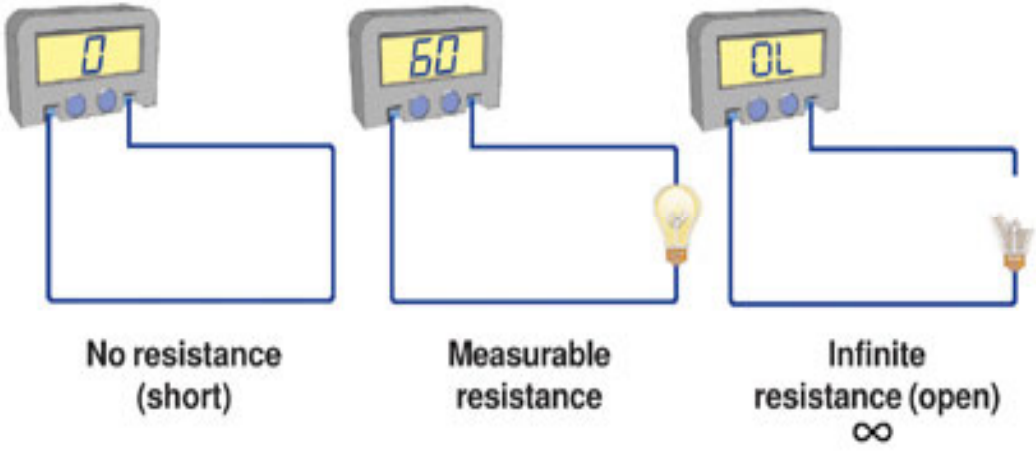
Ammeter

- Measures the electric current from the power source through the loads and back to the source
- Clamp-on uses electromagnetic induction (measures the magnetic field around the wire)
- Pick the correct scale (start high). Only clamp around one wire at a time
- Amperage draw increases as the load works harder



Ohmmeter

- Measures the resistance between two points. It has its own battery, so never hook one to a live circuit
- Disconnect the load or circuit to be tested from the power source for testing. And discharge any capacitors in the circuit
- Can use for testing continuity (a complete circuit)



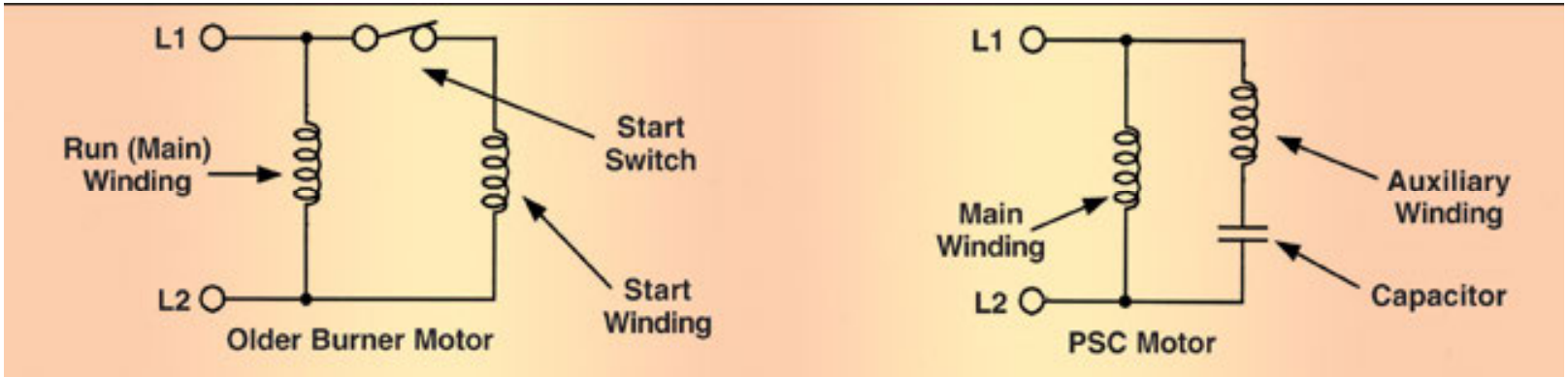
Chapter 9- Ignition Systems

- Intermittent ignition- (Constant Duty) spark is on the whole time the burner runs
- Interrupted ignition- spark shuts off after flame is established. Uses less electricity & results in longer component life

