NORA Technician Certification Silver Review

Presented by

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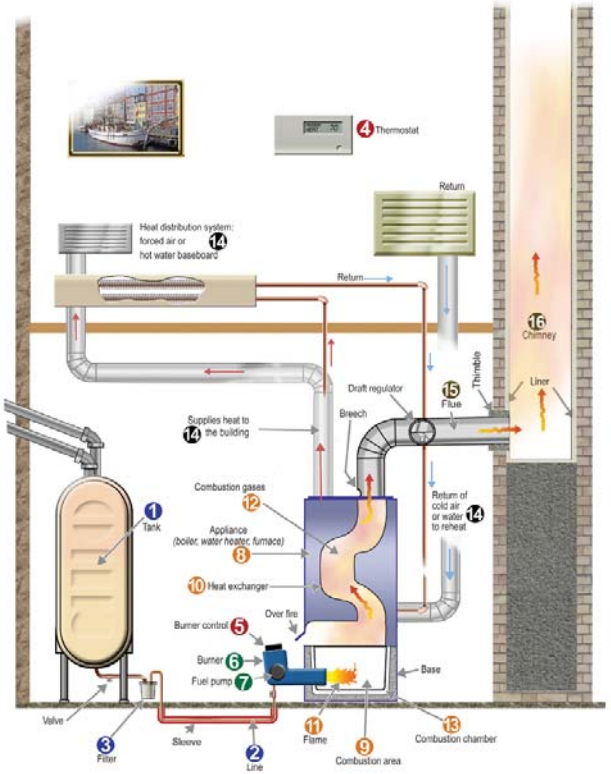
NORA Director of Education

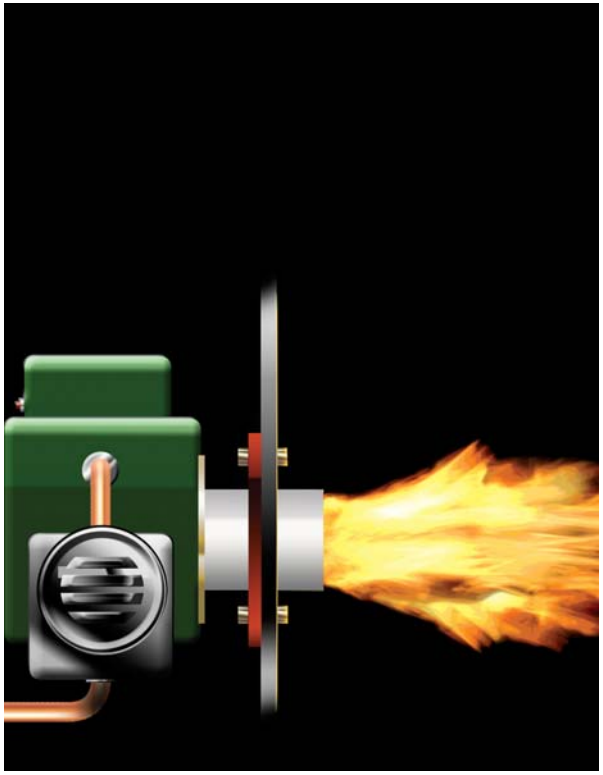
OMA Executive Director

NORA Certification



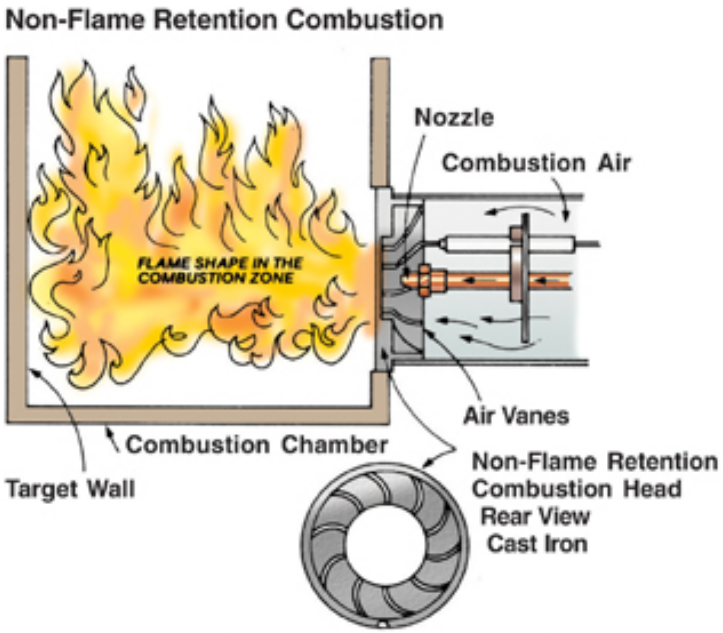
- Bronze- 80 hours of formal training
- Silver- 3 years experience & 100 hours of training
- Gold- 5 years experience &120 hours of training
- National Program, technician is certified not the company, state program for VT & NH
- Test: 100 multiple choice questions, closed book, 78 is passing, oral test option
- Good for 5 years, to renew need 24 CEUs, go for Gold, or retake test

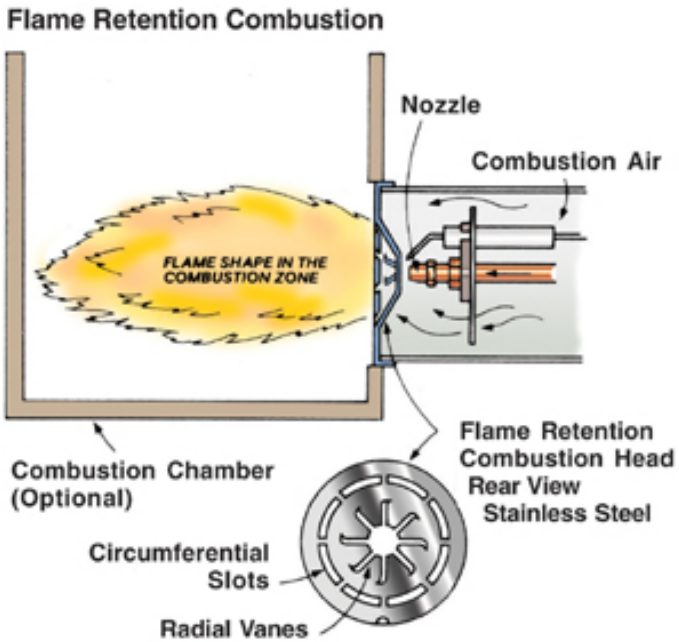
Chapter 1: Oilburners



- Fuel: flow rate set by size of nozzle and oil pressure
- Heat: initially from the spark then from the fire
- Combustion air: controlled by adjustable shutters or bands. Air adjustment is the key and final adjustment, 1-8

Flame Retention Burners





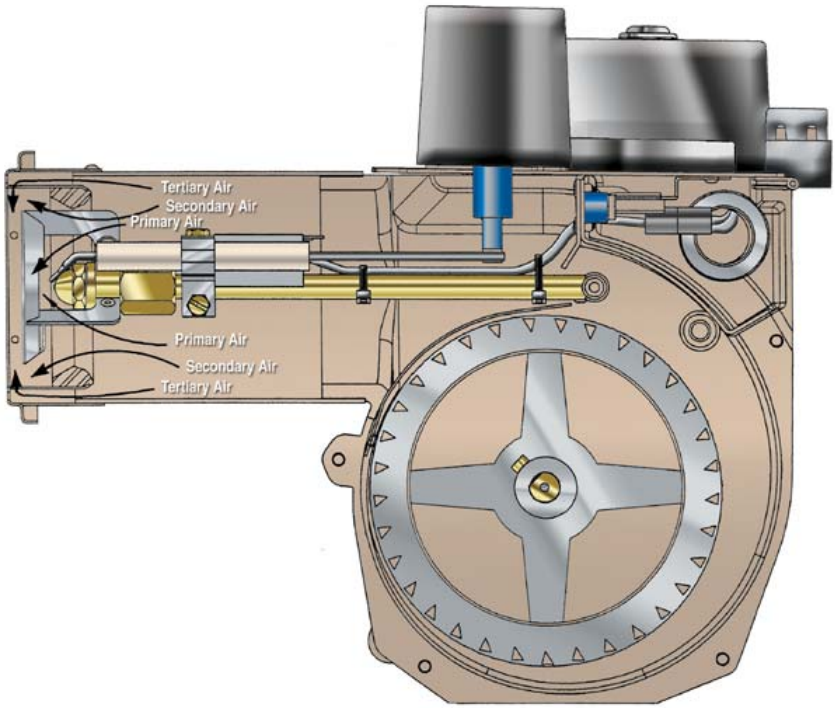
- Better air-oil mixing: Clean Burning and hotter flames with less excess air
- High Static Pressure: more stable flames, able to push through more restrictive heat exchangers, 1-4

Oil Burner Fan

- The beveled blades of the burner fan deliver the air to the air tube.
- The inside of the bevel must be kept clean to insure proper air delivery
- If the fan blades are dirty the fan will not grab the air and the electricity use will decrease, 1-7

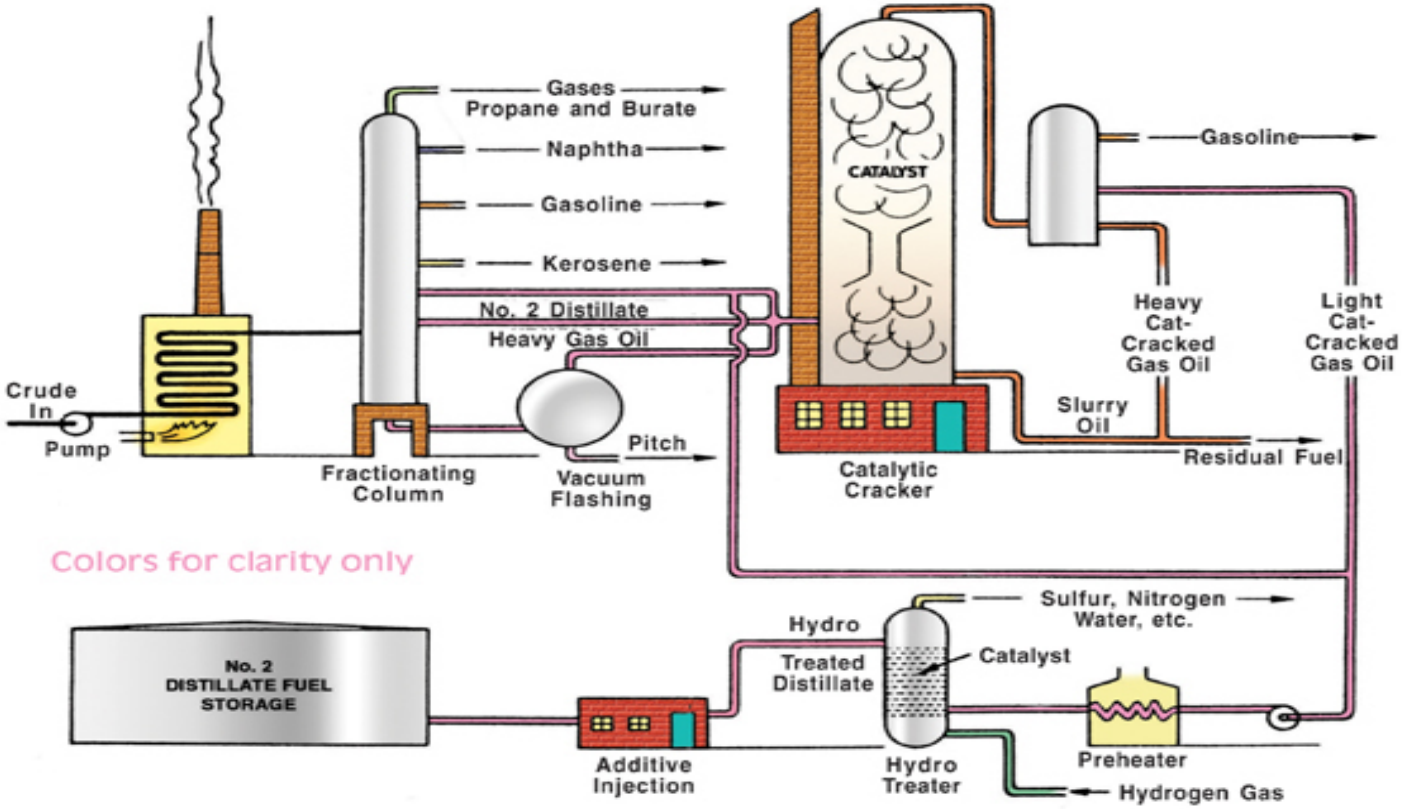
Fixed and Adjustable Heads

- Fixed head: the air ratio is set by the slots in the head. To change firing rates change the head, 1-9
- Adjustable: move head relative to the throttle ring to change the air ratio for different firing rates, 1-10



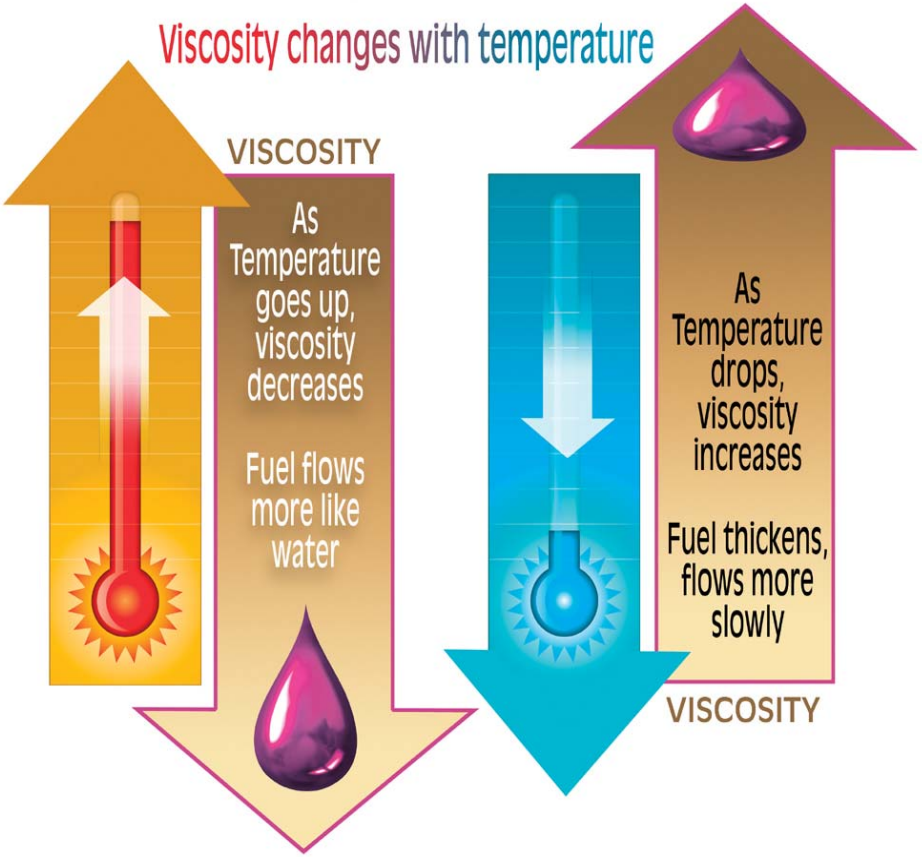
Chapter 2- Heating Oil

- Heating oil is a hydrocarbon fossil fuel manufactured from crude oil in a refinery
- #2 oil contains approximately 140,000 BTU's per gallon



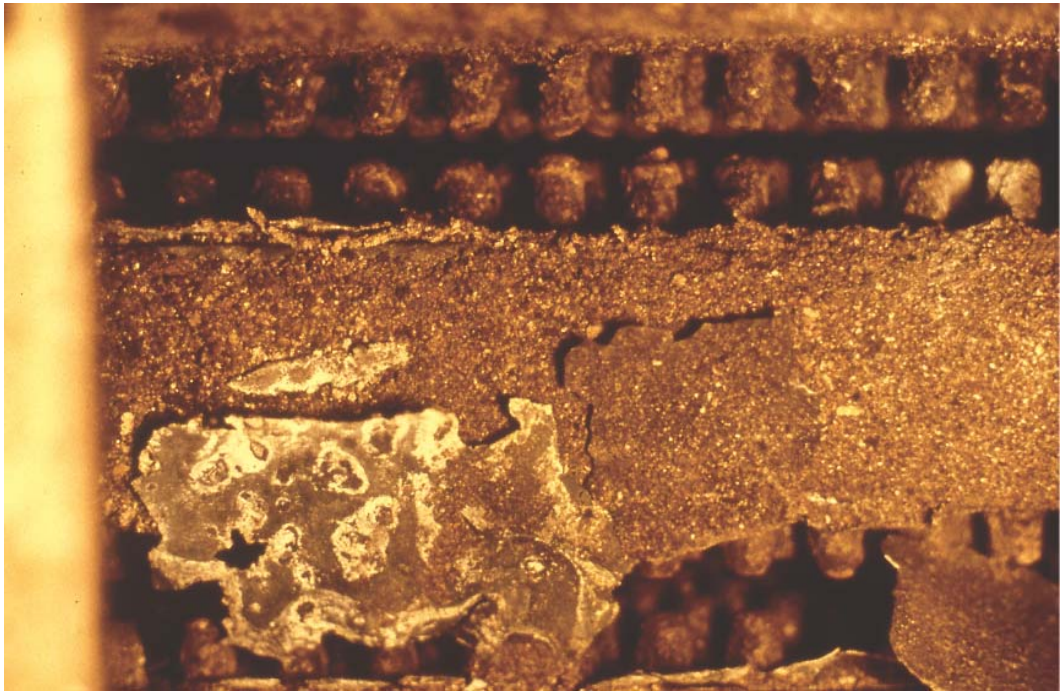
Properties of Heating Oil

- Flash Point: the lowest temp. that the fuel will flash but not continue to burn- over 100
- Ignition Point: the lowest temp. when rapid combustion of the fuel takes place in air- over 500
- Pour Point: lowest temp. at which it will flow. Can be lowered by blending with kerosene or additives. 2-4,5

