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WECC

Forced-Air Heat Systems

Adrian Scott- WECC

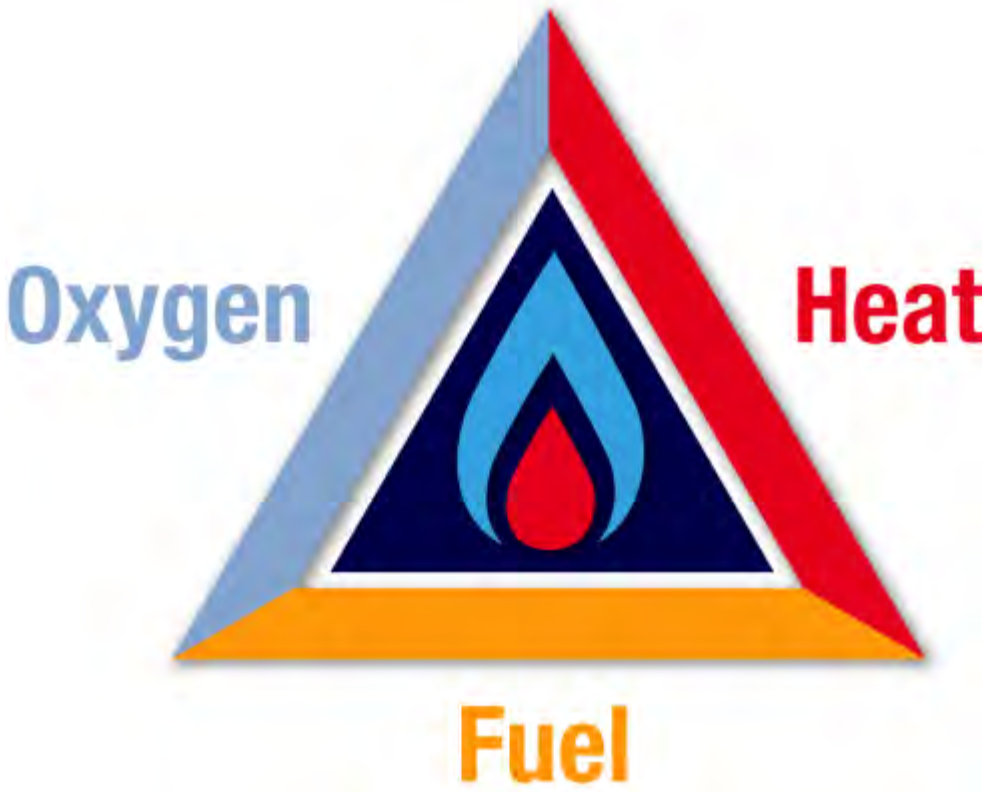
February 25, 2014

About WECC

- Proving the value of energy efficiency and renewable energy since 1980
- National leader in administering, implementing, and designing energy programs
- Anticipate and understand trends that affect the marketplace
- Exceed client goals and maximize program budgets