Transformers versus Igniters

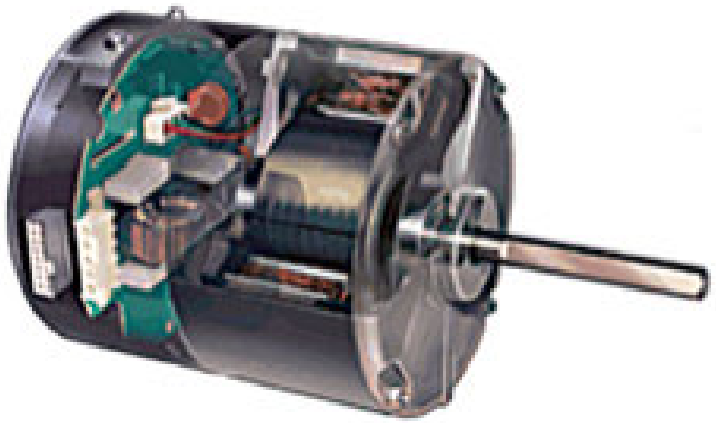
- The ignition transformer is a step-up transformer: primary voltage is 120 volts, secondary is 10,000 to 14,000 volts
- The advantages of solid state igniters are: less effected by voltage drops, higher peak output voltage, use less electricity
- Faulty ignition can cause rough starts that result in odor, smoke, and soot.
- Test igniters by setting the gap between the springs to 1/2” and energize, spark will jump the gap if OK

Chapter 10 Motors: PSC- Permanent Split Capacitor



- The capacitor, auxiliary windings, and main windings remain in the circuit while the motor runs
- Usually feature ball bearings instead of sleeve bearings
- More reliable and use less electricity

ECM

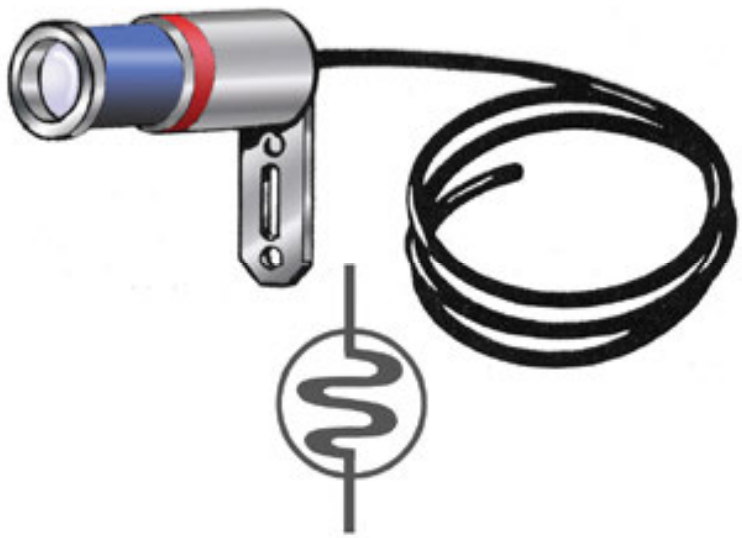


- Electrically Commutated Magnetic Motor
- Used for blower motors on warm air systems and circulators on hot water
- Variable motor speed, low power consumption, means superior efficiency and reduced noise

Chapter 11- Primary Controls

- Must be capable of reacting to the presence or absence of flame
- Goes off on safe if something is wrong
- Before pushing reset button be sure the chamber is not saturated with oil

Cad Cell

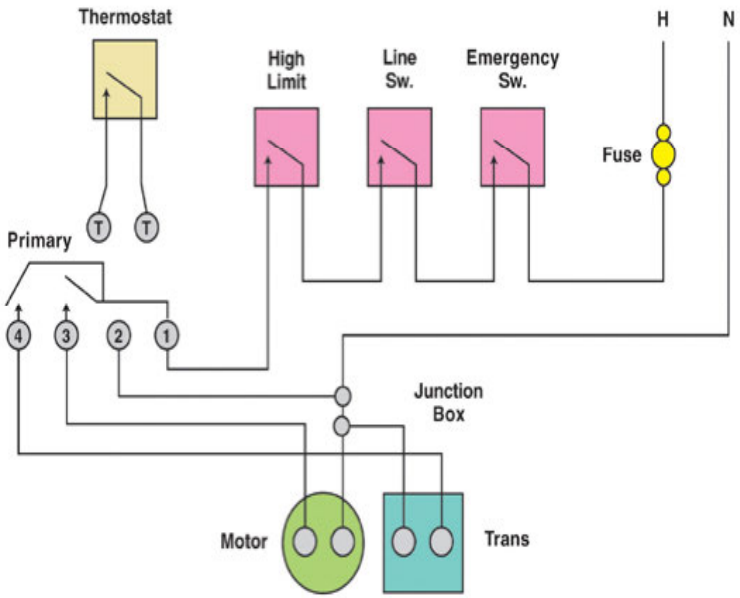


- A light actuated switch
- The brighter the light the cell senses the less resistance to electric flow it offers the circuit.
- As light intensity increases ohms decrease.