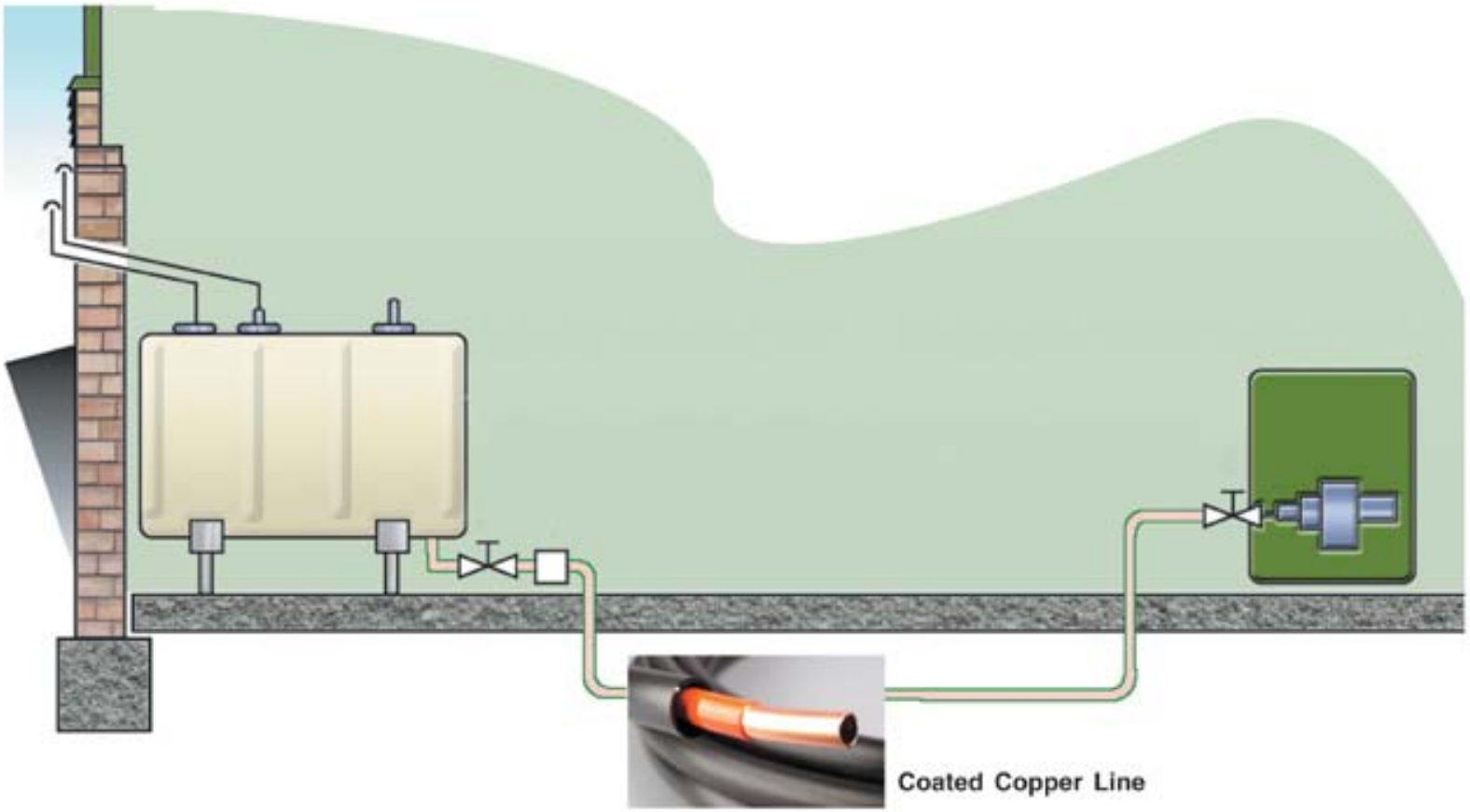


Sulfuric Acid

- Some of the sulfur in the oil burns, mixes with the water and creates sulfuric acid.
- If the acid condenses in the heat exchanger it creates scale. It also damages the flue liner and eats holes in the flue pipe. 2-8

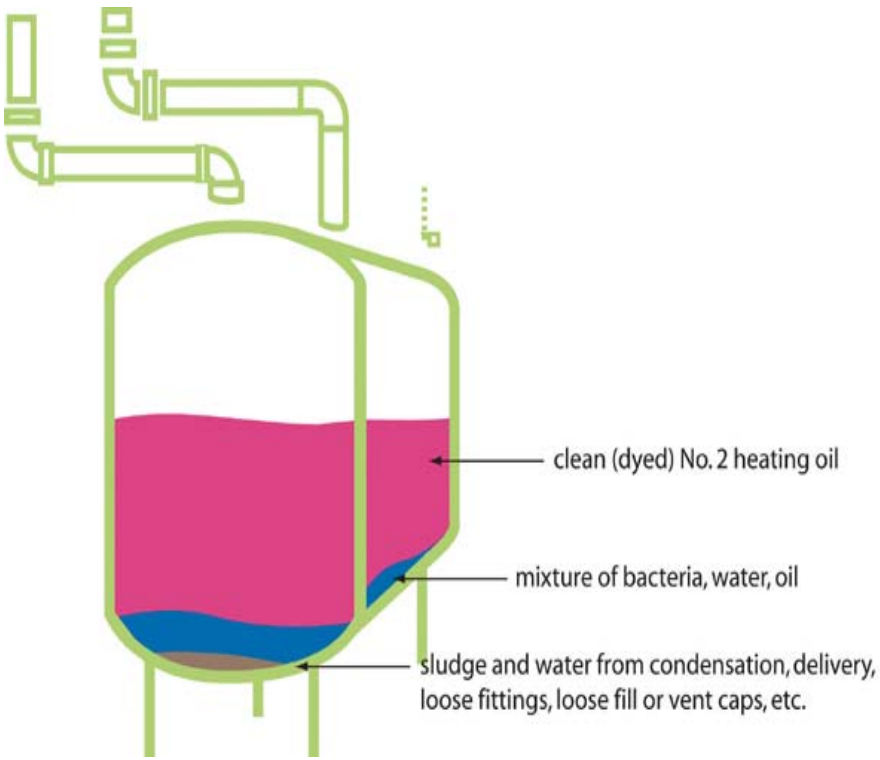


Chapter 3- Oil Tanks and Piping



Tank Bottom Sediment

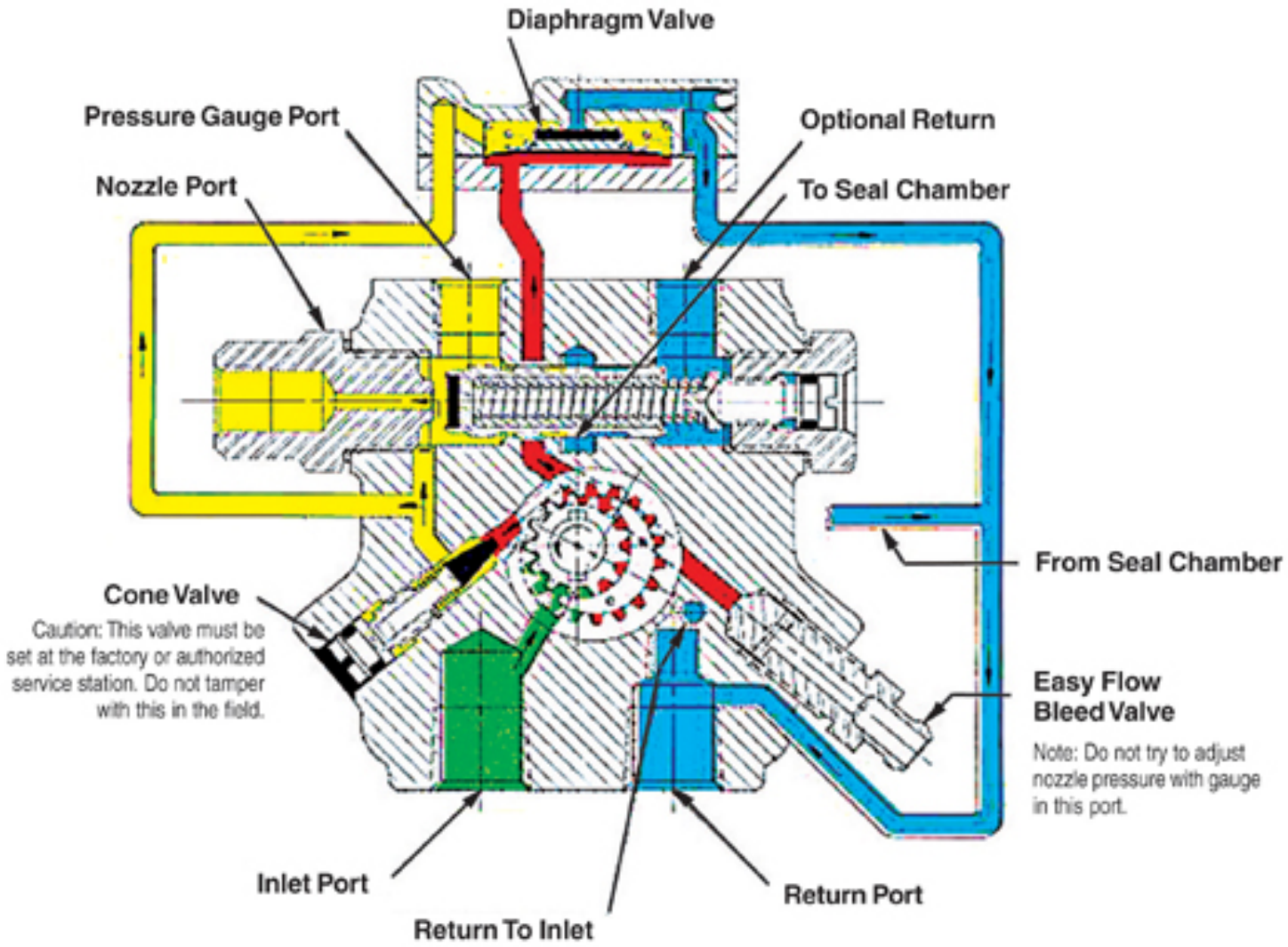
- Sludge is a combination of bacteria, mold, yeast, slime, acid, dirt, rust, and hydrocarbons
- It grows in the water at the bottom of the tank
- Water comes from condensation, loose or missing fill or vent caps, broken gauges, new tanks 3-4



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 ftgs
- Vent alarm, gauge, filter, 5 feet from burner
- Draw from bottom of tank, pitch 1/4” for every 1’
- Sleeve and protect oil lines, no compression ftgs, fusible valves, no Teflon, no ftgs below floor
- Regularly inspect tanks and fix problems

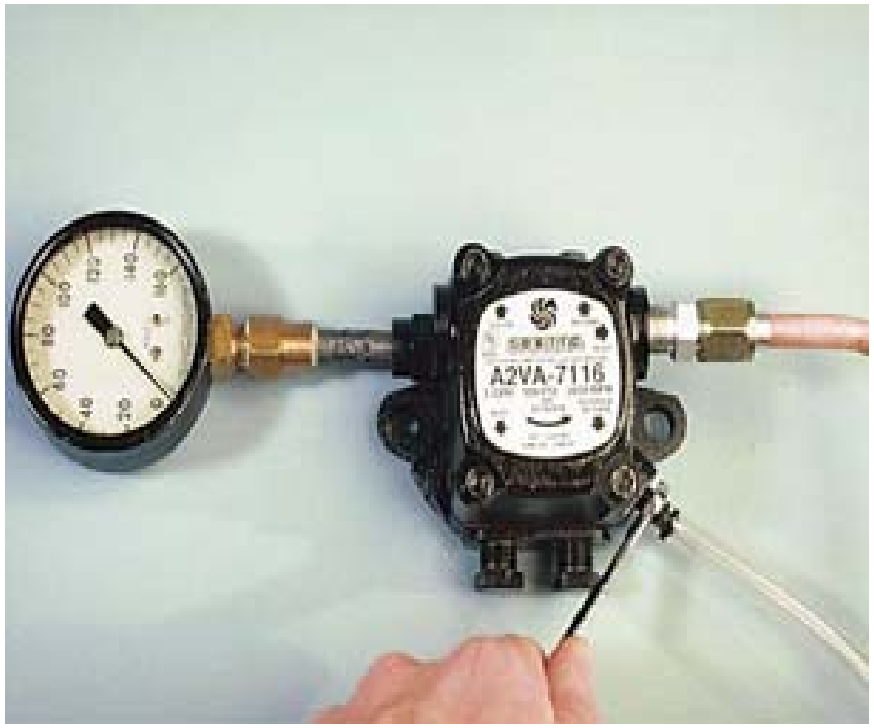
Chapter 4, Fuel Units, Oil Valves



Fuel Units

- Function: lift the oil from the tank, protect the nozzle, deliver oil at a constant and regulated pressure to the nozzle
- One pipe versus two:
  - Two pipe is self bleeding, pumps deliver over 15 gph. With two pipe you are cleaning the tank through the filter.
  - Return lines are 2 PSI, leaking return will not affect performance
  - Copper is a catalyst that destabilizes oil

Pressure

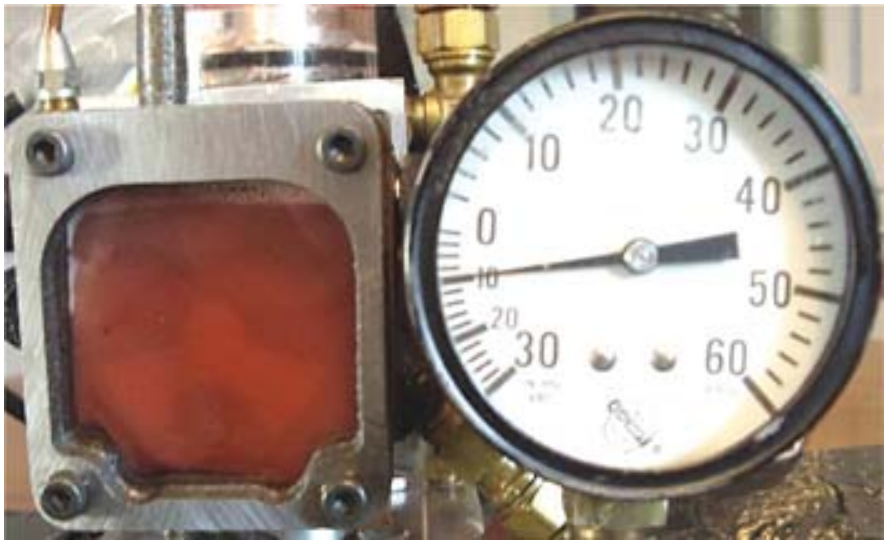


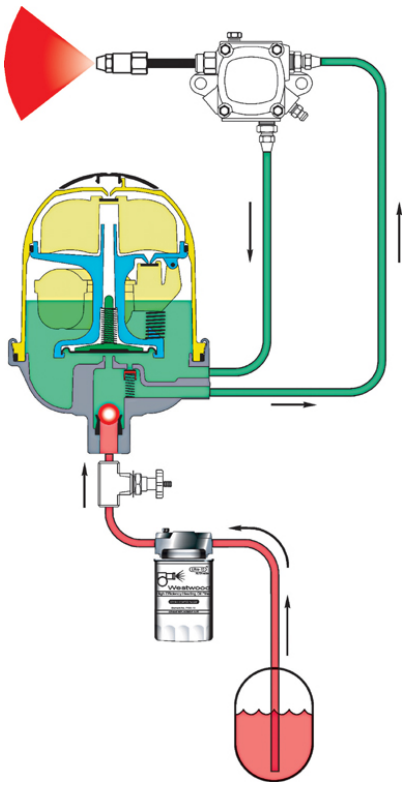
- Pump pressure is factory set at 100 psi. To adjust pressure and check cut-off install pressure gauge in nozzle port.
- On shut down pressure should drop and hold.
- Pulsating pressure caused by: air leaks, dirty strainer, worn gear set
- Pump noise caused by: high vacuum, air leaks, worn gear set

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 line, fittings or filter gasket
- To clear a plugged line use a hand pump to suck it out, do NOT use a CO2 gun to blow it out

De-Aerator

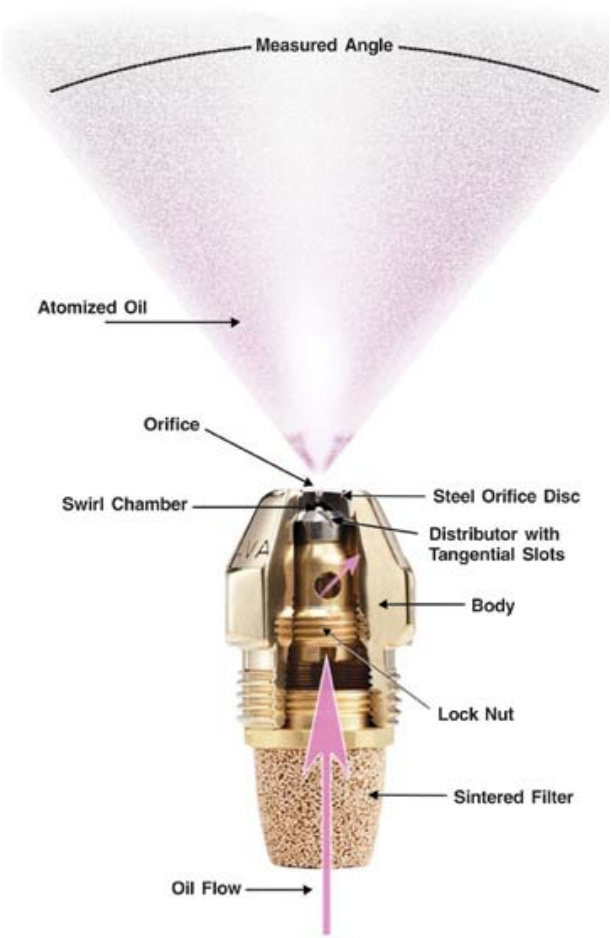




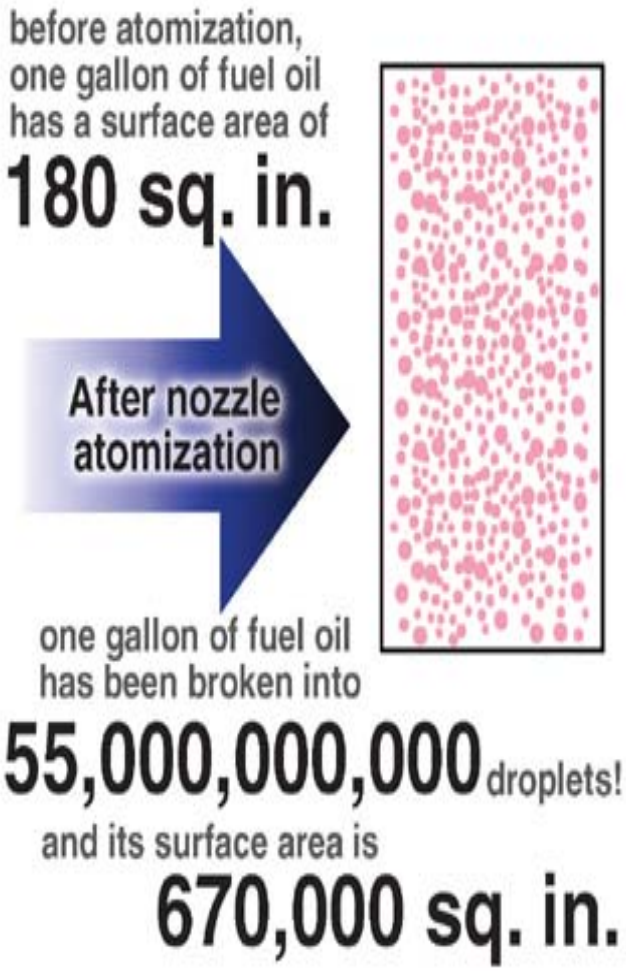
- Eliminates the need for a return line
- At about 7” of vacuum the oil foams
- Better than a two-stage pump for high lift requirements