The Combustion Triangle

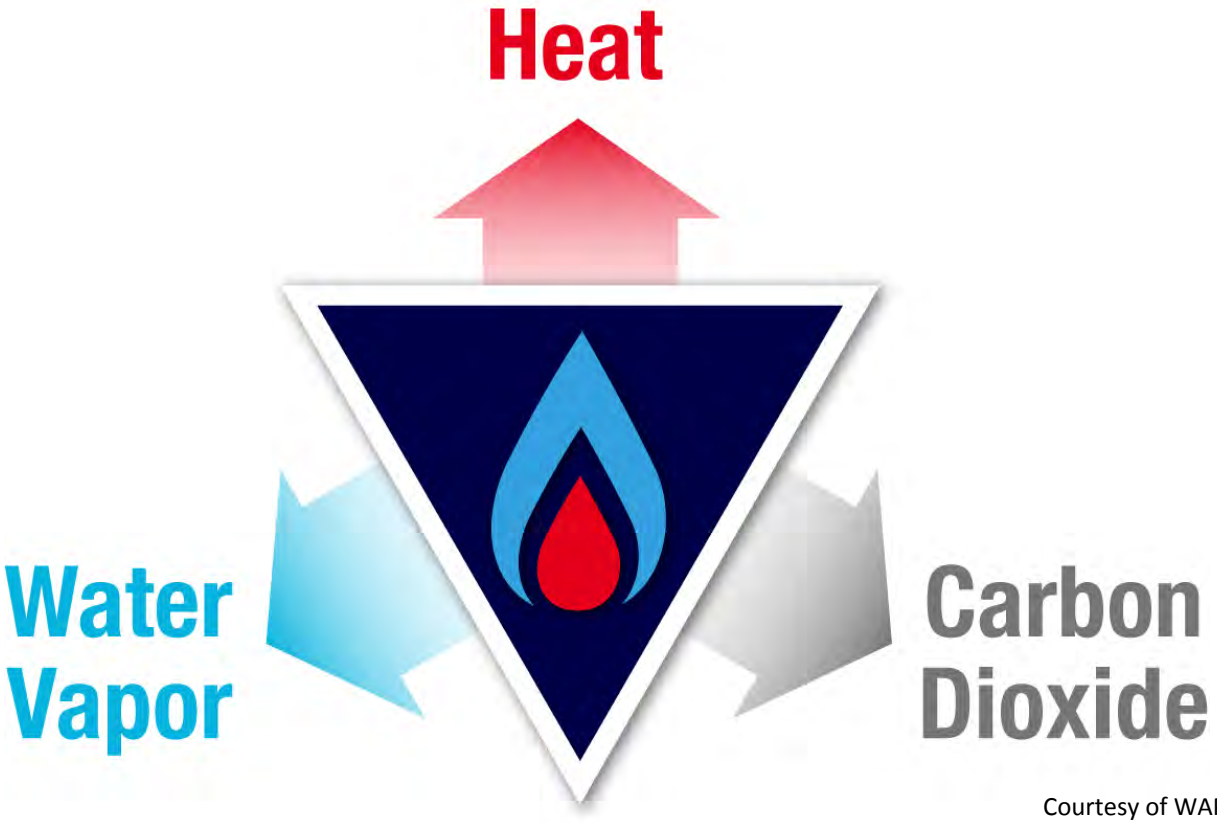
Requirements for Combustion (burning):



Courtesy of WAP Standardized Curriculum

Triangle of Combustion Products

Complete Combustion Results in:



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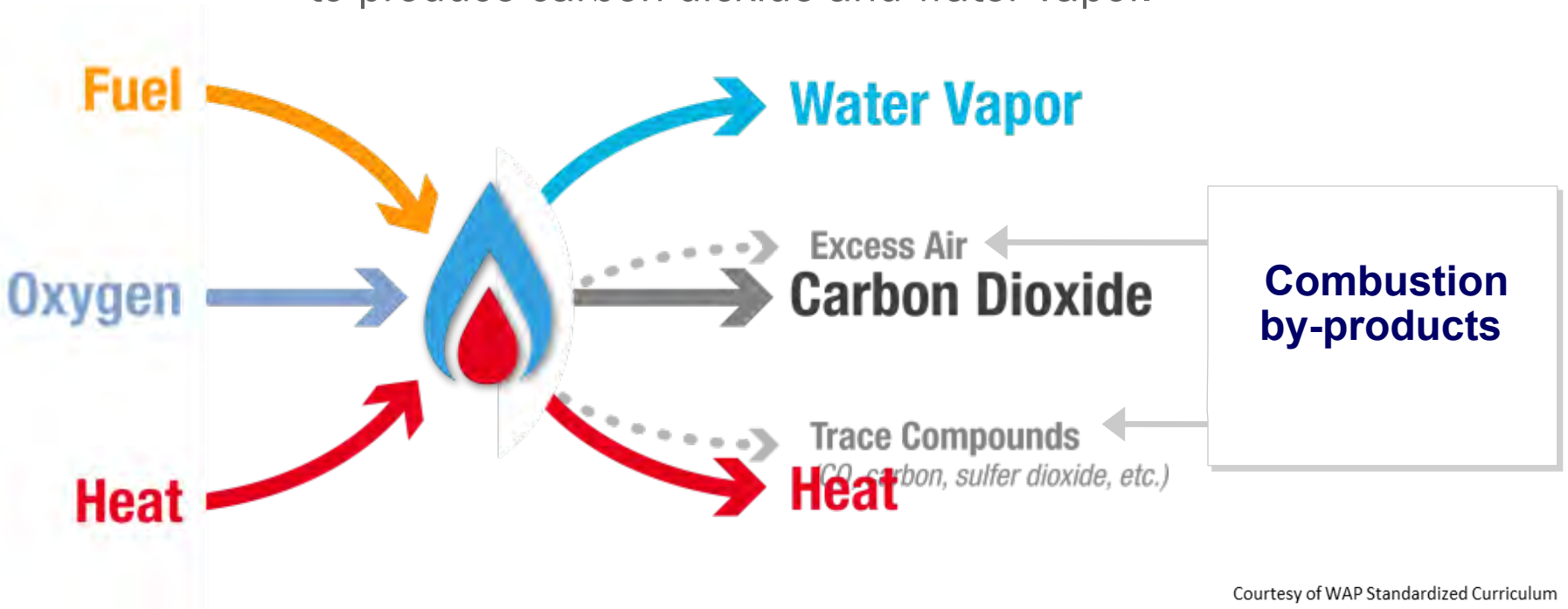
Complete Combustion

Complete Combustion Occurs....

When all the fuel is burned with sufficient oxygen to produce carbon dioxide and water vapor.



Courtesy of WAP Standardized Curriculum

Heating System Overview

Most Common in WI and MN

- 90+
  - Natural gas
  - Propane (LP)
- 80+
  - Natural gas
  - Propane (LP)
- Oil
  - #2 Fuel Oil

Natural Gas Characteristics

- Lighter than air which requires less pressure to move the fuel
- 3.2 to 4.0 Inch Water Column (IWC)
- Burns slightly hotter than LP
- Approximately 1,000 BTU per cubic foot
- 100,000 BTU per therm

LP Gas Characteristics

- Heavier than air which requires more pressure to move the fuel
- 10 - 11 IWC
- Burns slightly cooler than natural gas
- Measured by the gallon
- Approximately 93,000 British Thermal Units (BTU) per gallon

Fuel Oil

- Heaviest of the liquid fuels
- Requires an operating pressure of 100 to 130 (PSI?) to atomize the fuel to burn
- Does not sustain its own flame
- Requires a constant source of ignition
- Burns the hottest: ~140,000 BTU per gallon

Heating System Similarities

- Gas-forced air is the most prevalent heating system in Minnesota
- There is no difference in the design of a natural gas or an LP furnace
- The burner type and age determines the style of the heat exchanger