Microprocessor Controls

- Interrupted Duty Ignition
- 15 second safety timing
- Limited reset, goes into “latch-up” on 3rd push.
- Valve-delay-on and motor-delay-off: cleaner start ups and shut downs
- Diagnostic LEDs and Dry alarm contacts

Chapter 12- Limits & Thermostats

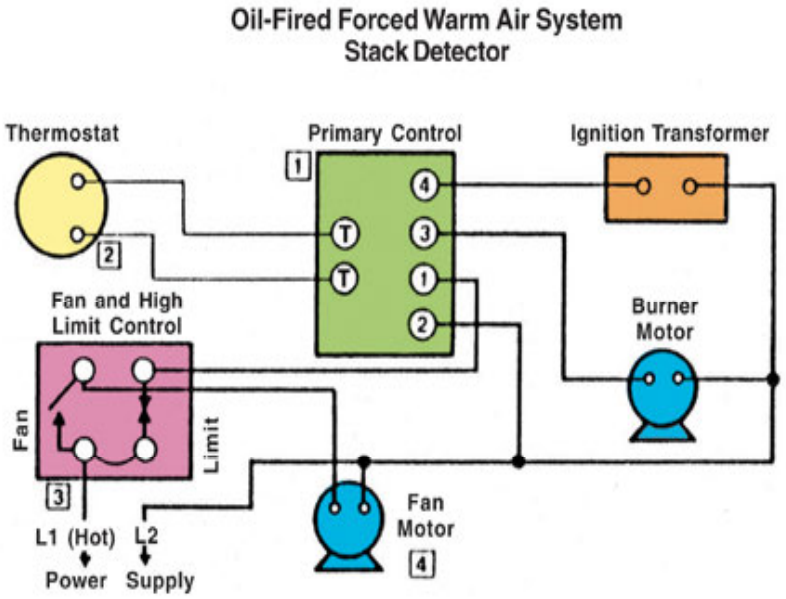


- The control that shuts off the burner in event of excessive temperature or pressure is a **high limit**. **It is always line voltage in series with the primary control.**
- Low limit or operating controls are direct of reverse acting that controls the burner, blower, or circulator
- All limit controls should be tested during a tune-up

Thermostats

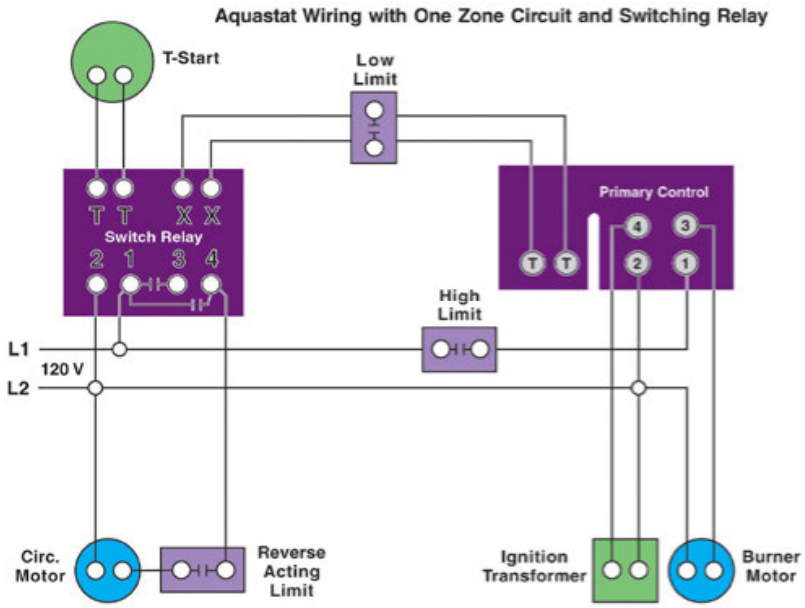
- Heat actuated SPST switch
- Heat only thermostats make (close on temp. fall)
- Old ones have heat anticipators that need to be set to the amperage draw of the control circuit they are in