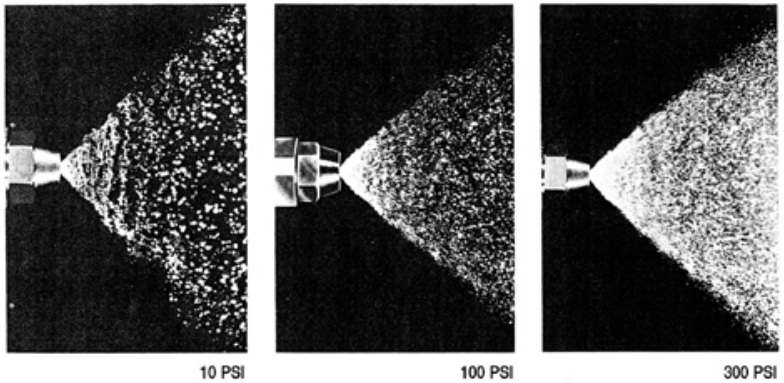
Chapter 5- Nozzles & Chambers

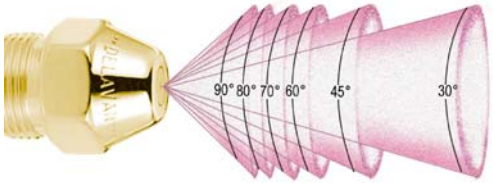
- Purpose:
  - Atomize the oil
  - Pattern the spray
  - Meter the amount of oil
- When replacing a nozzle:
  - Size according to mfg. Recommendations
  - Work clean
- The flow rate is based on 100 PSI.
- If you increase the pressure you increase the flow



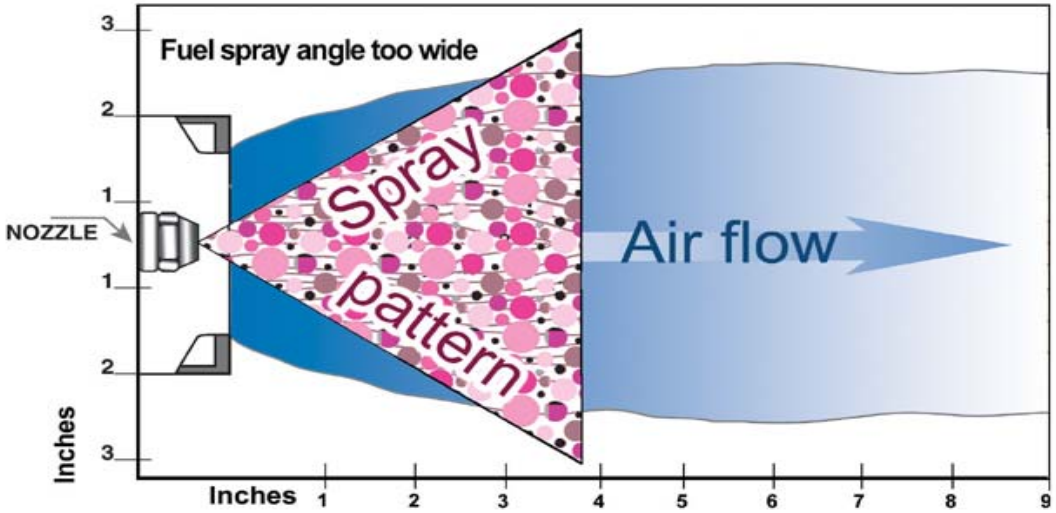
Chapter 5-Nozzles & Chambers

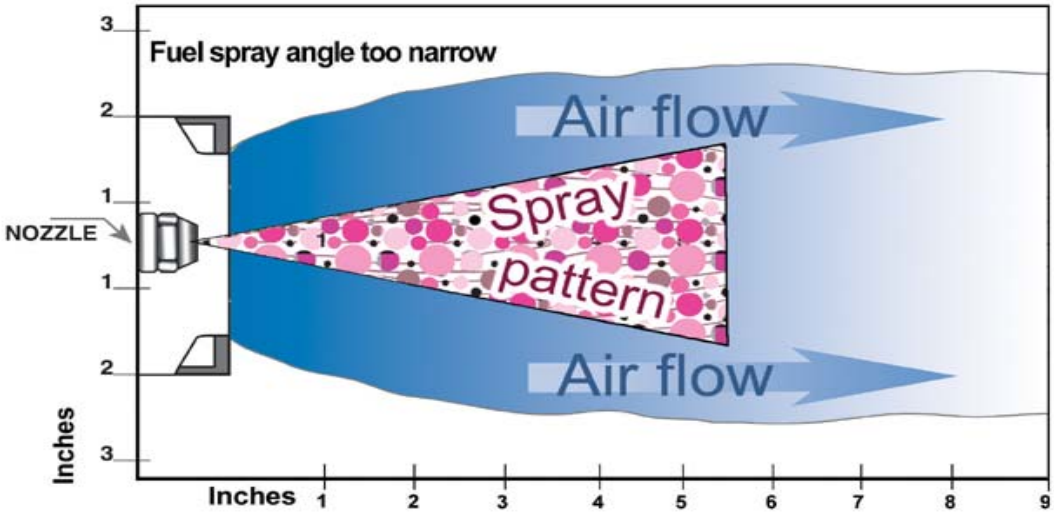




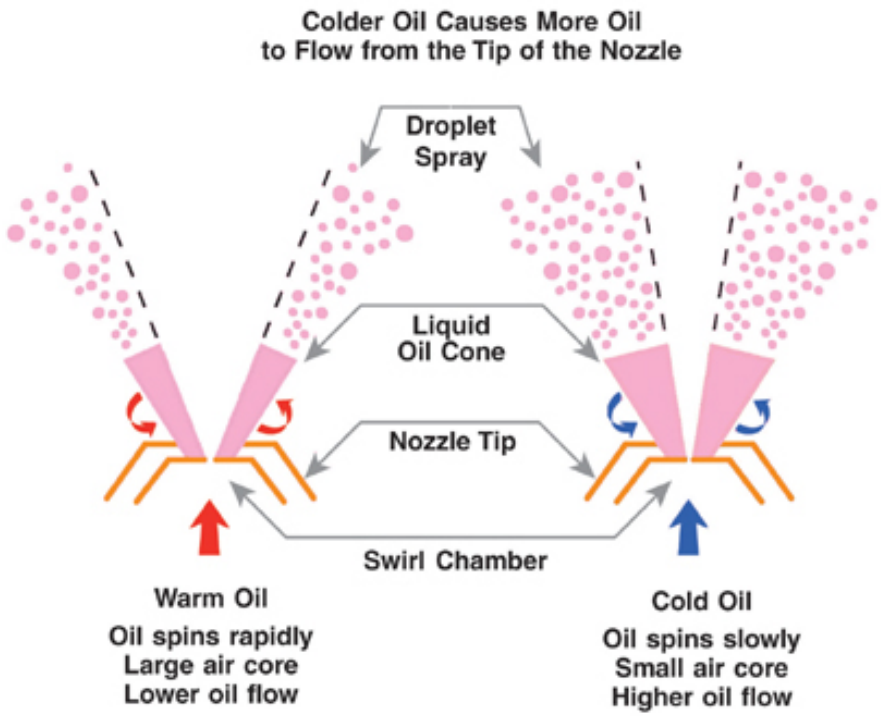


Chapter 5-Nozzles & Chambers





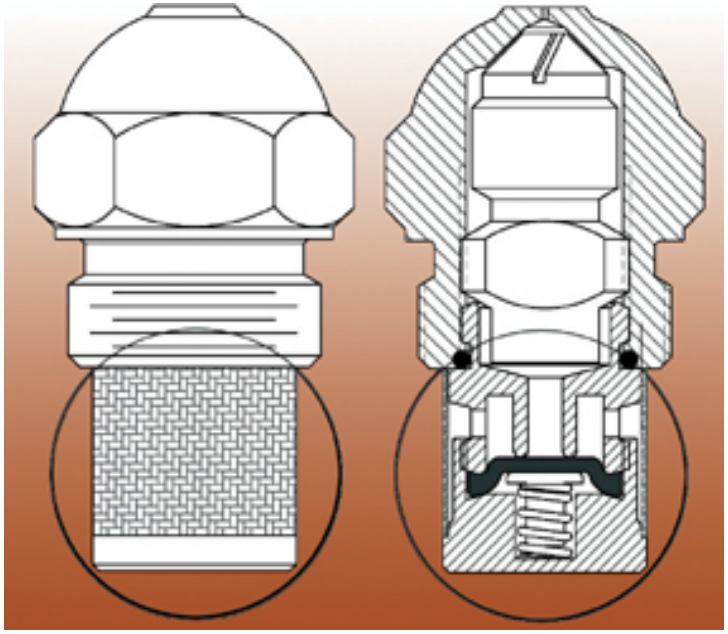
Cold Oil Increases Viscosity



To minimize effects:

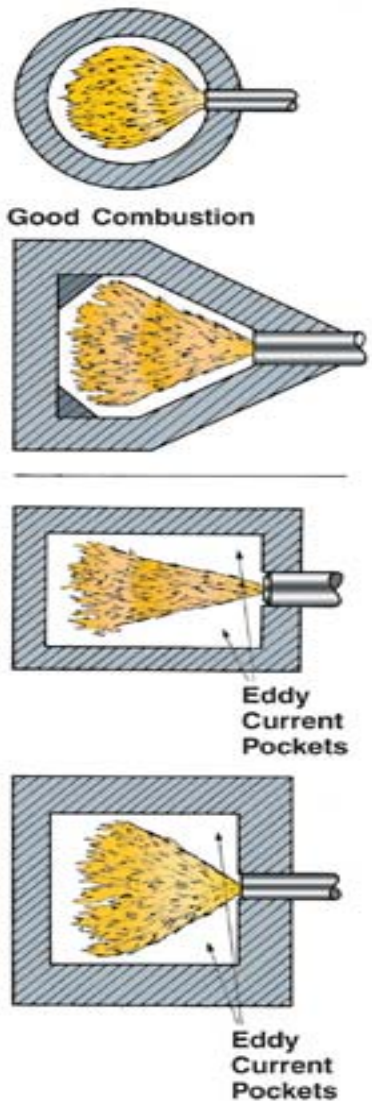
- Increase the pump pressure
- Install a nozzle line pre-heater
- Use additives or kerosene to reduce viscosity

After Drip



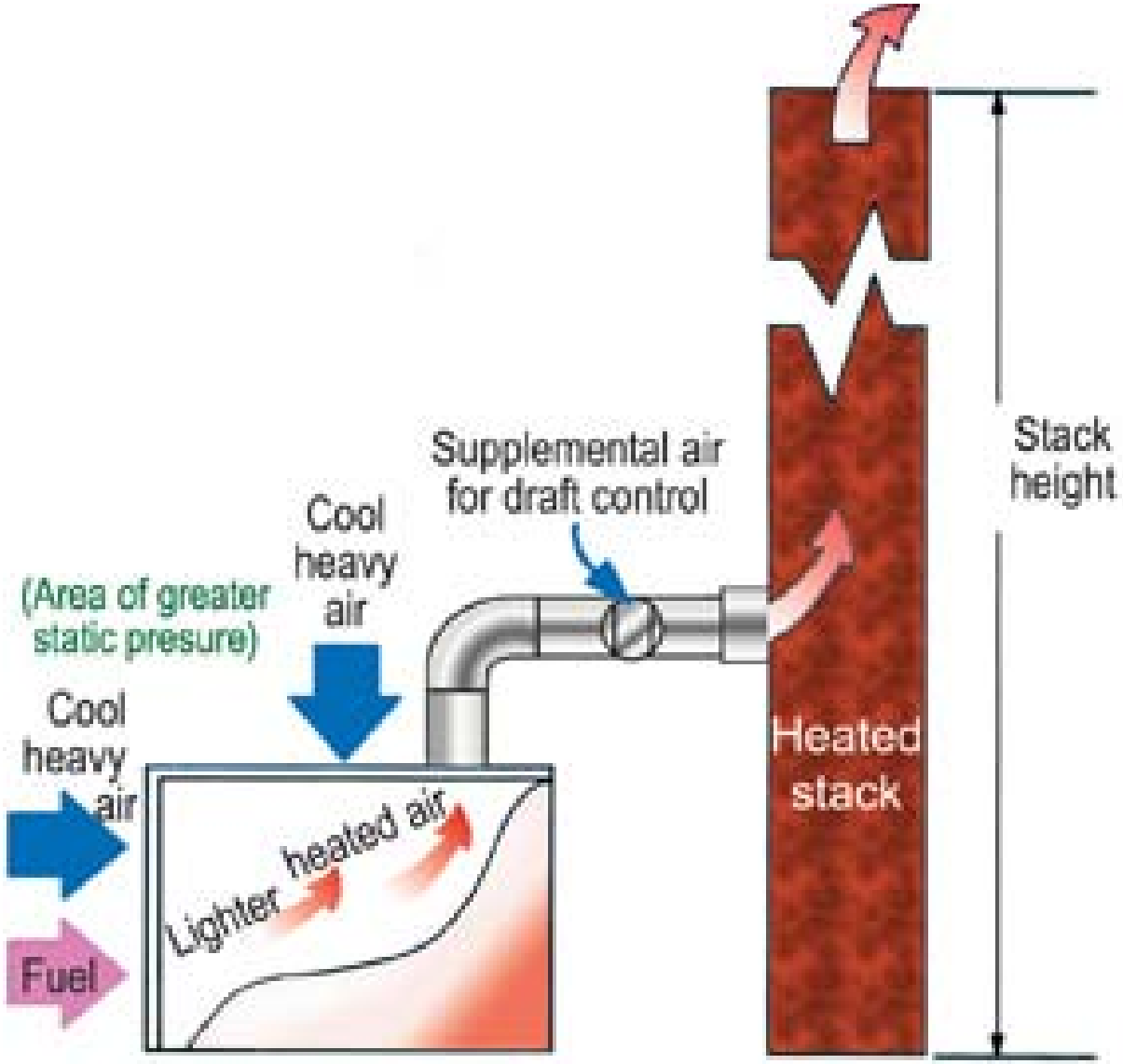
- Causes: defective pressure regulating valve, air in the nozzle line, oil expansion due to heat
- Solutions: pump pressure cut-off test, check for air leaks, de-aerator, anti-drip nozzles, motor delay-off (post purge)

Combustion Chambers



- Must be large enough so the fire does not impinge on any surface
- Heats and cools quickly
- Reflects heat back into the fire

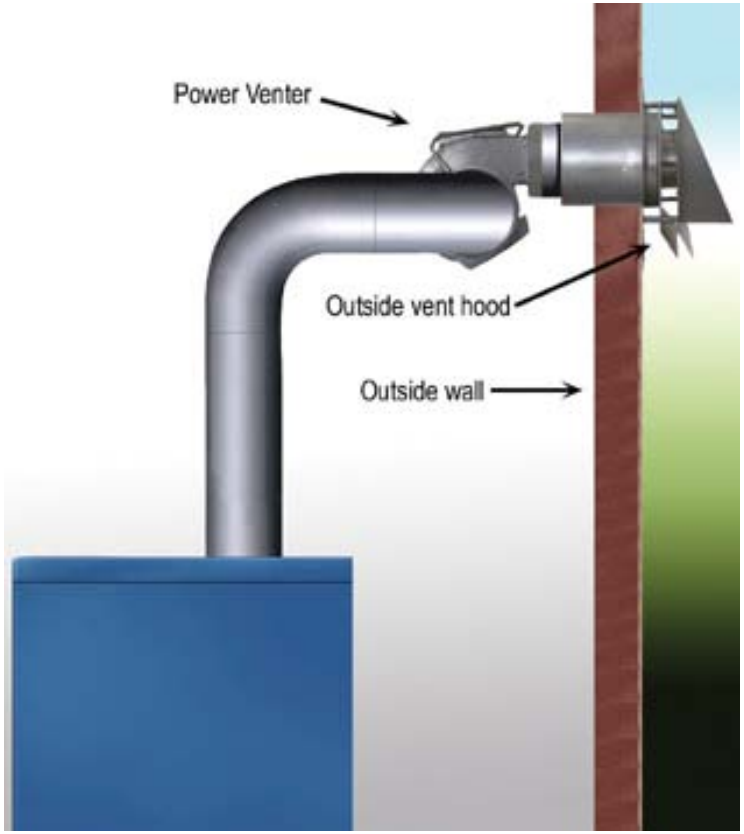
Chapter 6- Draft and Venting



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.
- The key measurement is draft over the fire. 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
- Draft regulators decrease overfire draft to a steady low draft