Heating System Similarities

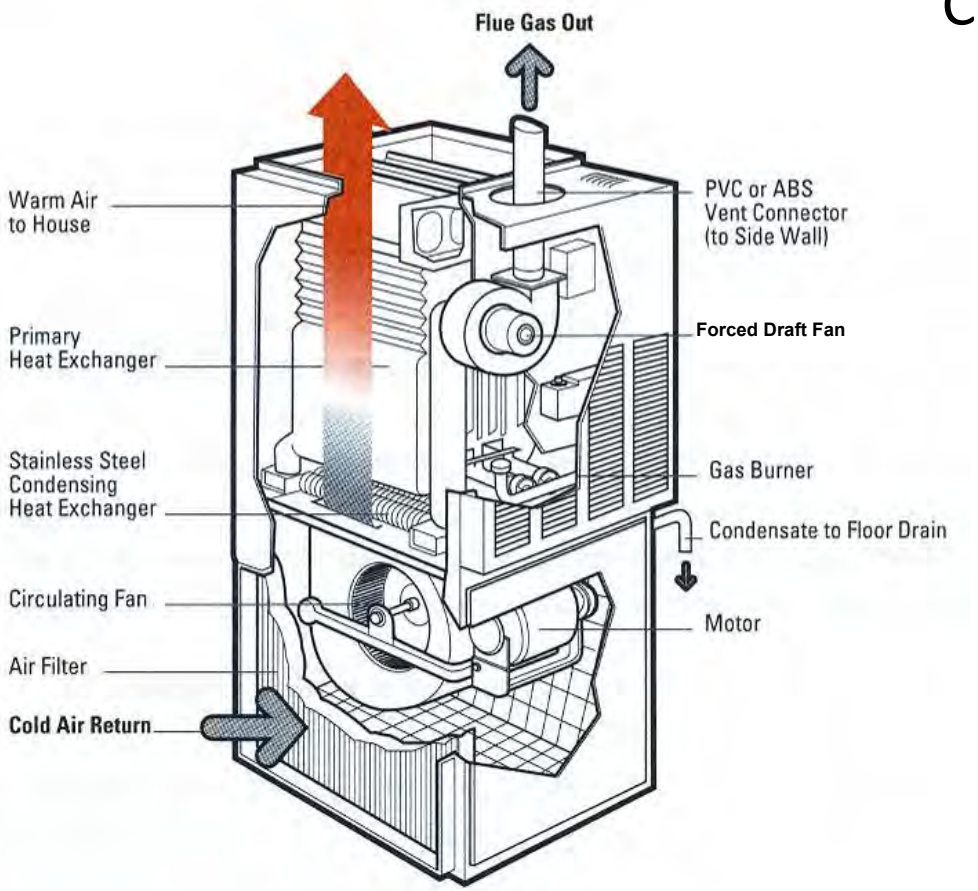
- All employ some form of heat exchange
- Older heating systems have a longer life expectancy
- The design efficiencies vary depending on the fuel type and age
- We need to keep this in mind when we start to assess heating systems

90% Condensing Furnace

90+ Forced-Air Furnace Characteristics

- Category III
- Two heat exchangers
  - Primary
  - Secondary
- Condensing
  - Requires a floor drain or condensate pump for the condensate produced
- *The secondary heat exchanger is what gives it the extra efficiency*

90% Gas Forced Air



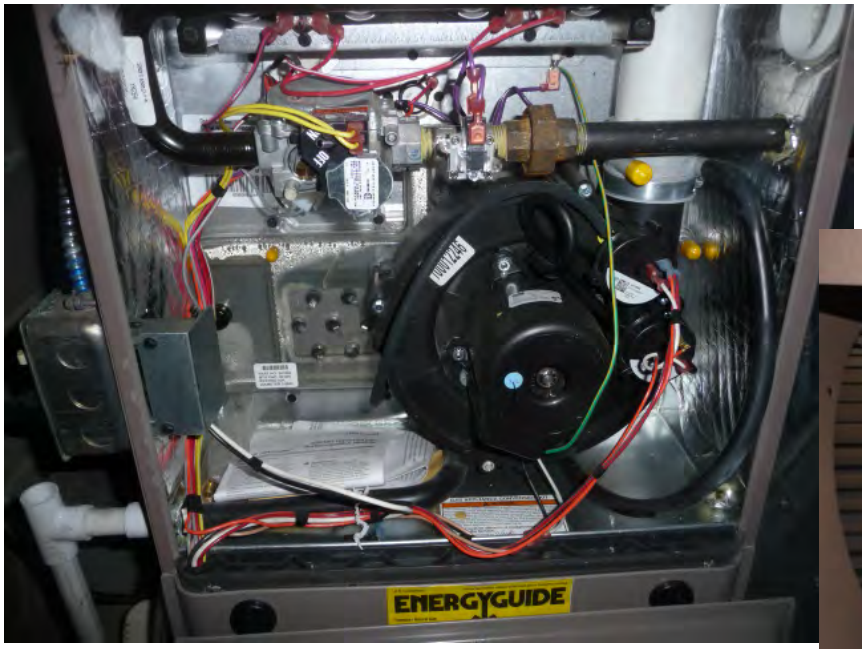
Source: *Heating with Gas*, Natural Resources Canada, 1998.