Fan Limit Control



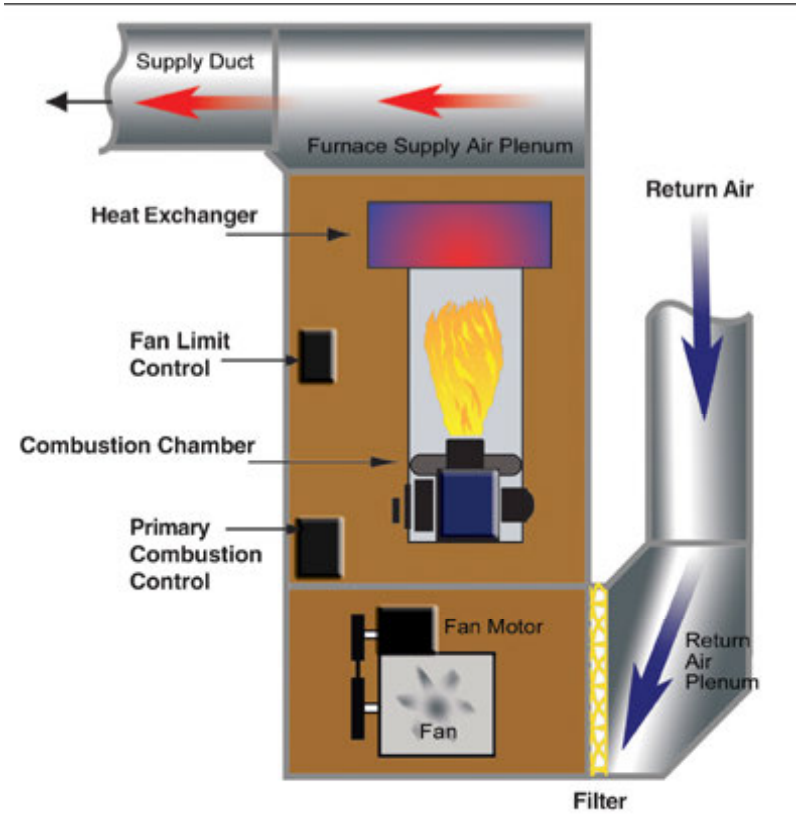
- Shuts off the burner at a predetermined temperature
- Starts the blower at a predetermined temperature
- Stops the blower at a predetermined temperature

Hot Water Heating System



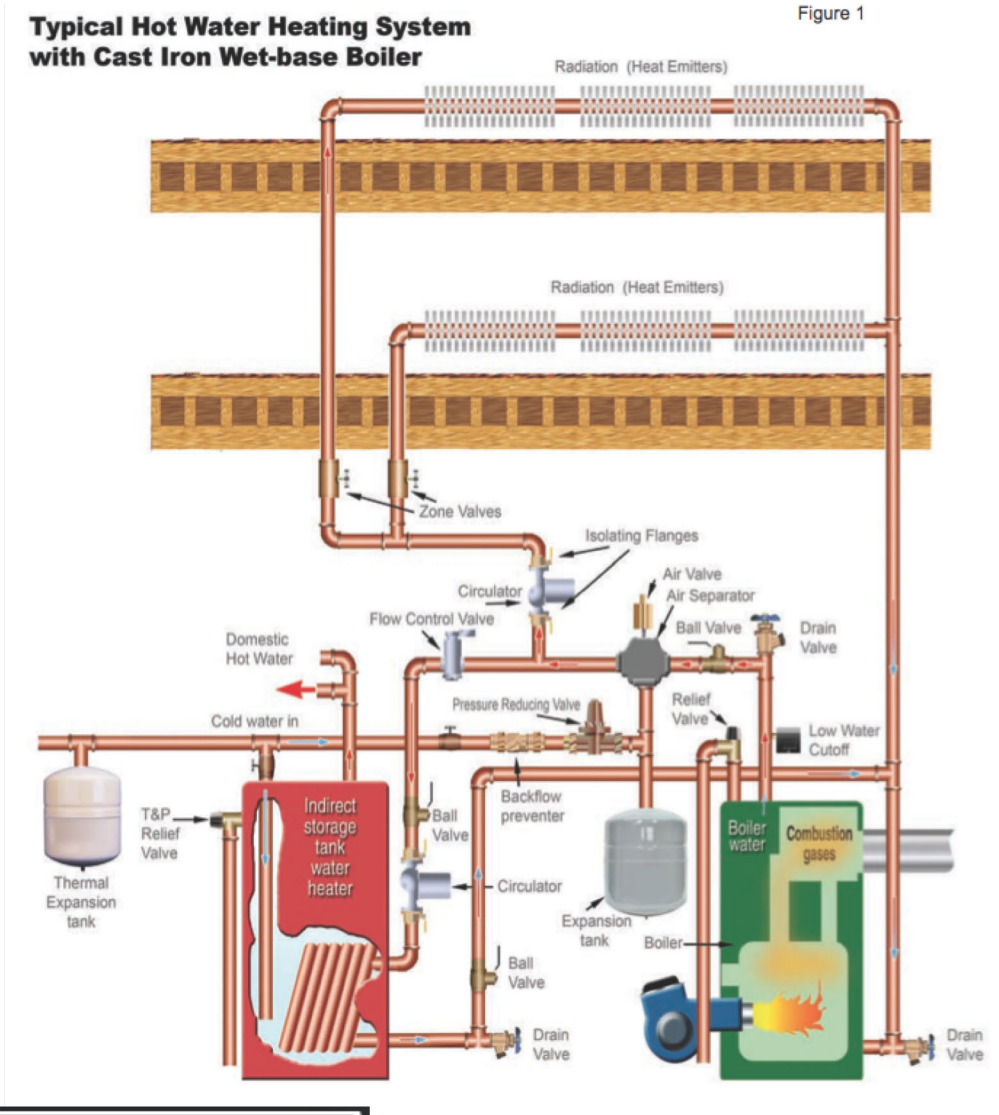
- Switching relay- controls the circulator (line voltage) with low voltage thermostat
- Reverse acting aquastat- stops the circulator when the boiler water temperature falls below the set point