Chimney Troubles

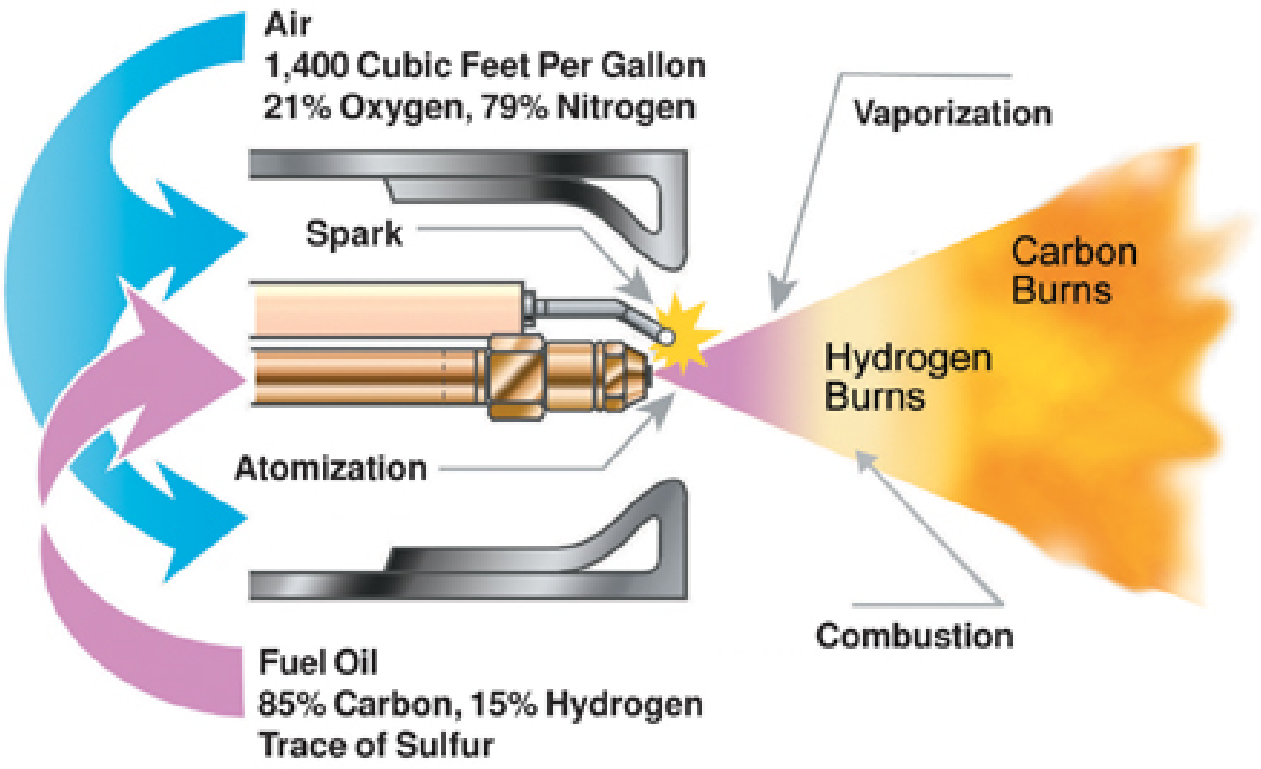


- New appliances have dramatically increased efficiency and reduced stack temperatures
- On cold starts and low temperatures the water vapor in the combustion gasses condense

Alternative Venting

- Draft Inducers: helps the chimney
- Power Venters: pull the combustion gasses through the heat exchanger and out of the building
- Direct Vent: uses the static pressure of the burner to push the gasses

Combustion



Heat
138,690

Hot Nitrogen
Carbon Dioxide
CO_2

Water Vapor
H_2O

Nitrogen Oxides
NOx

Excess Oxygen
O_2

Sulfur Oxides
SOx

Free Carbon
Smoke

Carbon Monoxide
CO

Excess Air (for every pound of oil)

0% Excess Air

14.36 lbs of air =

- Nitrogen: 11.02 lbs, 84.7%
- Oxygen: 0 lbs, 0%
- CO2: 3.16 lbs, 15.3%
- Water vapor: 1.18 lbs

Increasing the air also increases the stack temperature

50% Excess Air

21.54 lbs of air =

- Nitrogen:16.69 lbs, 82.7%
- O2: 1.51 lbs, 7.1%
- CO2: 3.16 lbs, 10.2%
- Water vapor: 1.18 lbs

Incomplete Combustion

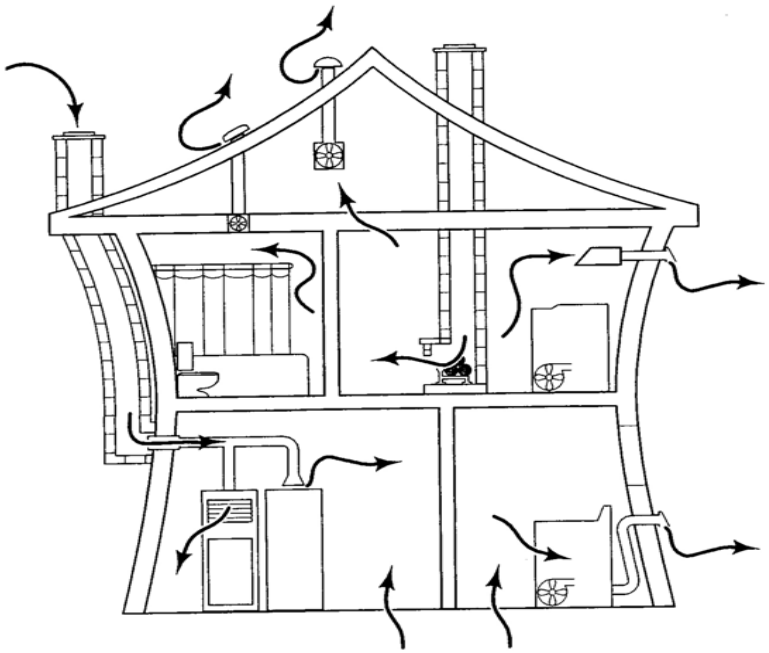


Figure 6-12 **Ventilation Problems Raise Carbon Monoxide Hazard**

- Getting enough combustion air is becoming a problem
- Carbon Monoxide levels rise with either too much or not enough combustion air.
- To have a CO event we need a combustion failure and a venting failure

Combustion Testing

- Combustion tests: measure temperature of the flue gasses, draft over the fire, smoke in the flue gasses, and amount of excess air to get the steady state efficiency
- The 1/4” holes 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
- The KOH in the CO2 tester is good for 200 tests
- A CO2 reading of 7% at the breach and 10% over the fire indicates air leaks in the heat exchanger

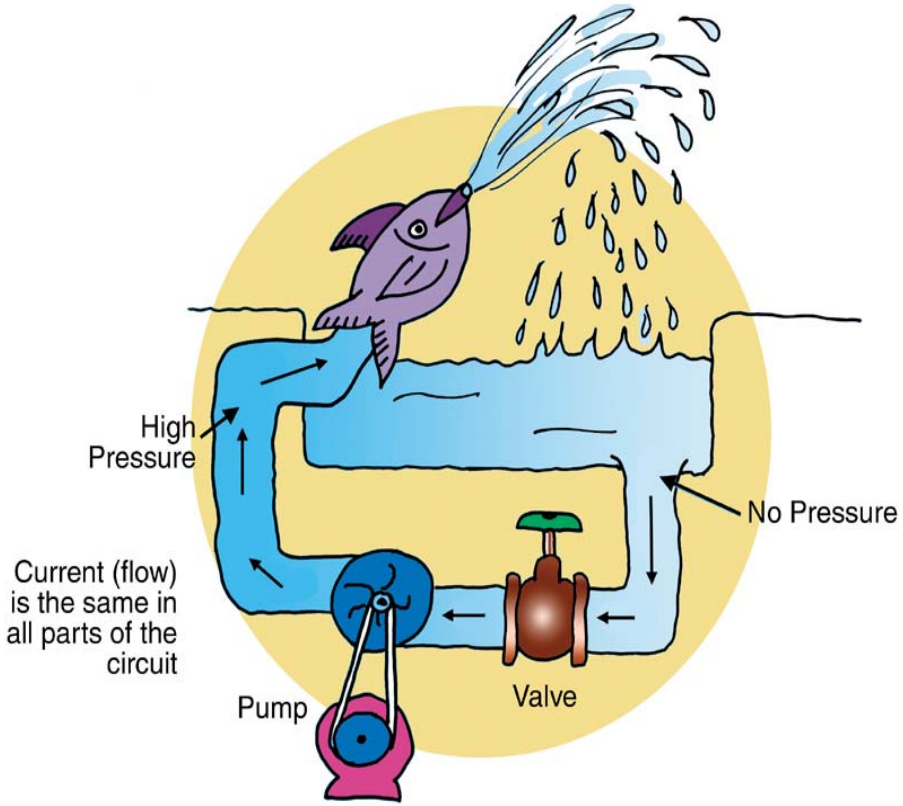
Smoke Tester

- 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

Digital Electronic Analyzers

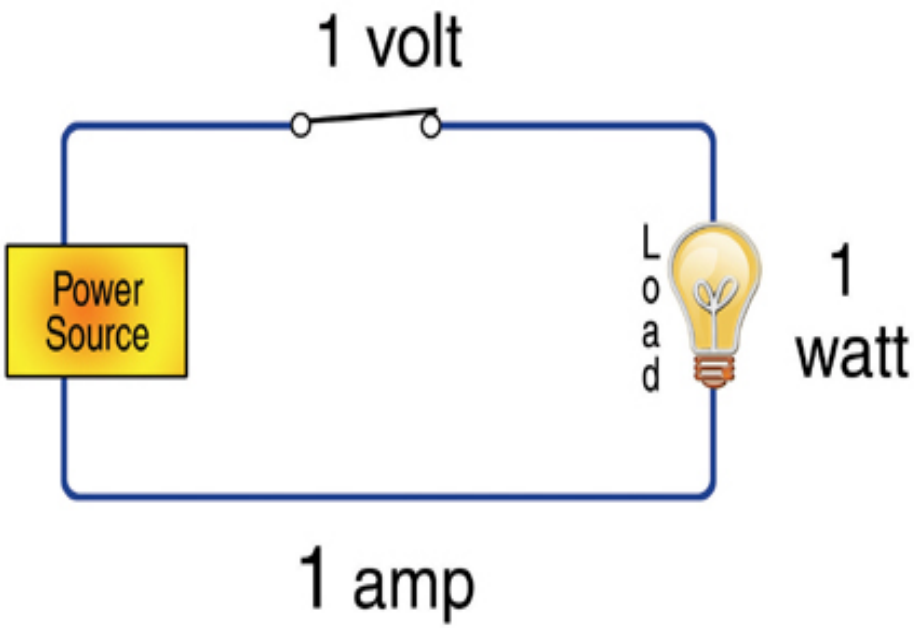
- Faster, more accurate, and created a printed record
- Perform a smoke test first and be sure it is a trace or less before using analyzer
- Do not leave in the cold
- O2 sensors must be replace periodically
- Calculate combustion efficiency by comparing the net stack temperature and excess air

Chapter 8- Basic Electricity



- Volts- Electric potential, like water pressure
- Amps- the amount of electric current flowing in the wire.
- 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

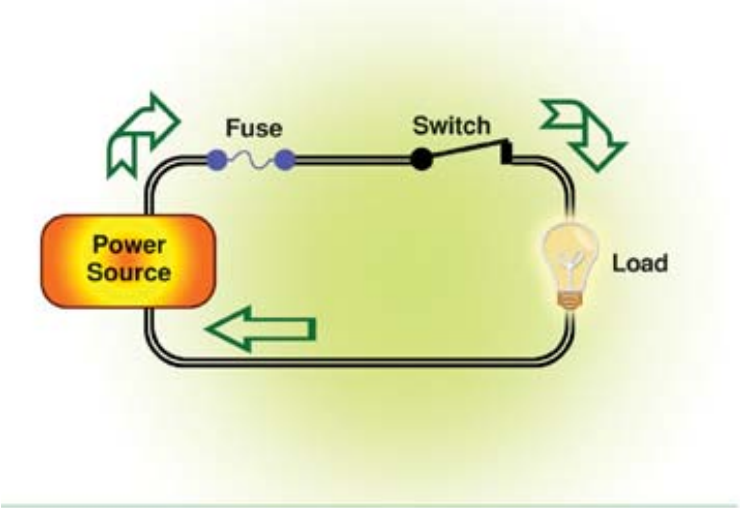
Electric Flow

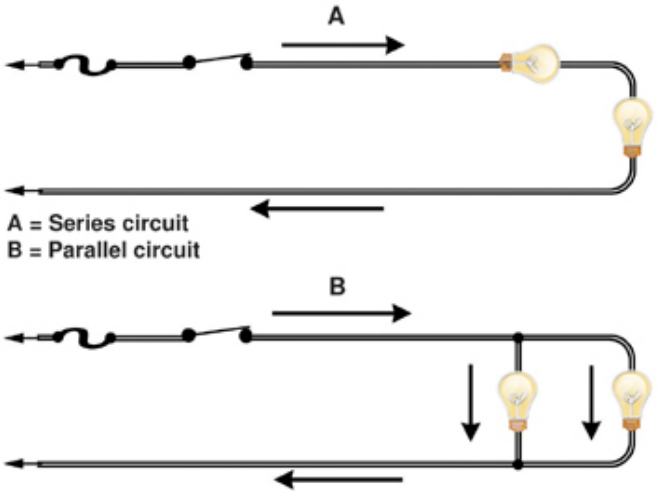


- Conductors- allow electricity to flow easily. Gold, copper, silver, and aluminum are good conductors
- Insulators- high resistance to flow. Air is a good insulator. So is glass, porcelain, plastic, & rubber.
- Load- a device that uses electricity to perform work, the work is measured in watts

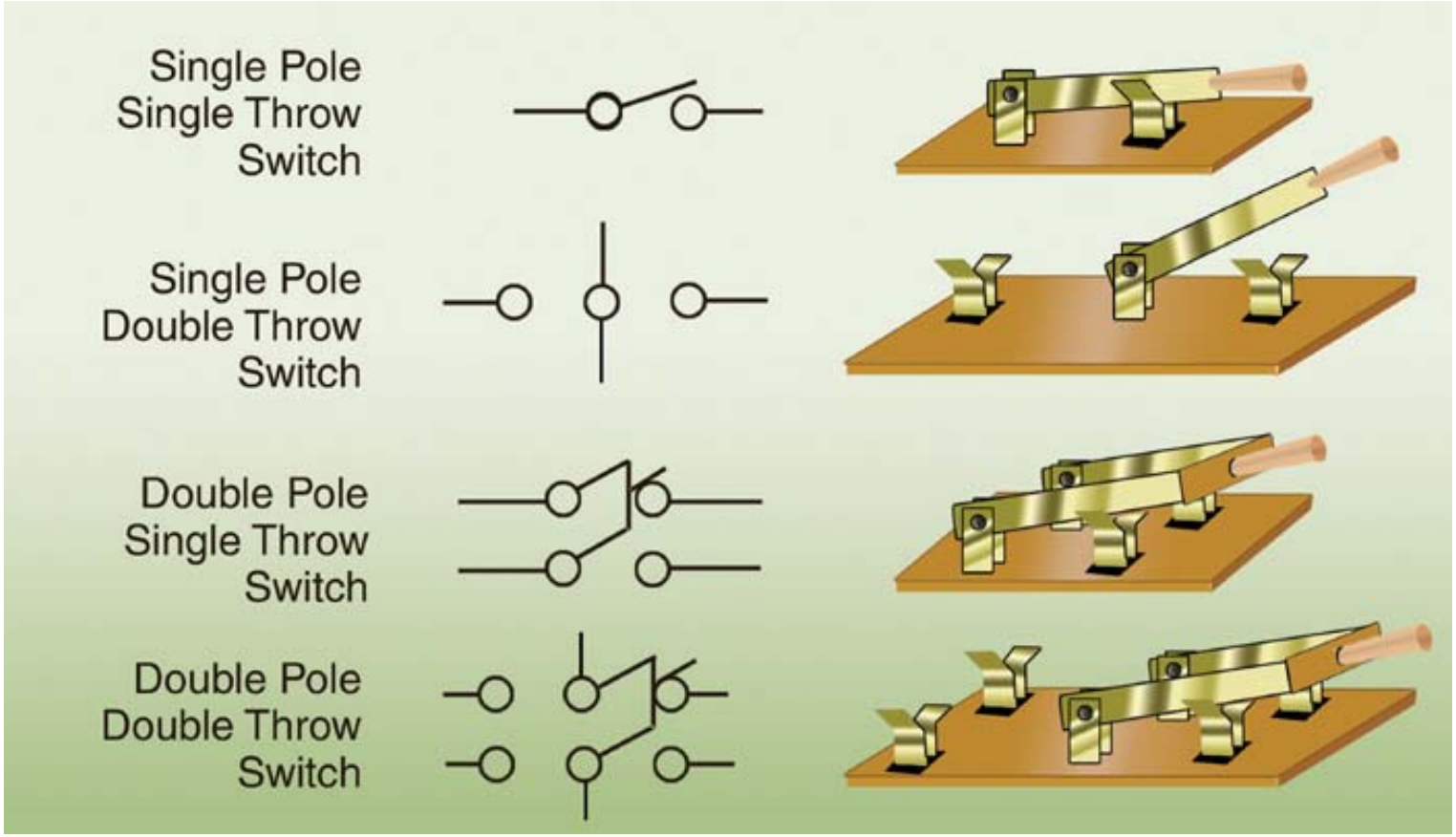
Circuits

- Circuit- a conductor runs from a power source to a switch, a load, and back to the power source.
- Series- only one path for the current through the loads
- Parallel- each load has its own branch