Category IV Forced Draft

- Positive pressure in the vent connector; condensing unit
- AFUE efficiencies are 90% and greater
- Takes advantage of latent heat of vaporization of water (970 BTUs per pound of water vapor condensed from flue gas in the unit)

Exhaust System

Inducer Motor



Pressure Switch

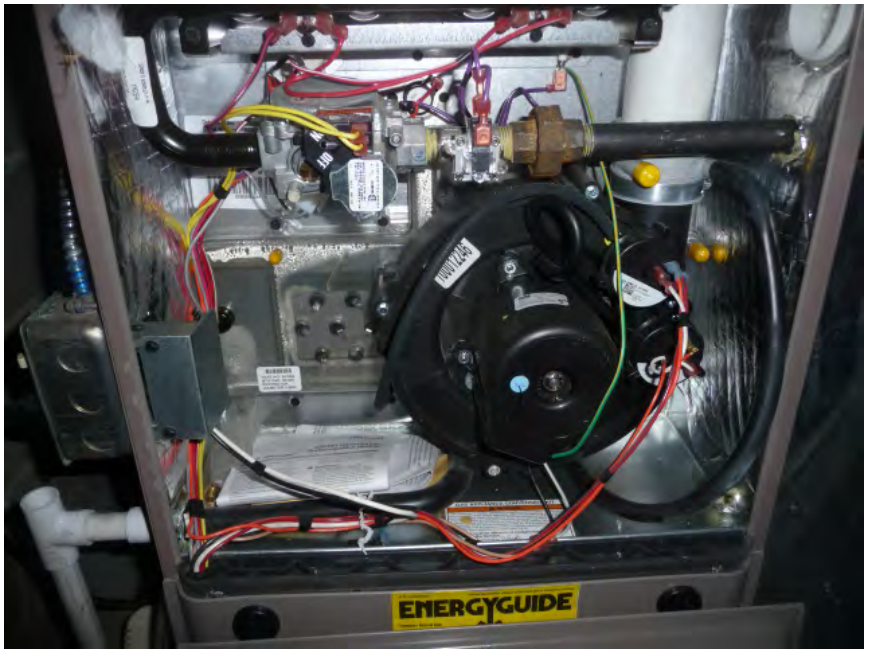
Control Board

Ignition System

Heat Exchanger

- Visually check the top and bottom
- Use bright light and mirrors
- Look for rust, discoloring
- Look for signs of cracking, pin holes
- Plug baffles at top of heat exchanger
- Large amount of debris at the bottom
- Perform simple testing