Chapter 13- Heating Systems



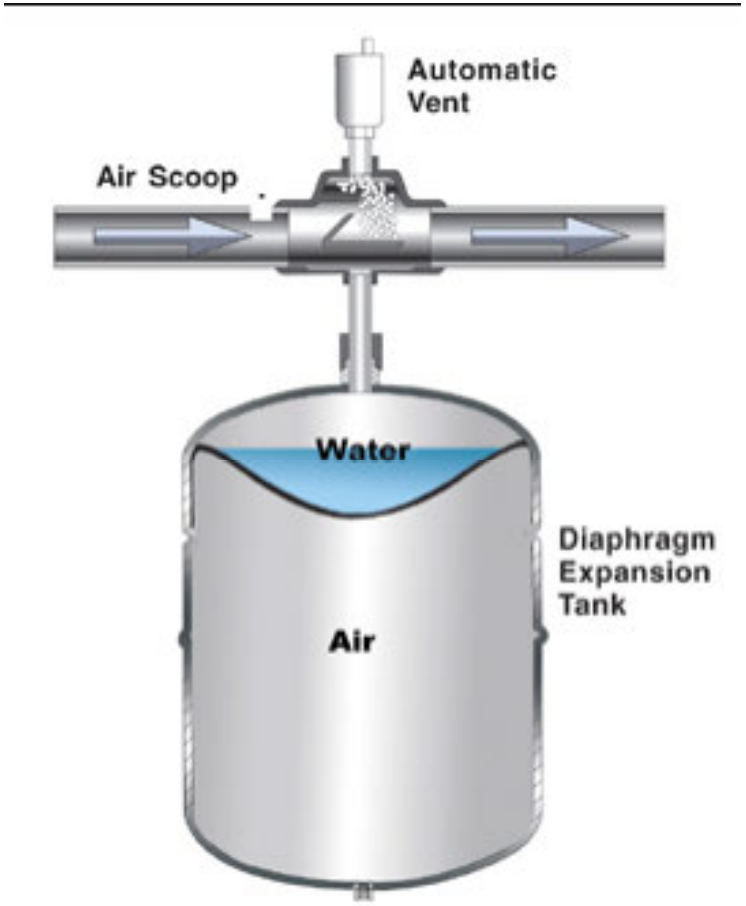
- Furnace is for warm air heat
- Be sure there is good air flow through the furnace, returns must be large enough, filters must be clean
- If there is not enough return air the burner will short-cycle off the high limit.
- Can be used with air conditioning and can purify, and clean the air