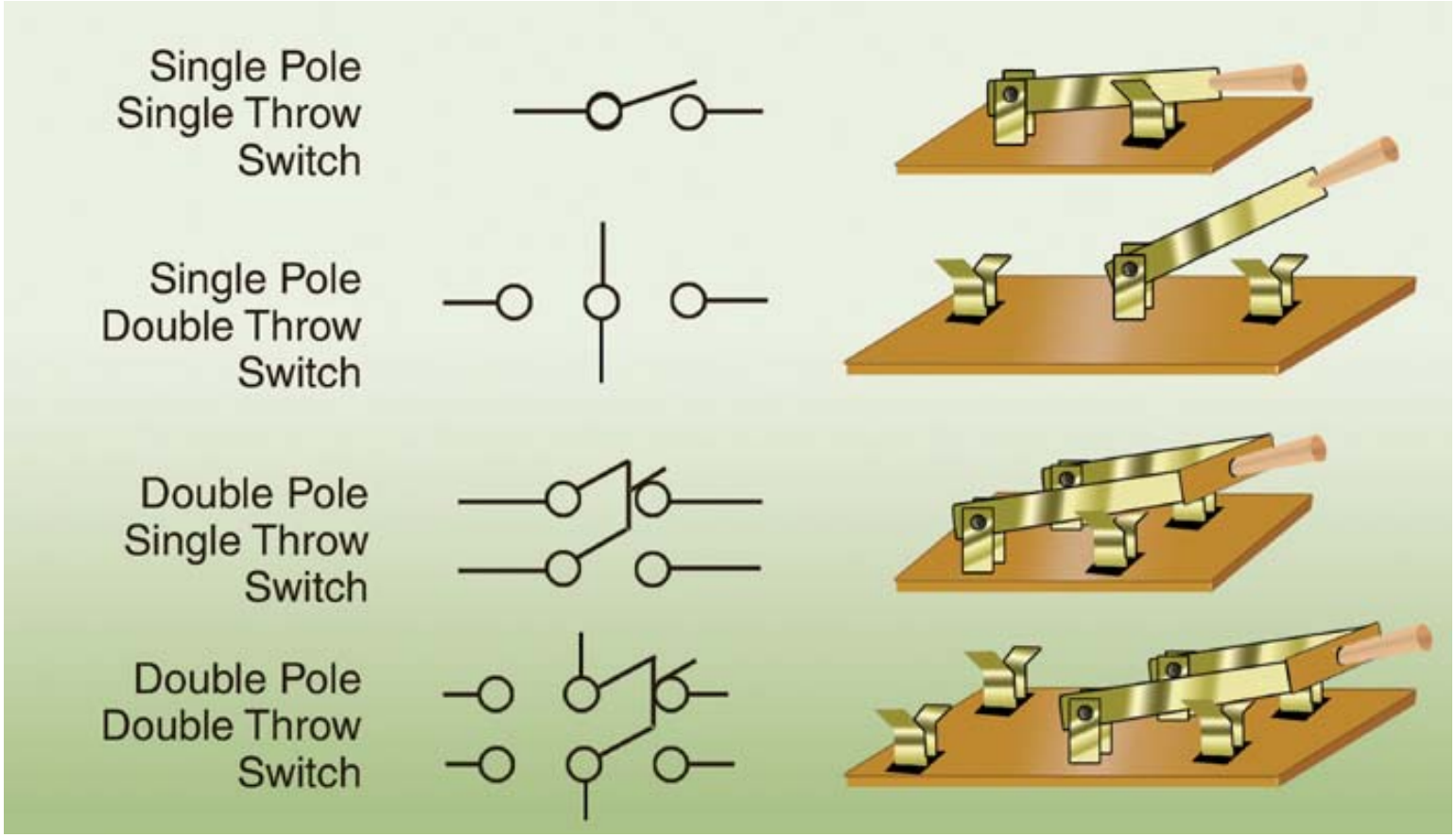




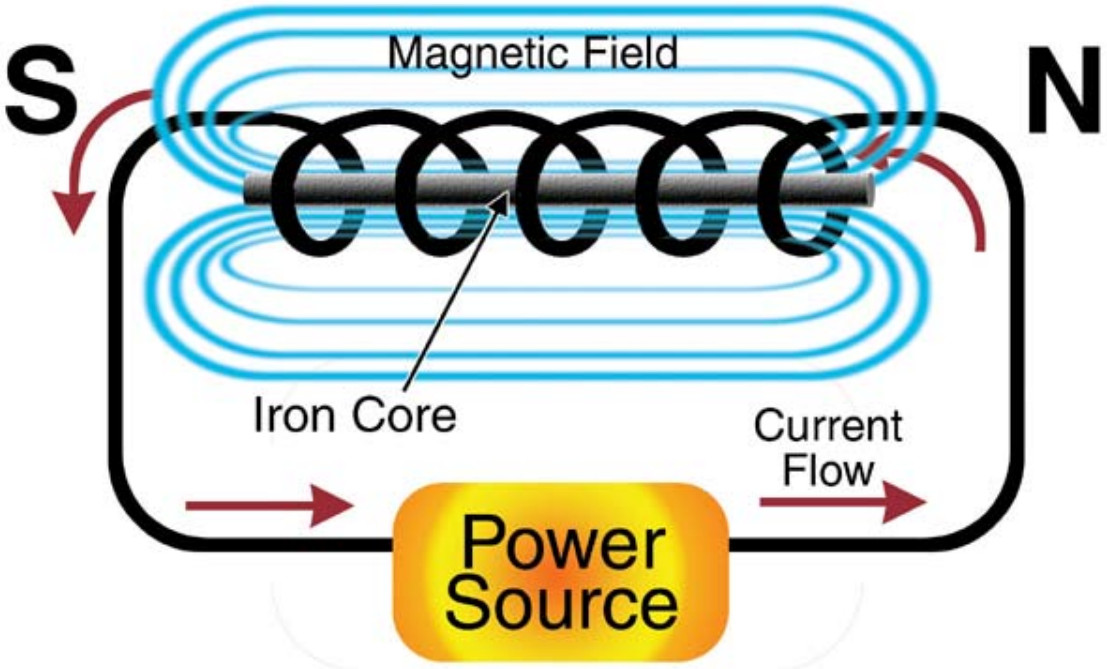
Switches


Single Pole
Single Throw
Switch
Single Pole
Double Throw
Switch
Double Pole
Single Throw
Switch
Double Pole
Double Throw
Switch