Burners and Burner Compartment



90% Gas Forced Air Sequence of Operations

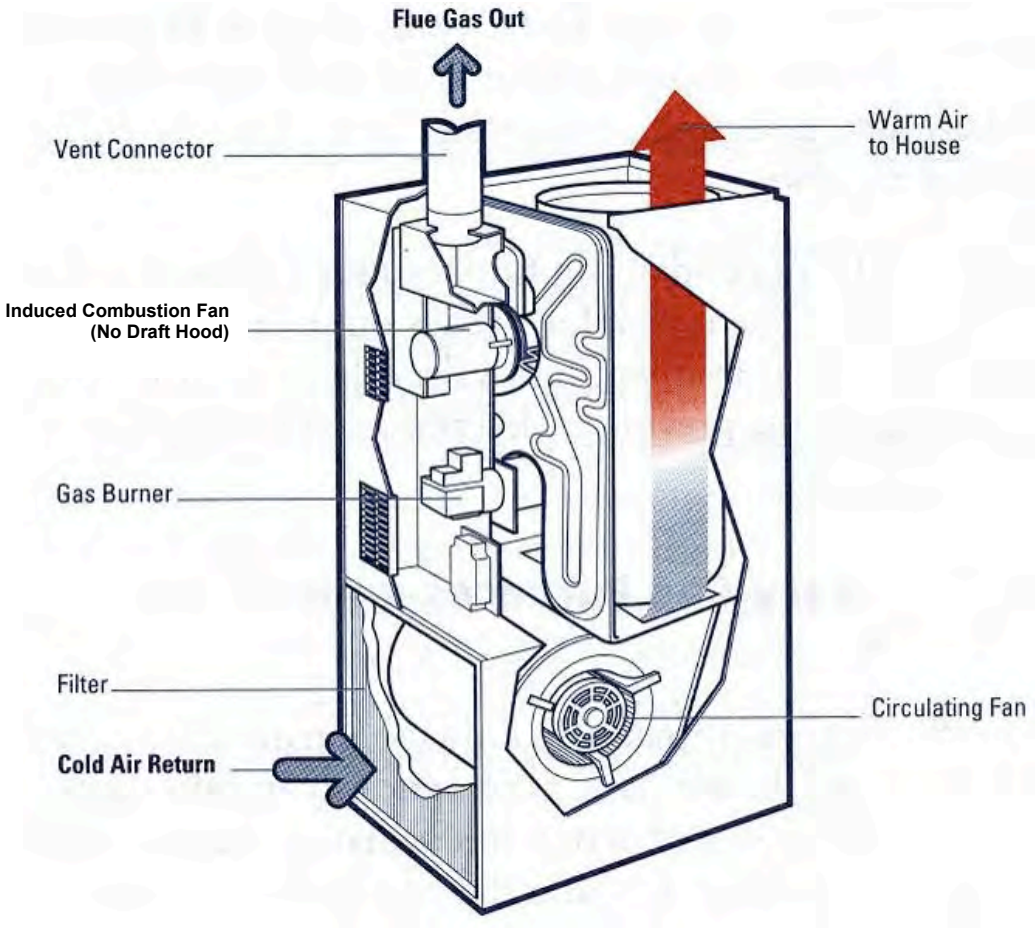
(see handout)

90+ Forced-Air Furnace Sequence of Operations

- Thermostat calls for heat
- Draft inducer turns on and runs for 30-60 seconds
- Gas valve opens and burners light
- When unit comes up to temperature the main blower turns on and delivers warm air to the residence
- When the thermostat reaches temperature, the gas valve turns off and the main blower will run one to three minutes then turn off

Induced Draft Furnace

Induced Draft Furnace



Source: *Heating with Gas*, Natural Resources Canada, 1998.