Hot Water (Hydronic) Heat

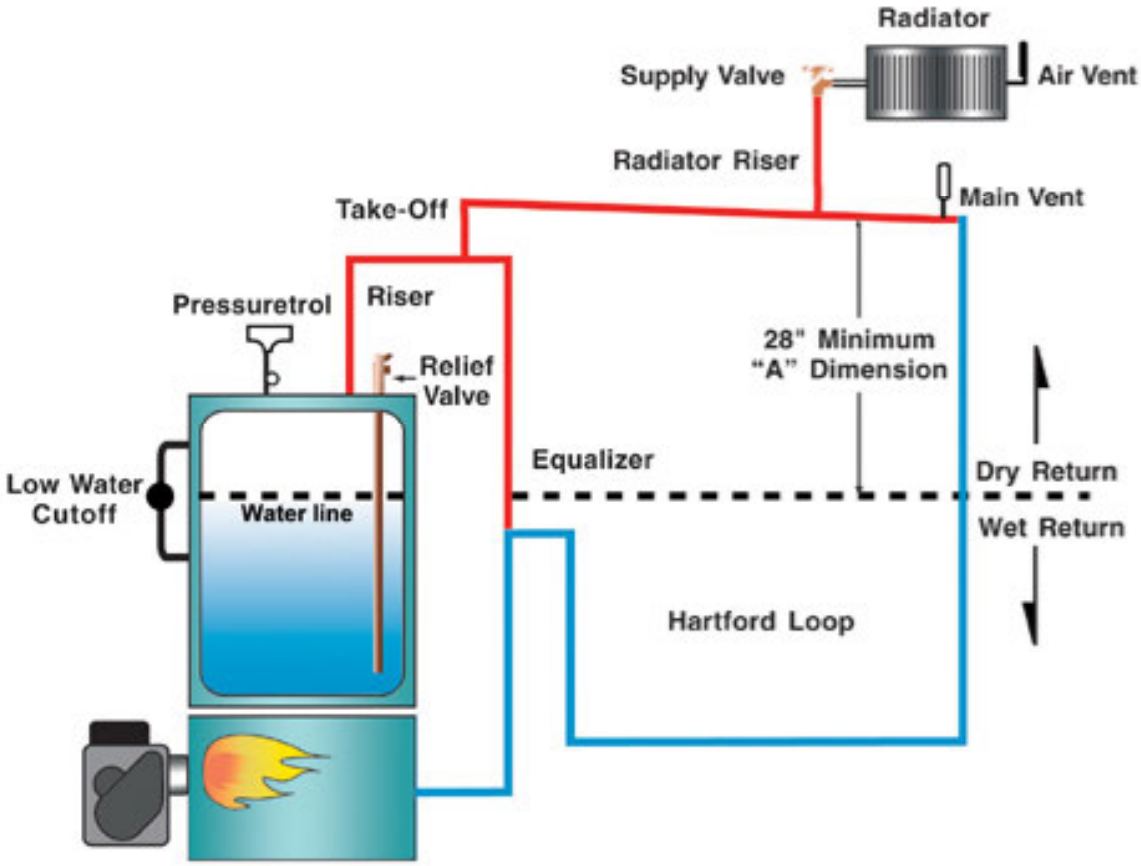


Hydronic Requirements

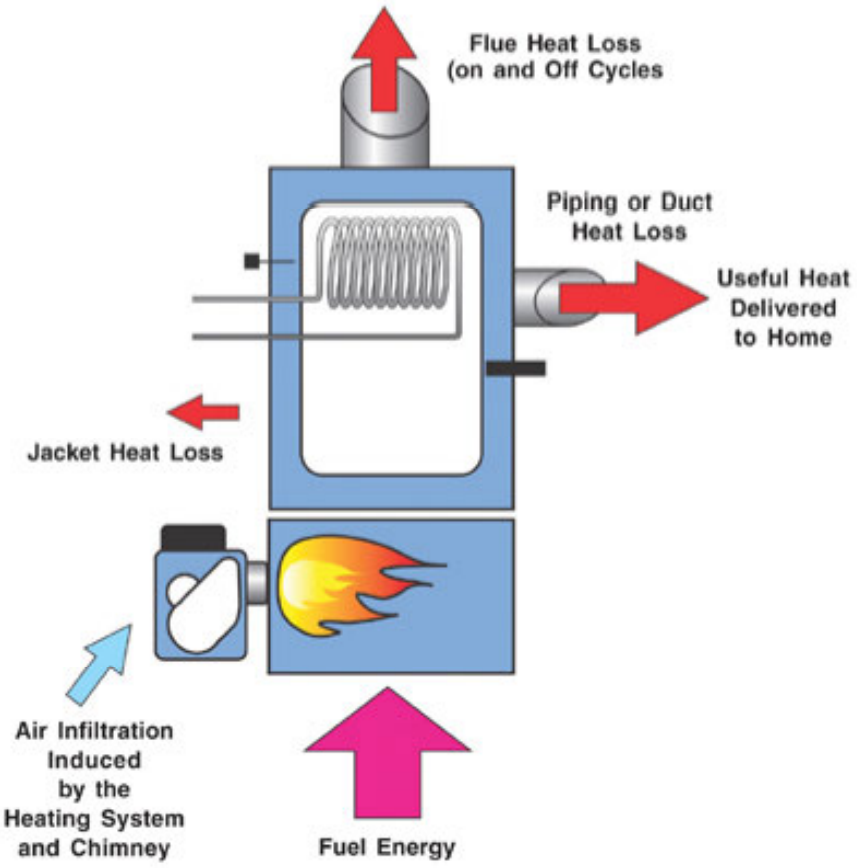
- Proper air elimination
- System water expansion: if the diaphragm leaks the tank will become waterlogged and the relief valve will blow-off.
- 12 PSI pushes water 28’ up a pipe