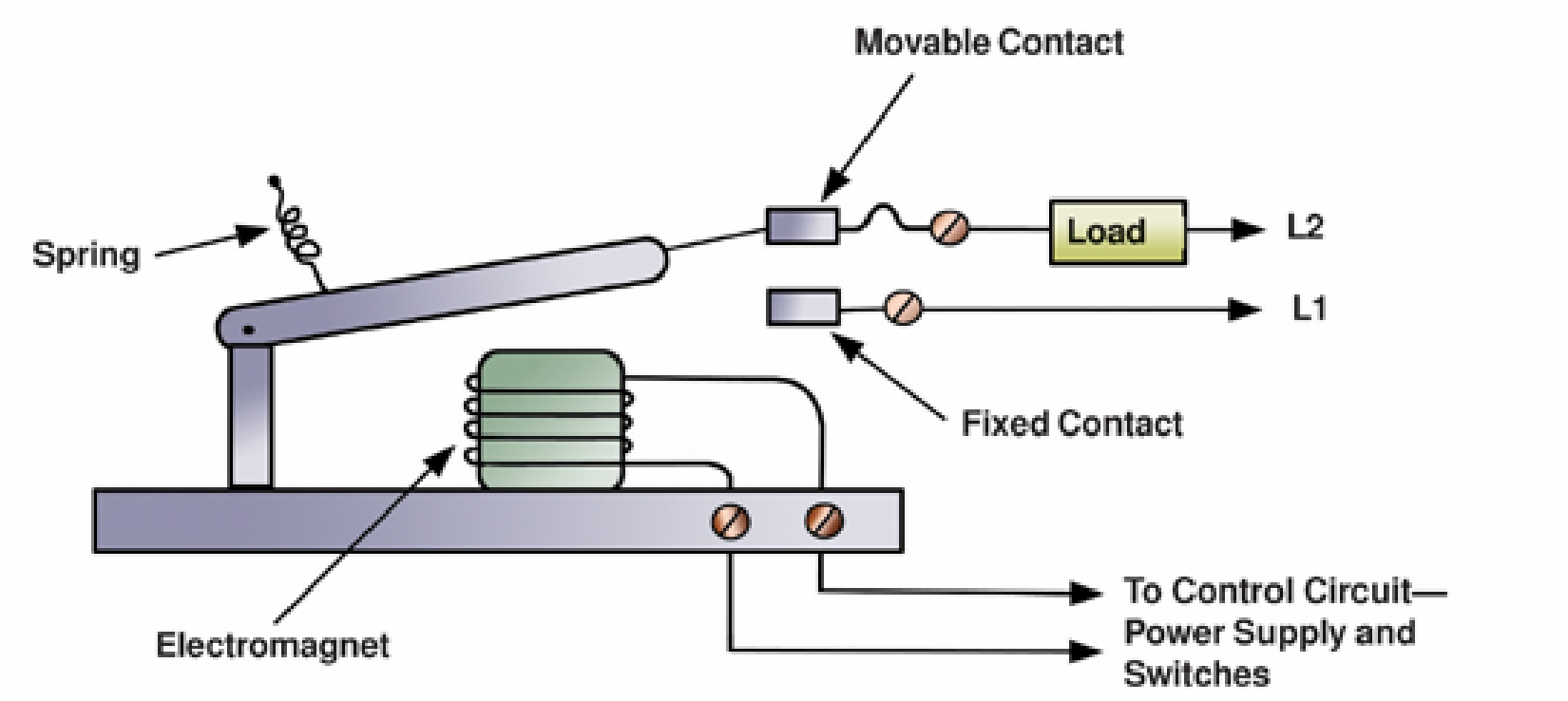
Bimetal Switch



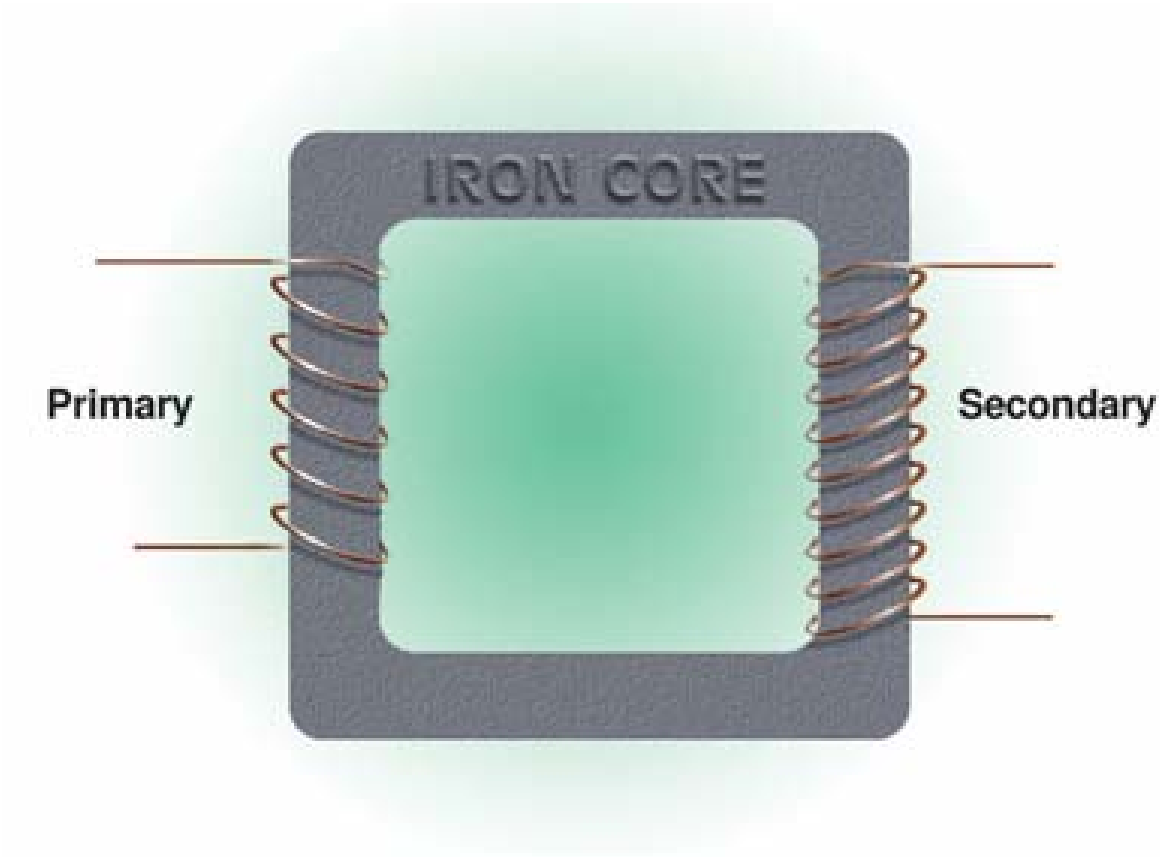
Electromagnet



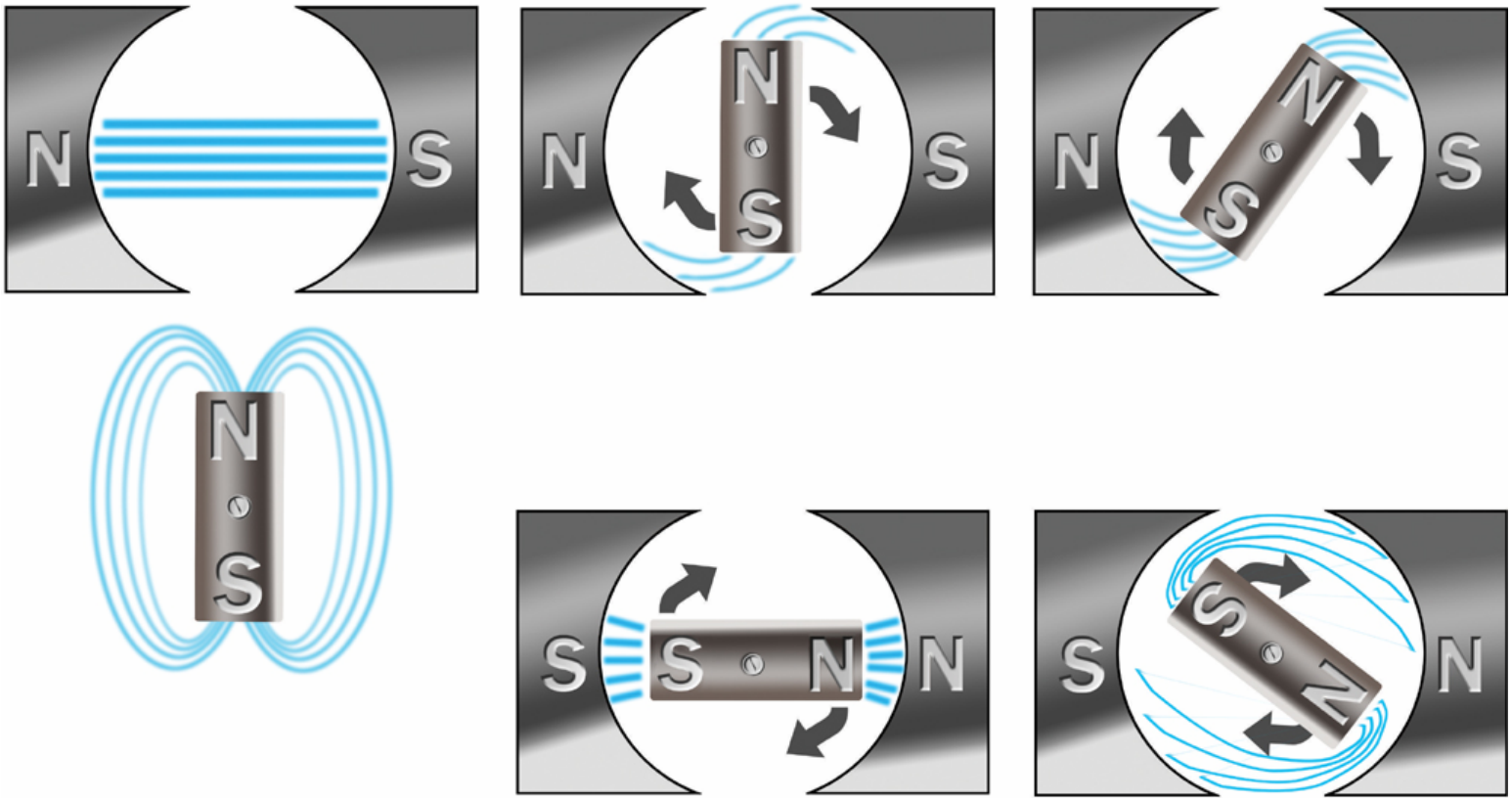
Relay Switch



Transformer

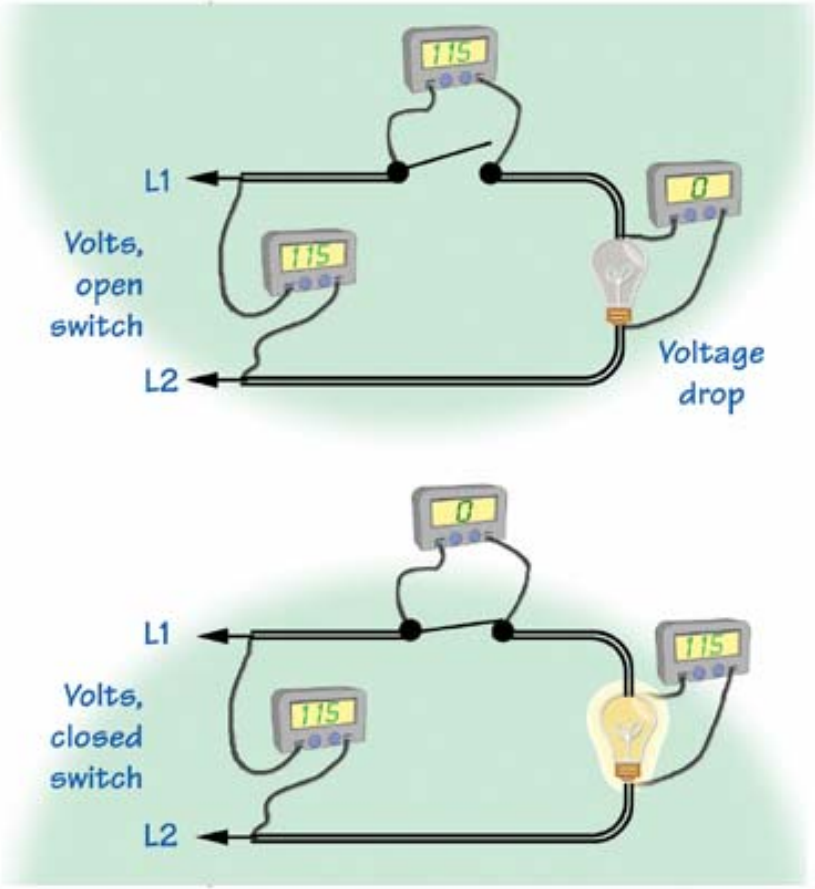


Motor



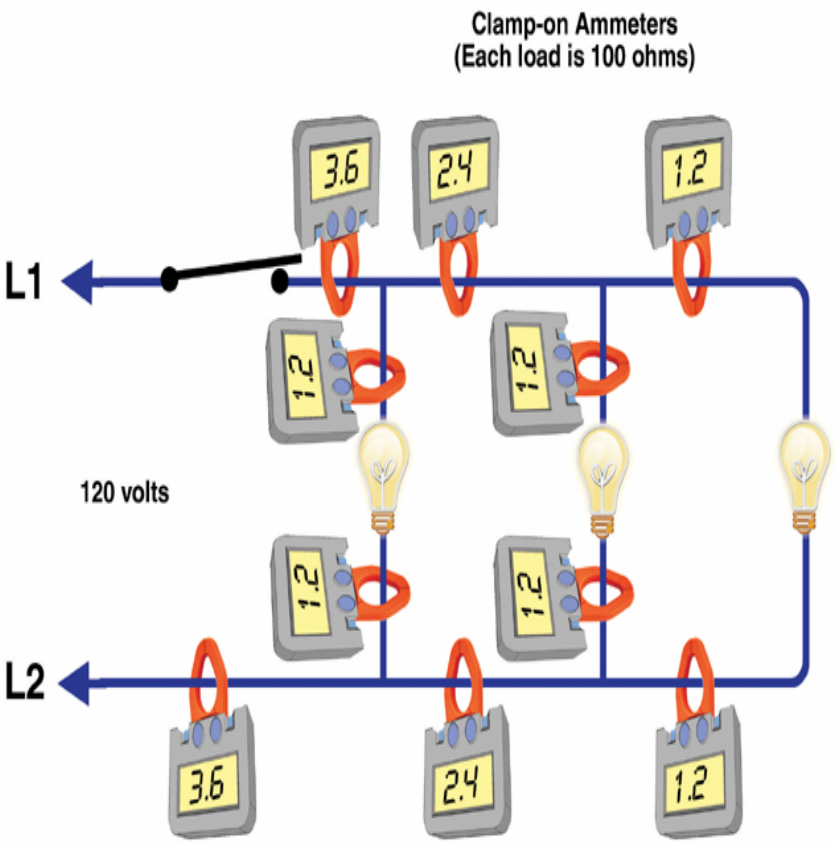
Voltmeter

- 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



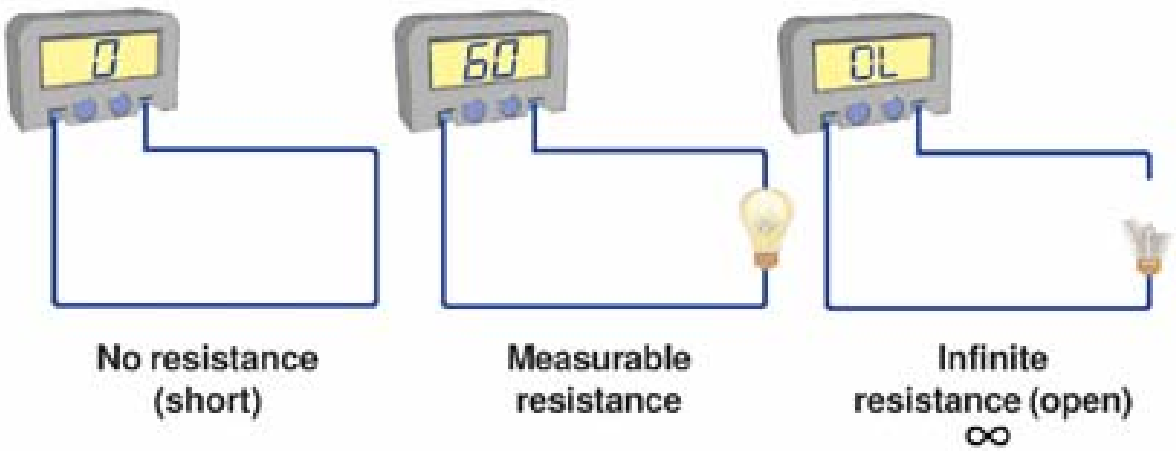
Ammeter

- 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 load works harder

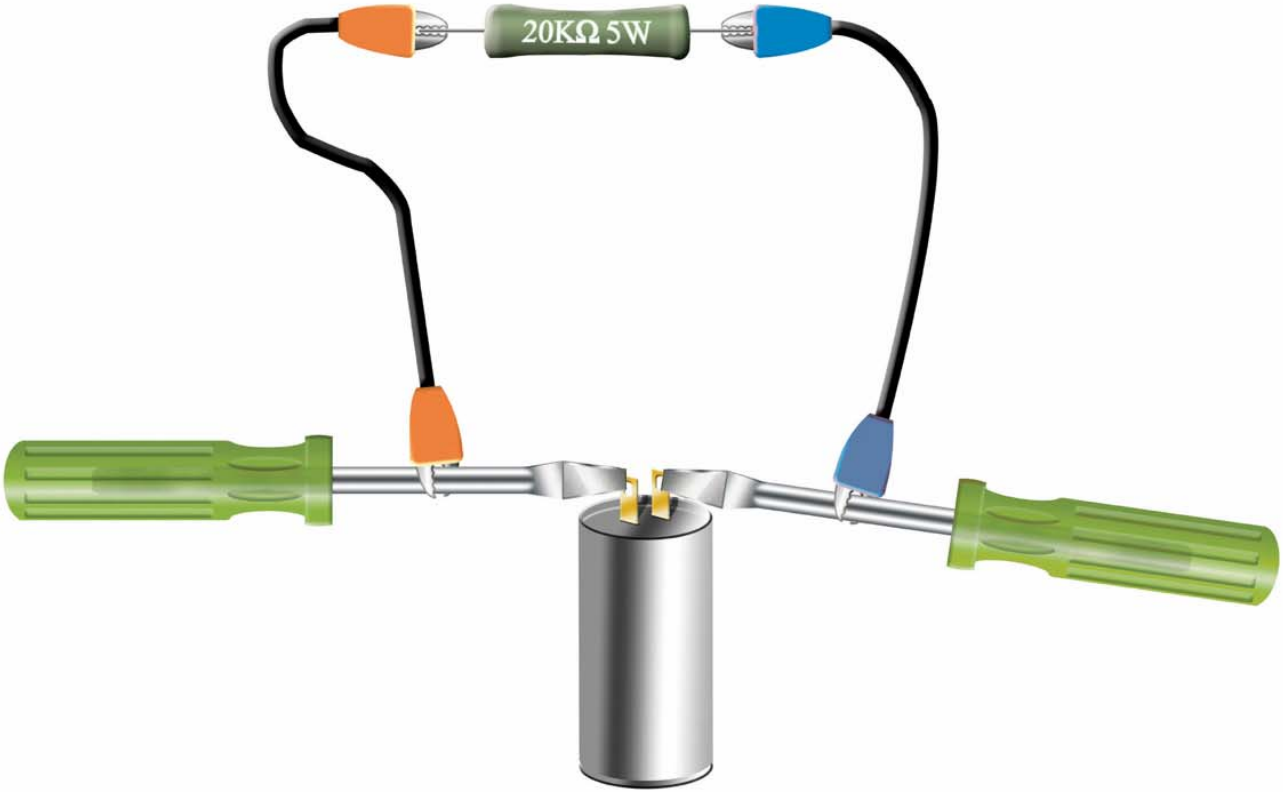


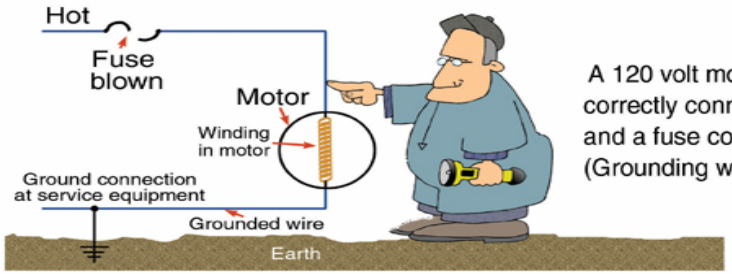
Ohmmeter

- 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)



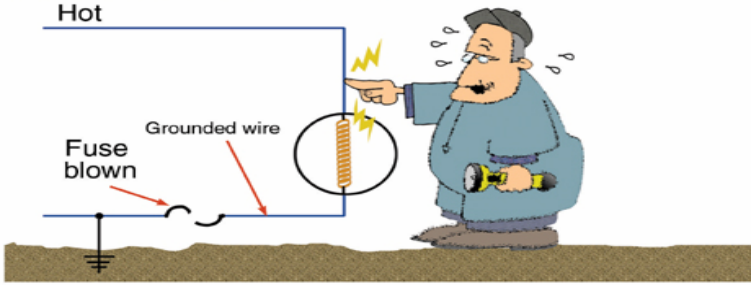
Discharging a Capacitor

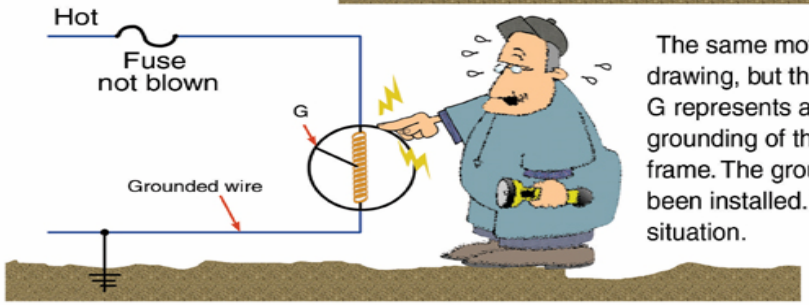




A 120 volt motor with grounded wire, correctly connected to the grounded neutral and a fuse correctly placed in the hot wire. (Grounding wire not yet installed.)

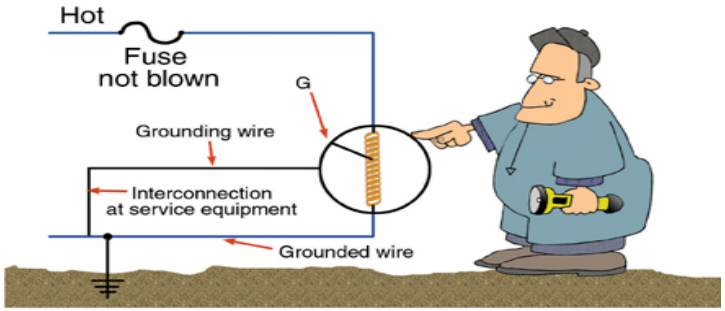
A 120 volt motor with a fuse wrongly placed in the grounded wire. It is a dangerous installation





The same motor as in the top drawing, but the motor is defective. G represents an accidental grounding of the winding to the frame. The grounding wire has not been installed. This is a dangerous situation.

The same defective motor as in the figure above, but now a grounding wire has been installed from the frame of the motor to ground. Even though the winding is accidentally grounded to the frame, as prepresented by G, there is no shock hazard.

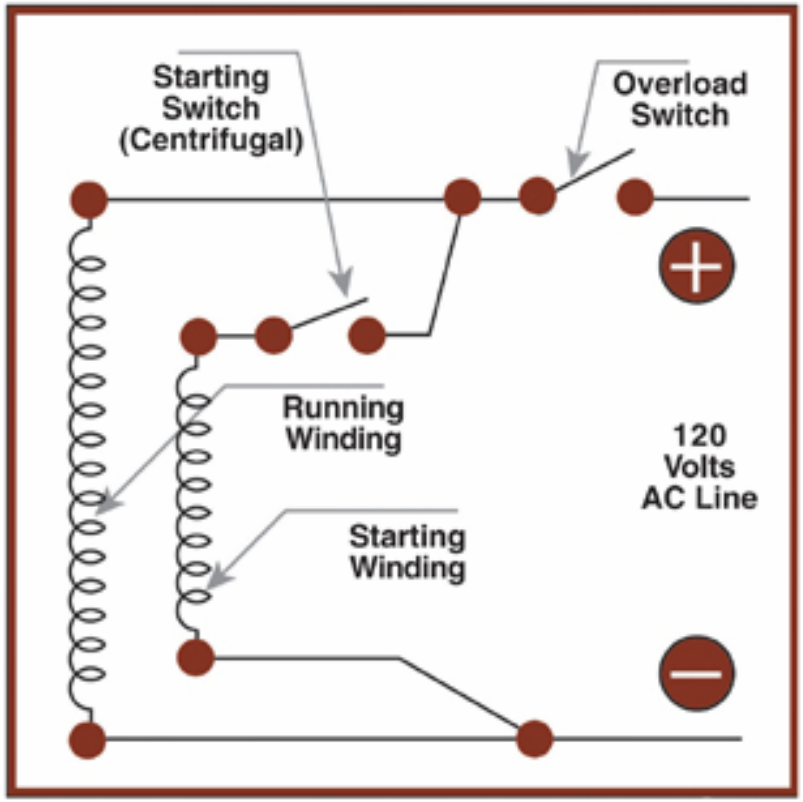


Chapter 8- Ignition Systems

- The ignition transformer is a step-up transformer: primary voltage is 120 volts, secondary is 10,000 to 14,000 volts
- Intermittent ignition- ignition is on the whole time the burner runs
- Interrupted ignition- ignition shuts off after flame is established, uses less electricity & longer component life
- The advantages of solid state igniters are: less effected by voltage drops, higher peak output voltage, use less electricity
- Test igniters by setting the gap between the springs to 1/2” and energize, spark will jump the gap if OK

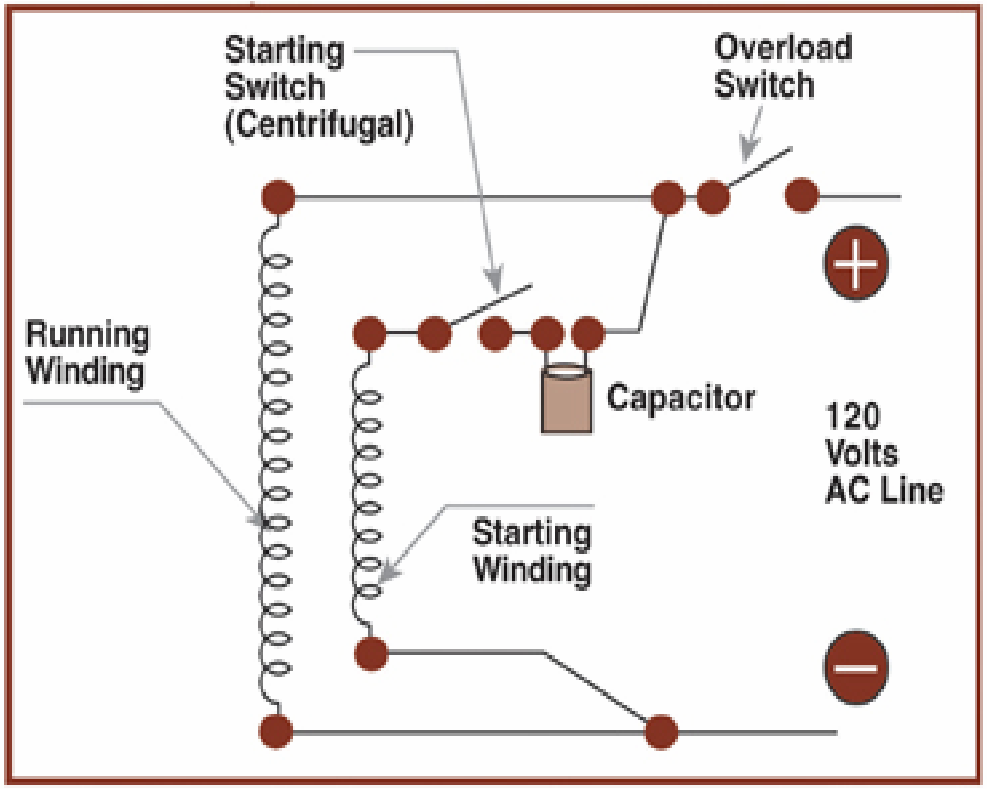
Chapter 10- Motors

- Split phase motor has running windings and starting windings.
- Starting windings are operated by a start (centrifugal) switch that opens when the motor has almost reached full speed.
- The motor is protected by a thermal overload switch



Capacitor Start Motors

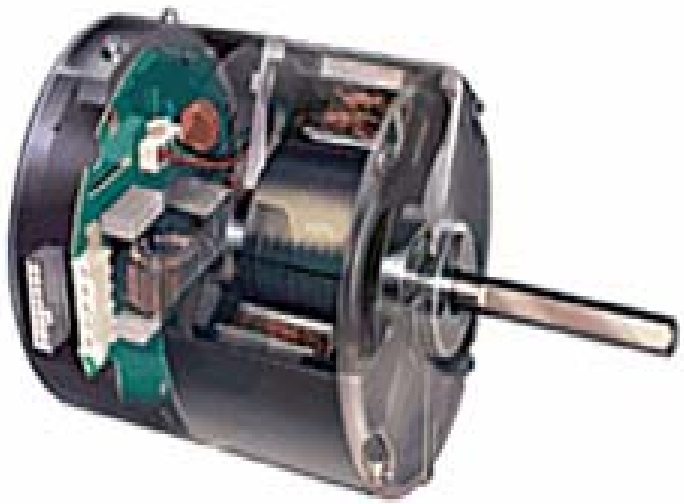
- Circulator motors and larger burner motors
- Capacitors build an electric charge an store it until needed
- Creates much greater phase shift that gives it more starting torque