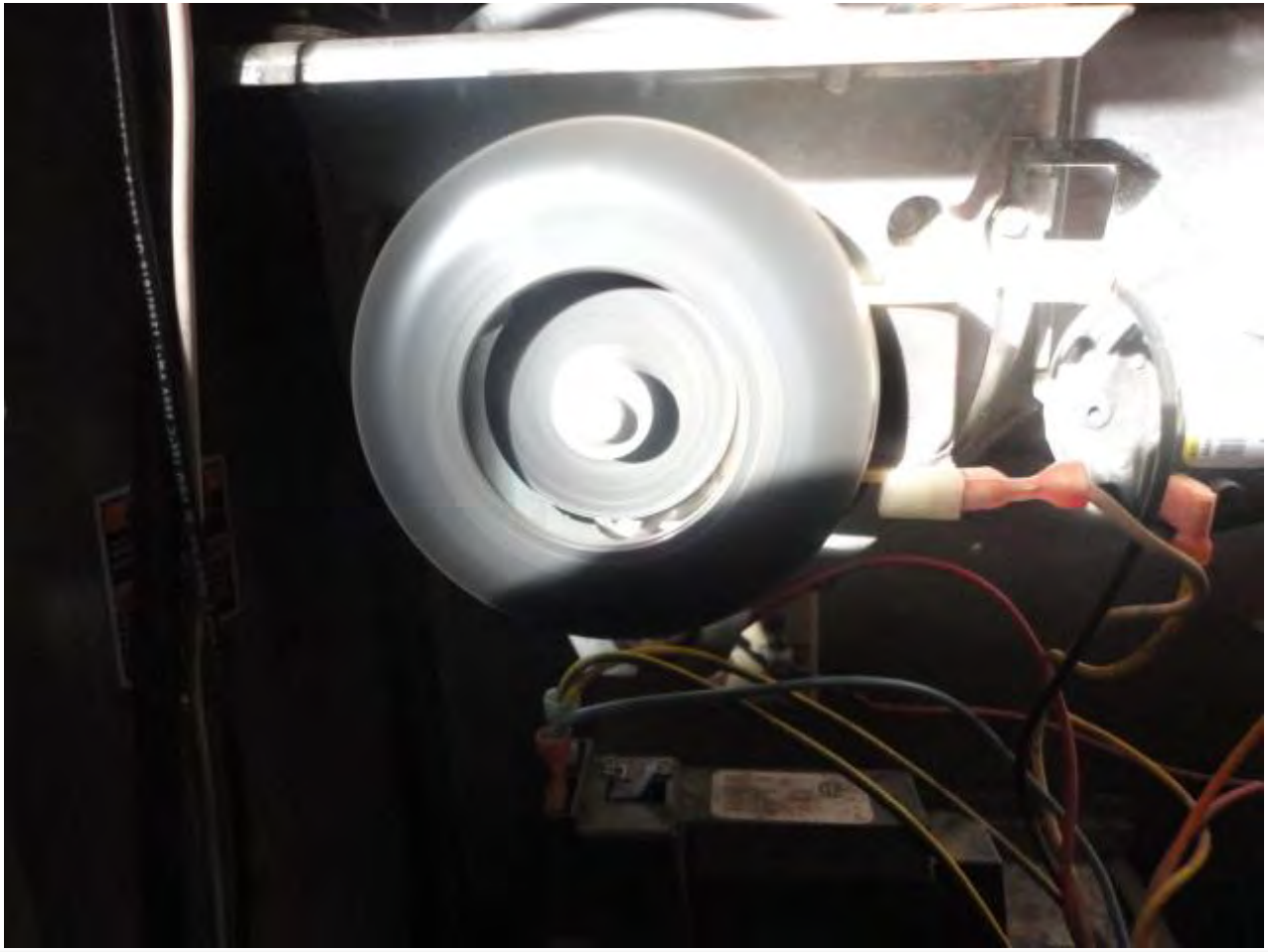
Category I Fan-assisted

- Unit OEM fan pulls a consistent volume of combustion air through the combustion chamber
- Natural draft unit
- These units hit the U.S. market around 1990