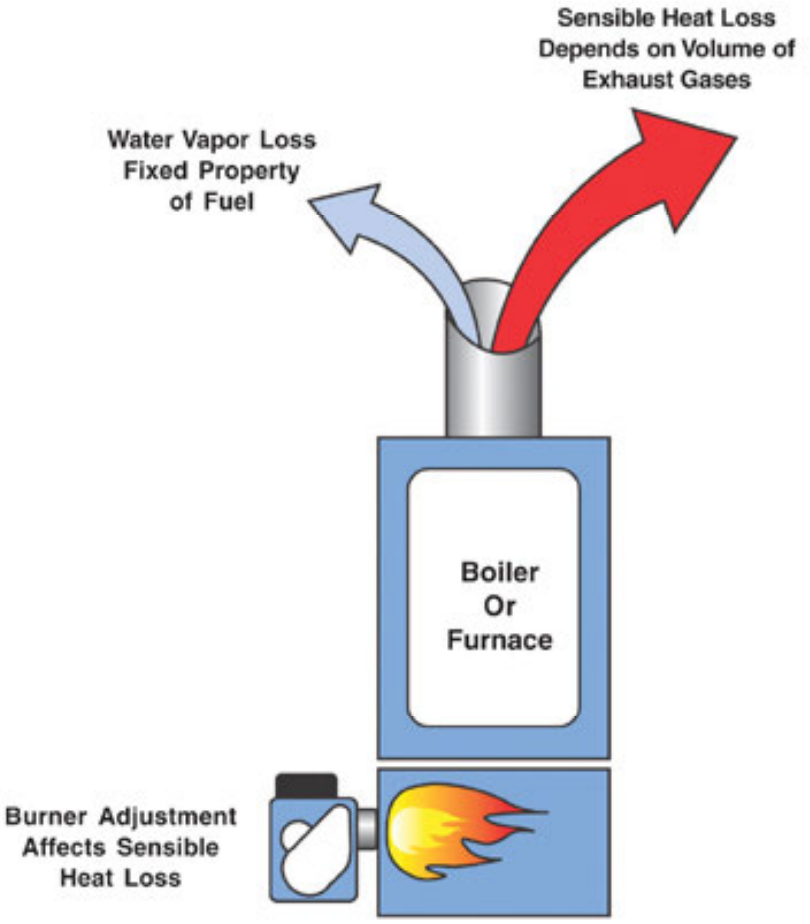
Steam, 2 PSI


Radiator
Supply Valve
Air Vent
Radiator Riser
Main Vent
Take-Off
Pressuretrol
Riser
Relief Valve
28" Minimum "A" Dimension
Equalizer
Dry Return
Low Water Cutoff
Water line
Wet Return
Hartford Loop