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

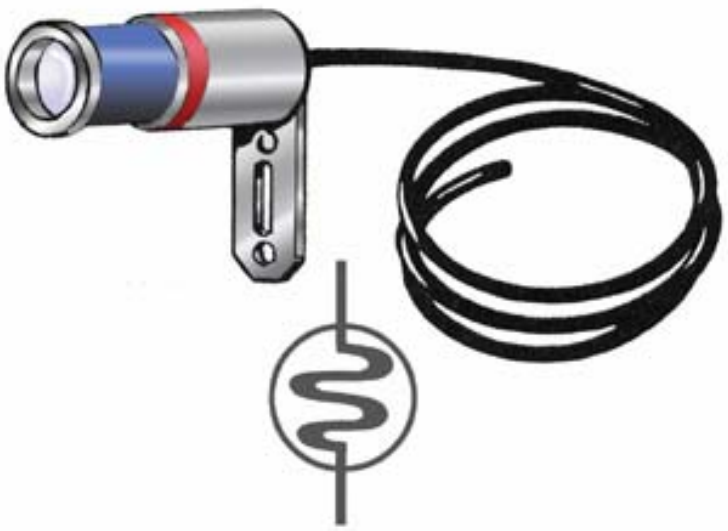


Electrically Commutated Motor

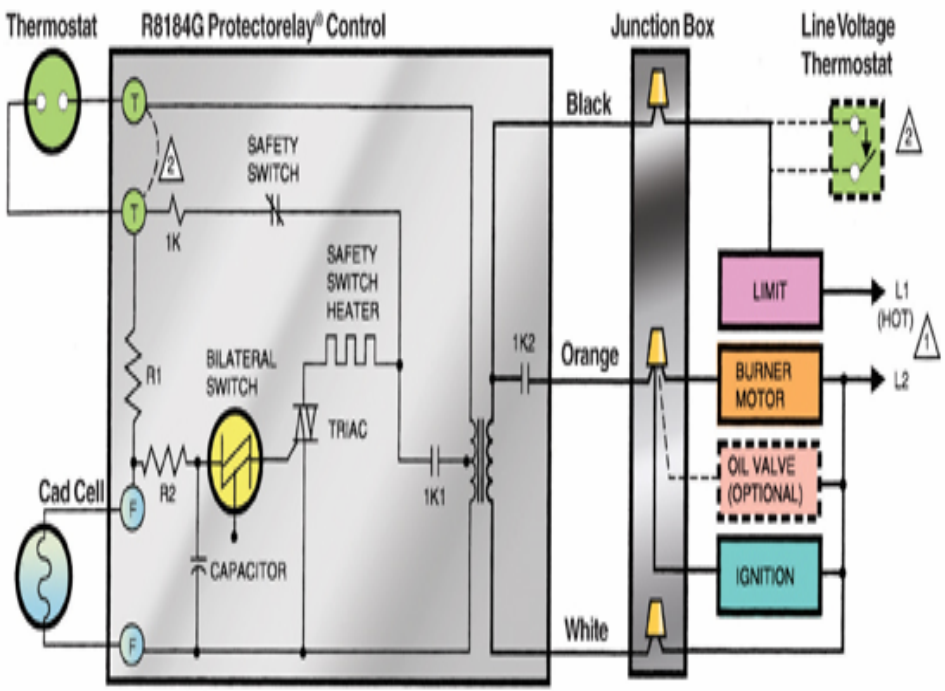
- Used for blower motors on warm air systems
- Variable motor speed, low power consumption, means superior efficiency and reduced noise

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

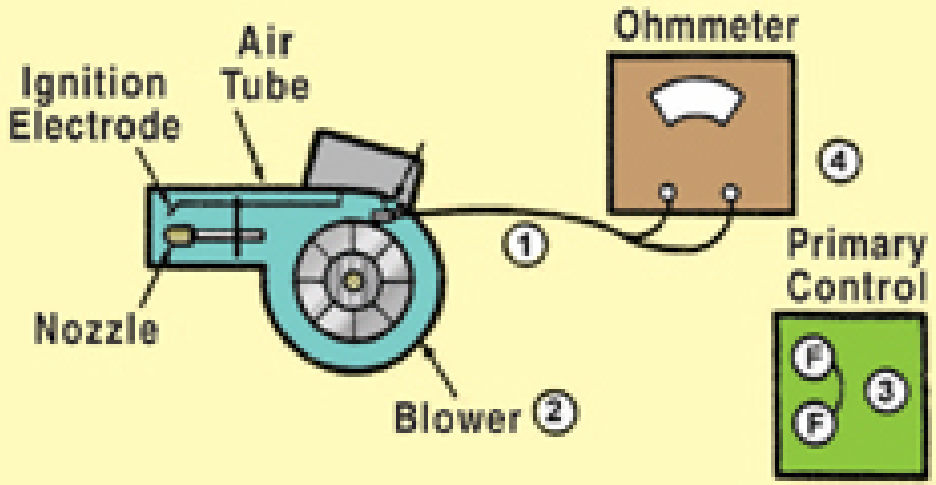


Cad Cell



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

Checking Cad Cell and Primary



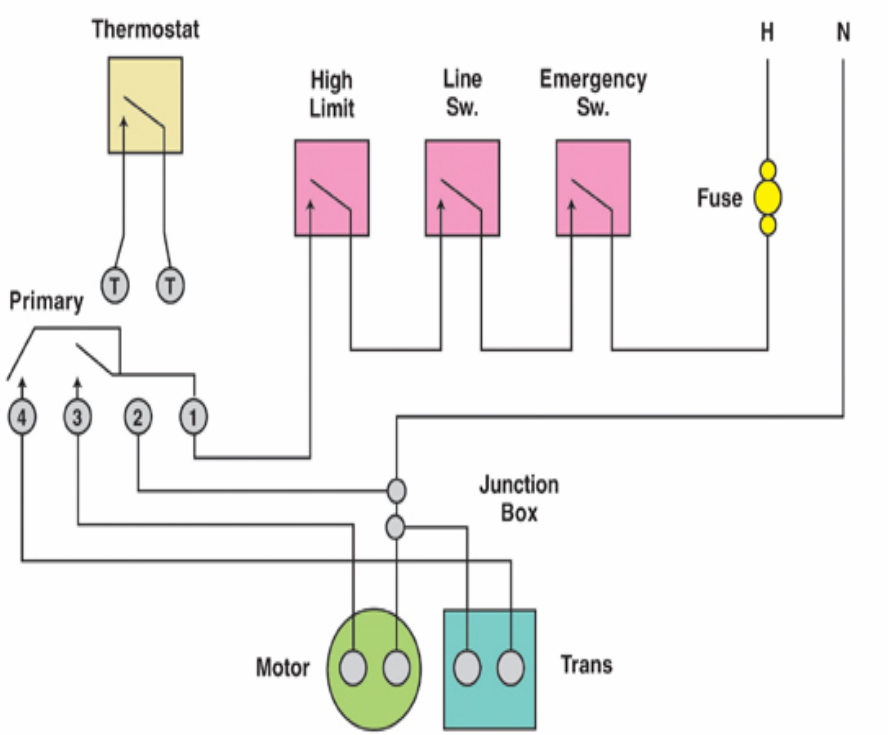
1. Remove Lead Wires From Primary Control
2. Start Burner
3. Jumper F-F (With 1500 Resistor)
   Control Locks Out—Replace—
   Burner Runs—Trouble is Cad Cell
4. Check Resistance—
   Infinite—Open Circuit (Cell Defective or Not Seated)
   Greater Than 1600 Ohms—Cell Dirty
   or Not Sighting Properly

Microprocessor Controls

Feature:

- Interrupted Duty Ignition
- 15 second safety timing
- Limited reset
- Valve-delay-on and motor-delay-off
- Diagnostic LEDs and Dry alarm contacts

Chapter 12- Limits and Thermostats

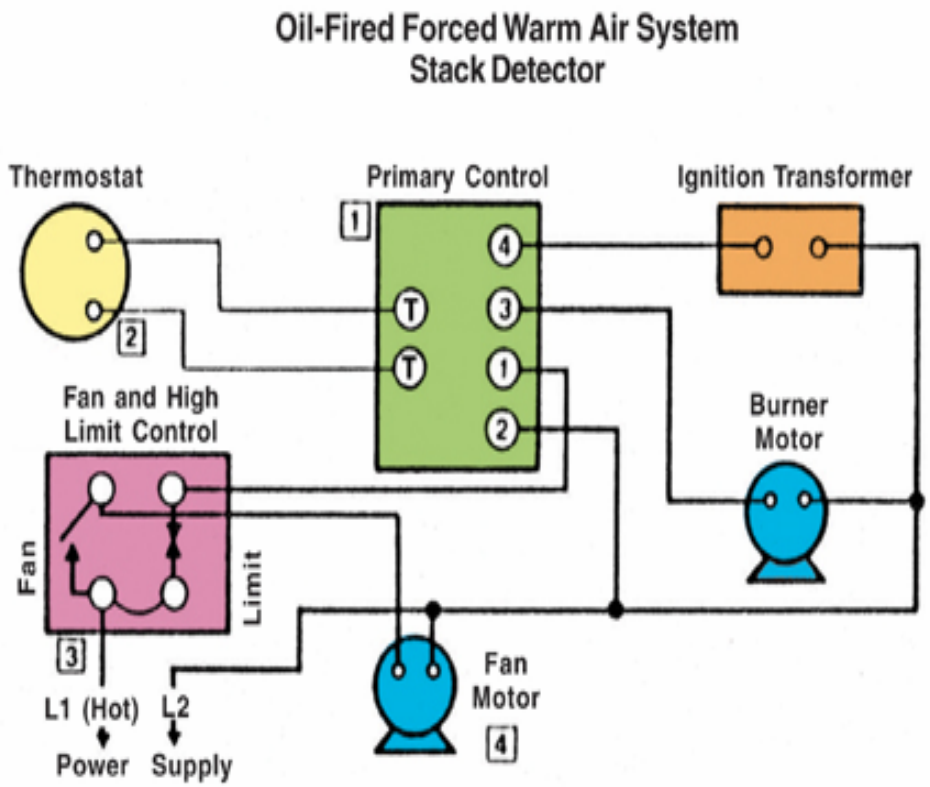


- The control that shuts off the burner in event of excessive temperature or pressure is a high limit. It is always line voltage in series with the primary control.
- Low limit or operating controls are direct of reverse acting that controls the burner, blower, or circulator

Thermostats

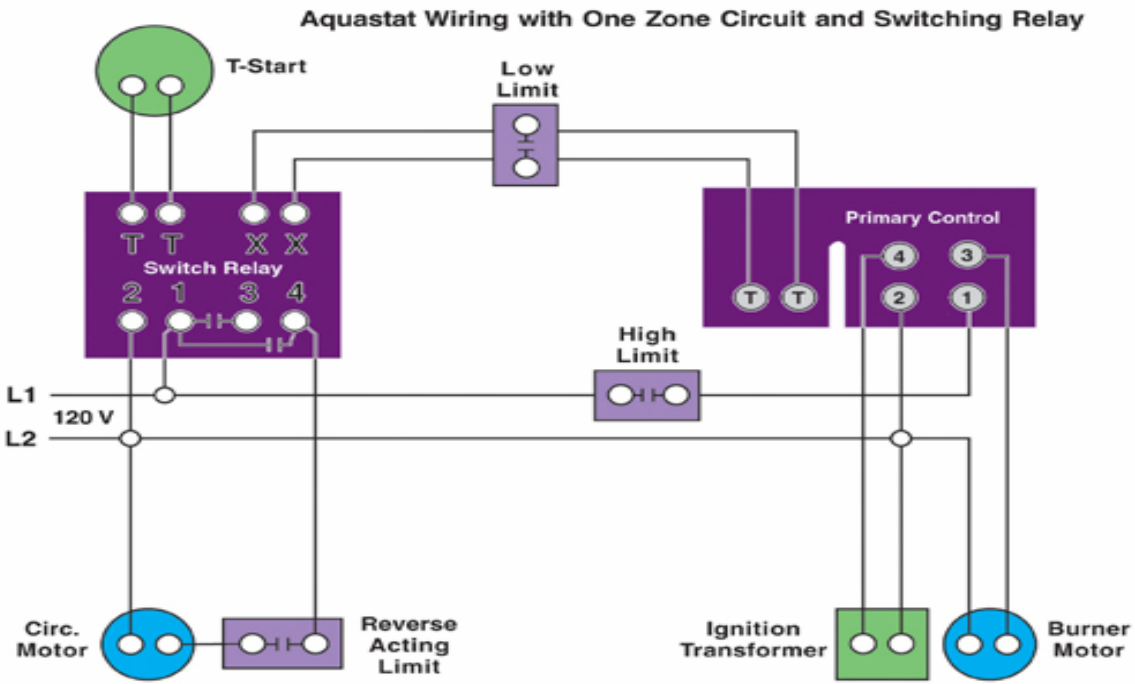
- Heat actuated switch
- Heat only thermostats make (close on temp. fall)
- Old ones have heat anticipators that need to be set to the amperage draw of the control circuit they are in

Fan Limit Control



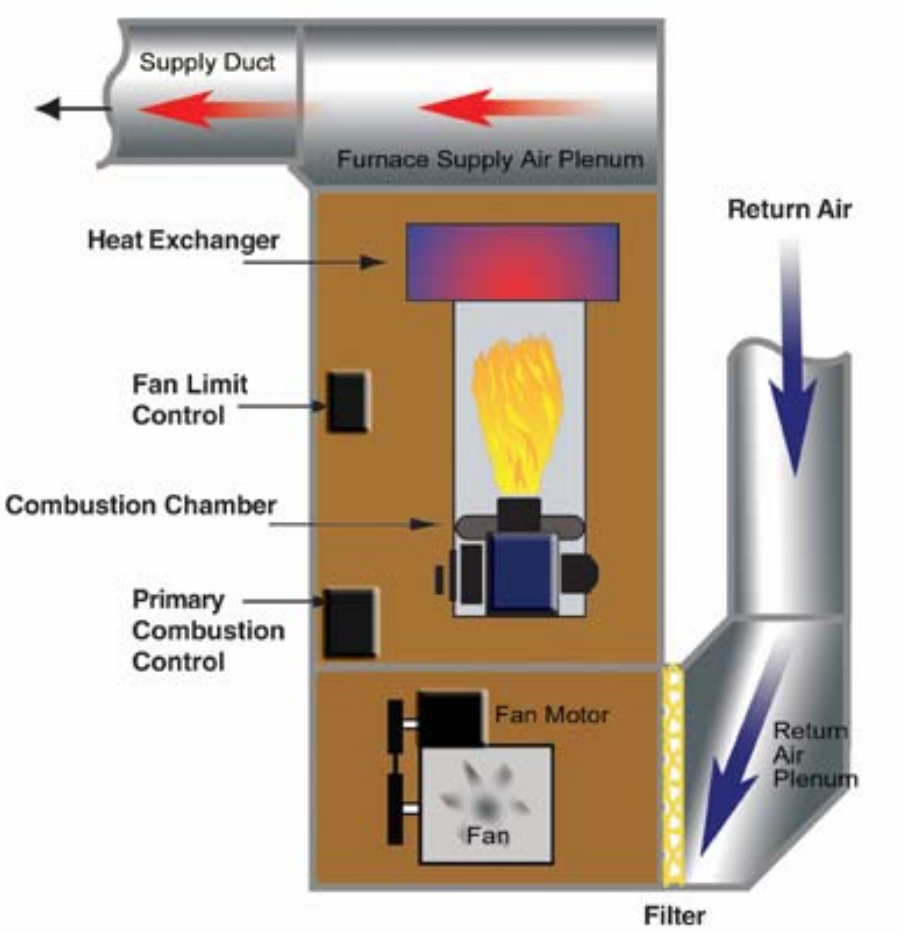
- Shuts off the burner at a predetermined temperature
- Starts the blower at a predetermined temperature
- Stops the blower at a predetermined temperature

Hot Water Heating System



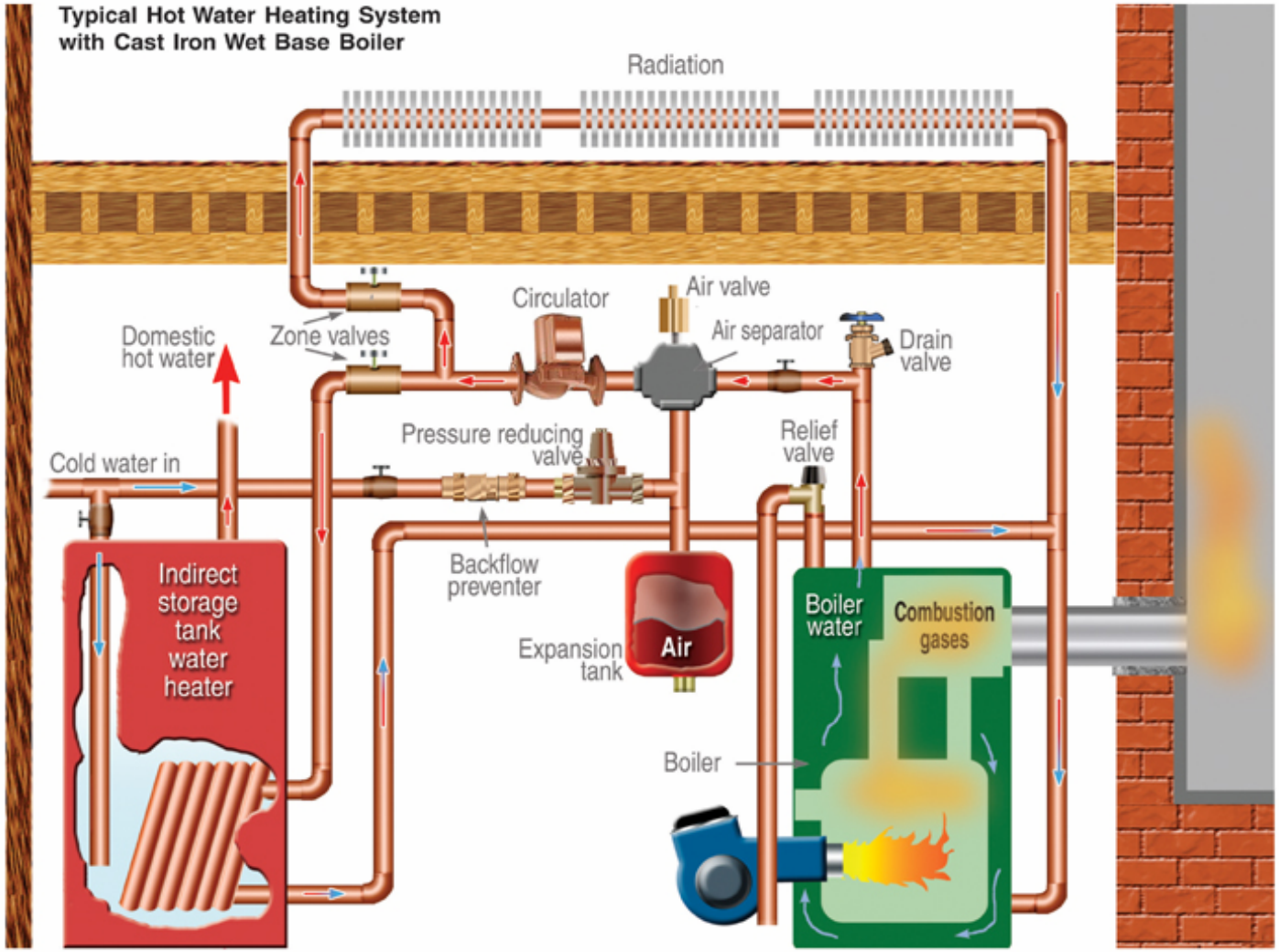
- Switching relay- controls the circulator (line voltage) with low voltage thermostat
- Reverse acting aquastat- stops the circulator when the boiler water falls below the set point

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
- Can be used with air conditioning and can purify, clean, and humidify the air

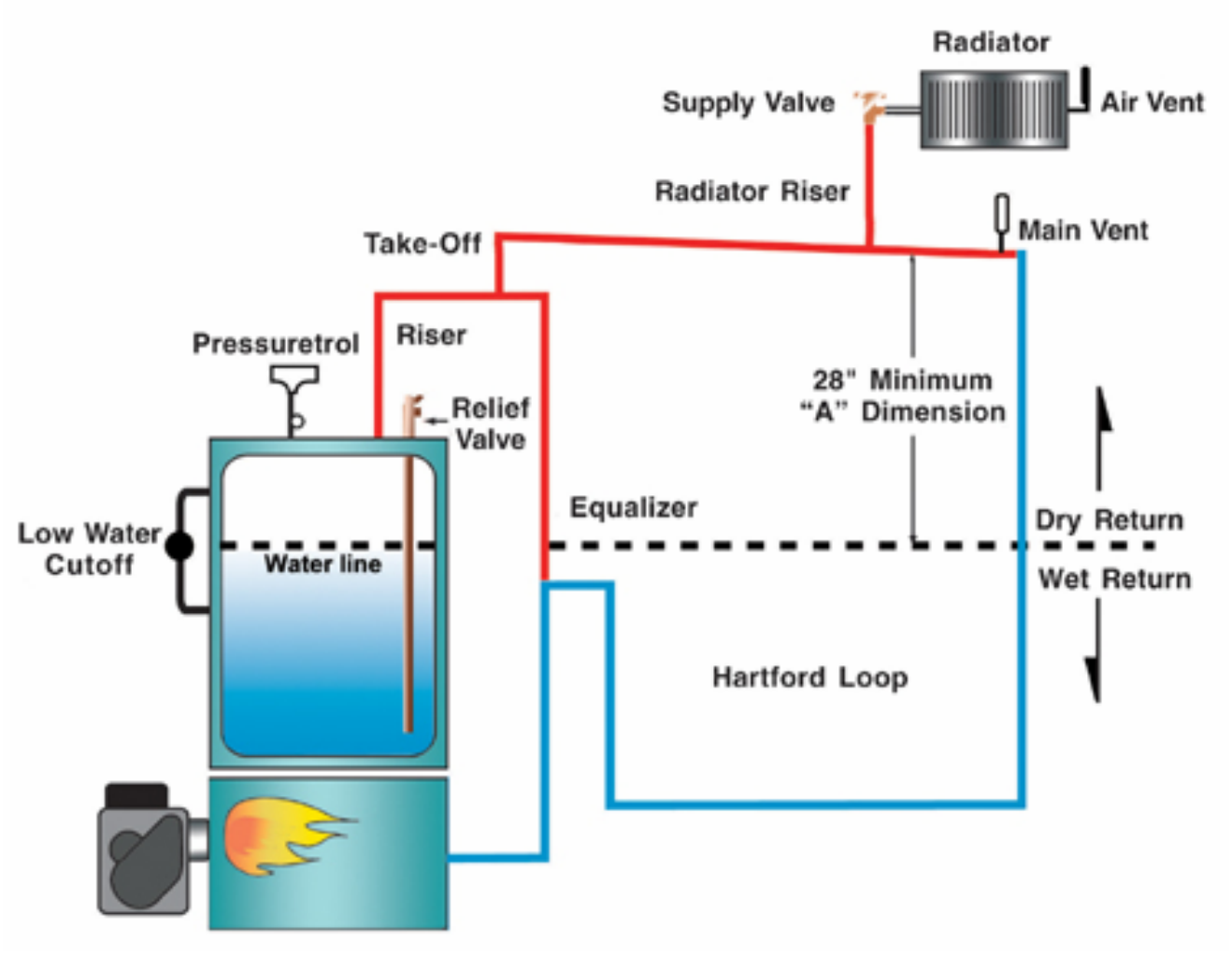
Hot Water Heating System



Hot Water System Requirements

- Proper air elimination
- Proper pipe sizing
- System water expansion
- 12 PSI pushes water 28’ up a pipe

One-pipe Steam, 2 PSI



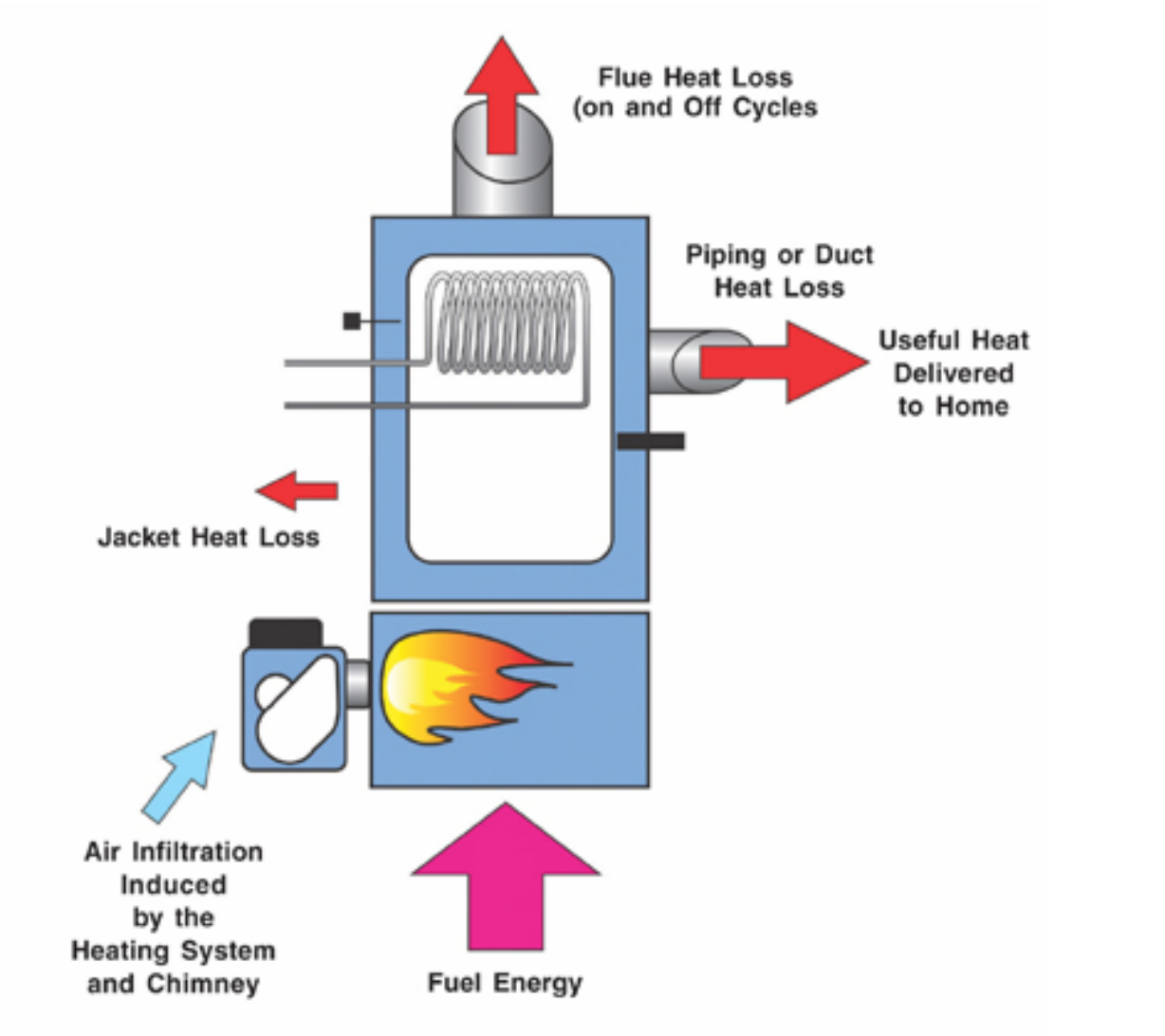
Chapter 14- Tune Ups

- Perform a Combustion Efficiency Test
- Leave the outside of the system and the area around it cleaner than you found it
- Check the oil tank for water

Chapter 15- Service Procedures

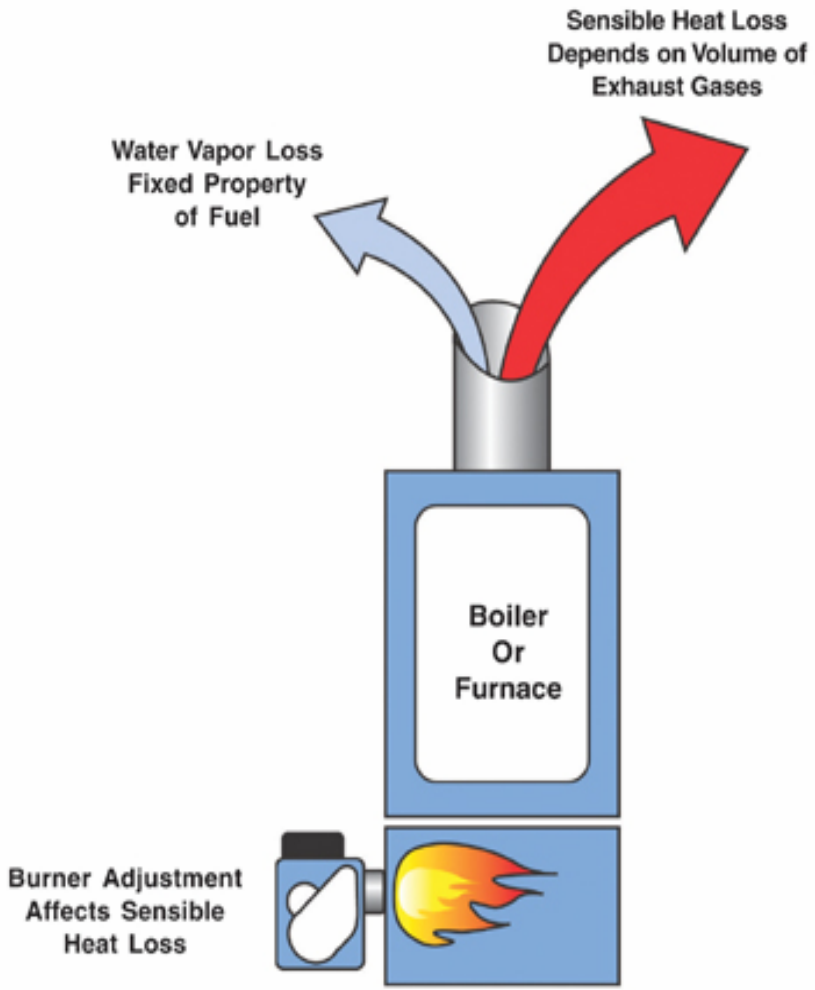
Pushing the reset button does not fix an oil burner

Chapter 16- Energy Conservation

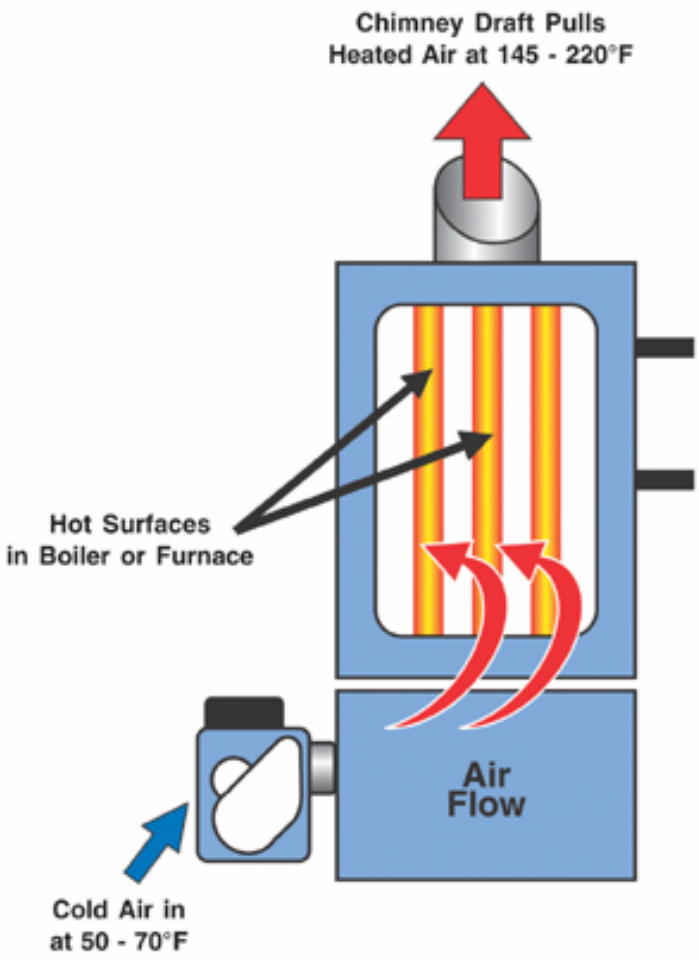


On-cycle Loss

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

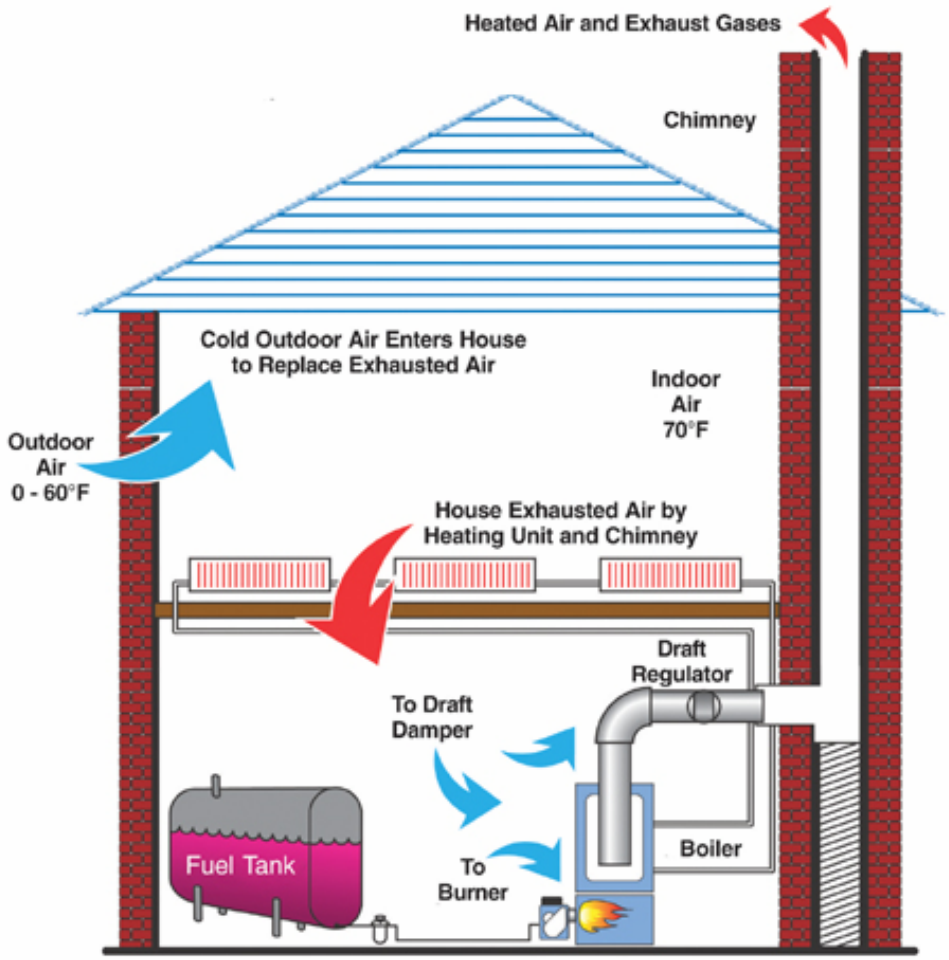


Off-cycle Loss



- Much greater for old units with wide open flue passages
- 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

Replacing the burner, boiler or furnace reduces on-cycle, off-cycle, and infiltration losses. It is the best investment you can make!

Savings For Every $100 Fuel Costs by Increase of Combustion Efficiency
Assuming Constant Radiation and Other Unaccounted-for Losses

From an Original Efficiency of:	To an Increased Combustion Efficiency of: 55%	60%	65%	70%	75%	80%	85%	90%	95%
50%	$9.10	$16.70	$23.10	$28.60	$33.30	$37.50	$41.20	$44.40	$47.40
55%	—	8.30	15.40	21.50	26.70	31.20	35.30	38.90	42.10
60%	—	—	7.70	14.30	20.00	25.00	29.40	33.30	37.80
65%	—	—	—	7.10	13.30	18.80	23.50	27.80	31.60
70%	—	—	—	—	6.70	12.50	17.60	22.20	26.30
75%	—	—	—	—	—	6.30	11.80	16.70	21.10
80%	—	—	—	—	—	—	5.90	11.10	15.80
85%	—	—	—	—	—	—	—	5.60	10.50
90%	—	—	—	—	—	—	—	—	5.30

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 there is an “all of the above” and two answers seem right, the third one is probably right too.
- If unsure pick the one that seems most right. There is no penalty for guessing