Chapter 16- Energy Conservation



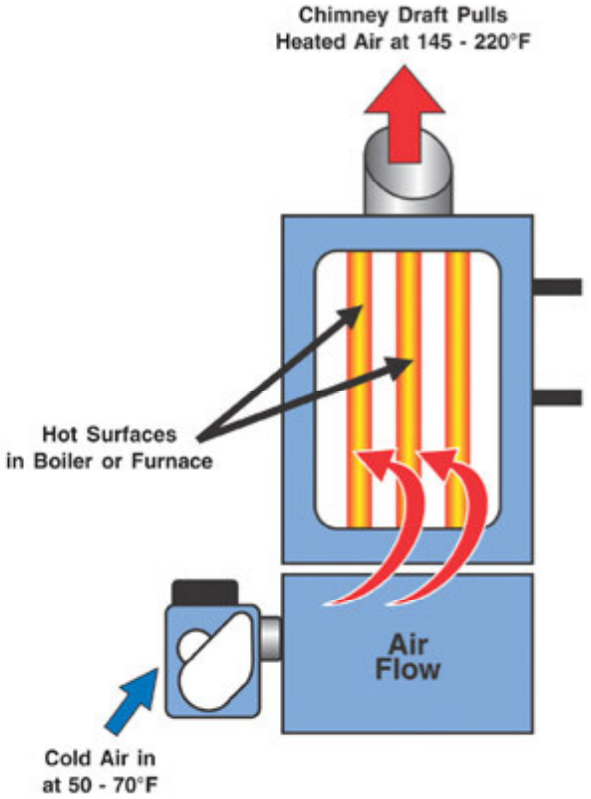
On-Cycle Loss



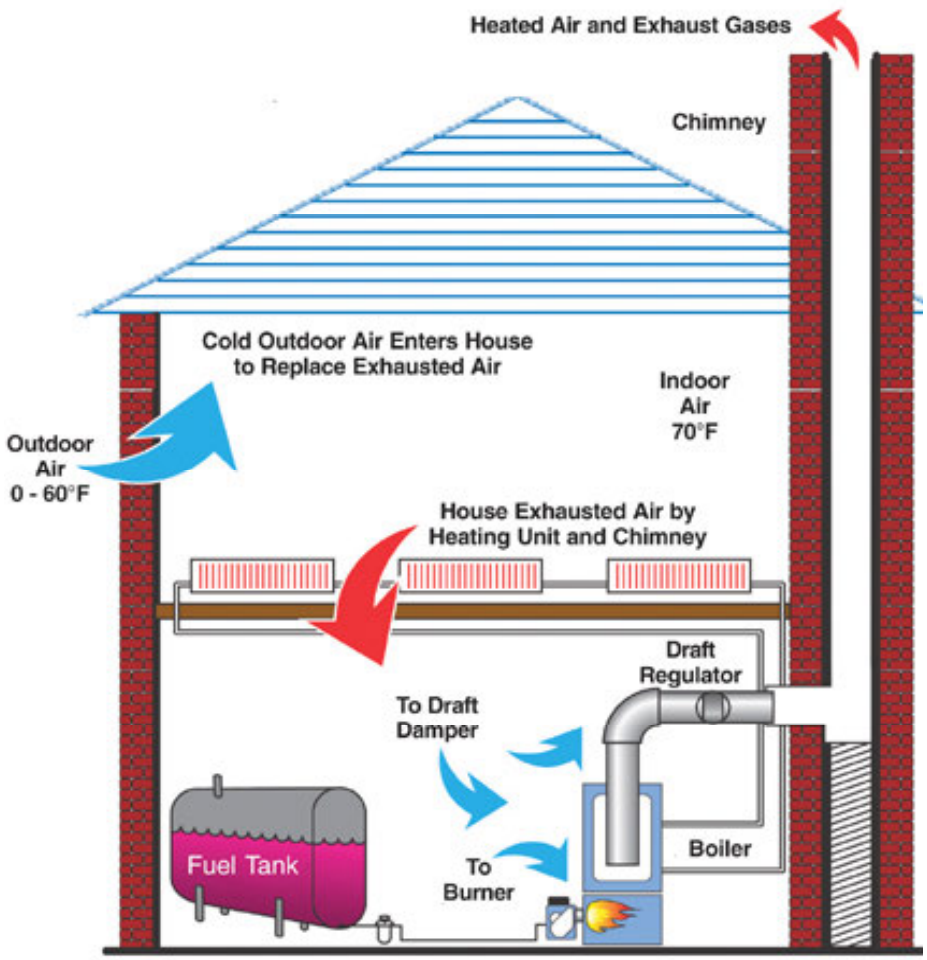
- Steady State Combustion Efficiency
- Adjust burner properly (Excess air increases stack temperatures and decreases efficiency)
- Keep heat exchanger surfaces clean
- Replace inefficient burners and boilers or furnaces

Off-Cycle (Idle) Loss

- Much greater for old units with wide open flue passages. This loss is the reason new equipment uses so much less energy then older units.
- Increased by air leaks into the heat exchanger
- Greater for units whose air bands are open wider
- Greater for units that are oversized



Infiltration Loss



- The energy required to heat the cold air draw into the building to replace the warm air going up the chimney
- Isolated combustion reduces infiltration as well as keeping the fan clean, and avoiding combustion air problems. It will help avoid back-drafting the burner if the air pressure in the building goes negative.

Replacing the boiler or furnace reduces on-cycle, off-cycle, and infiltration losses.

It is the best investment your customer can make!

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Please allow 3 weeks for results.

Test Taking Tips

- Take your time
- Read all the answers before marking the sheet
- If not sure skip it and come back, just be sure to skip a space on the answer sheet!
- If unsure pick the one that seems most right. There is no penalty for guessing