Induced Draft Furnace

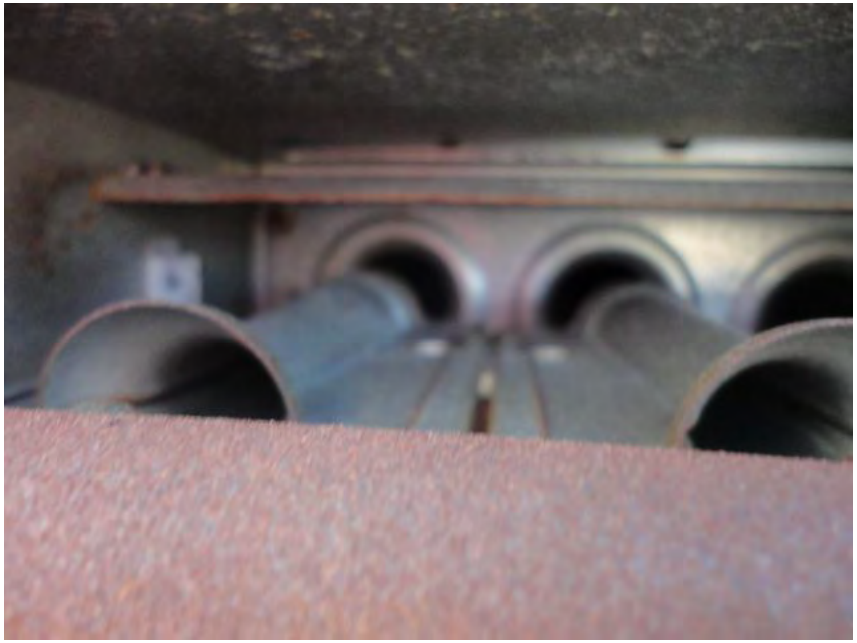
- About 80% Steady State Efficiency
- 78 to 83 % Annual Fuel Usage Efficiency
- One heat exchanger
- May have a draft inducer (older units do not)

Inducer Motor



Control Board

Burners



Ignition System

Heat Exchanger

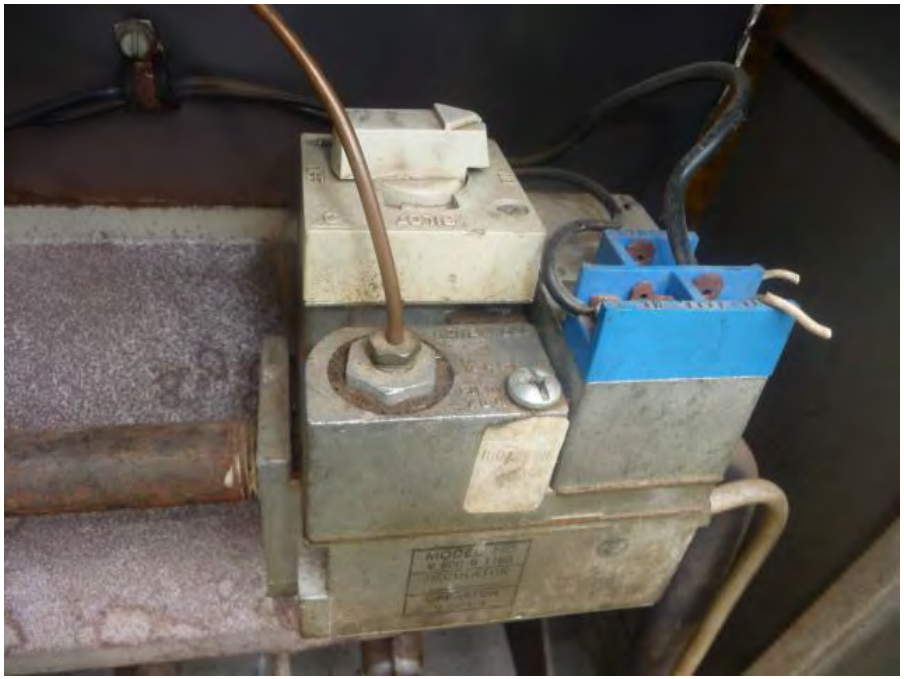
Top of Clams

Restrictors

Mechanical Controls

Fan Control
with High Limit

Gas Valve



Air Handler

Belt Drive

Air Handler

Induced Draft Forced Air Sequence of Operations

(see handout)

80 + Forced-Air Furnace Sequence of Operations

- Thermostat calls for heat
- Gas valve opens and burners light
- When unit comes to temperature the main blower turns on and delivers warm air to the residence
- When the thermostat reaches temperature, the gas valve turns off and the main blower will run for one to three minutes then turn off

Note: If the unit has a draft inducer it operates the same as a 90+ furnace.

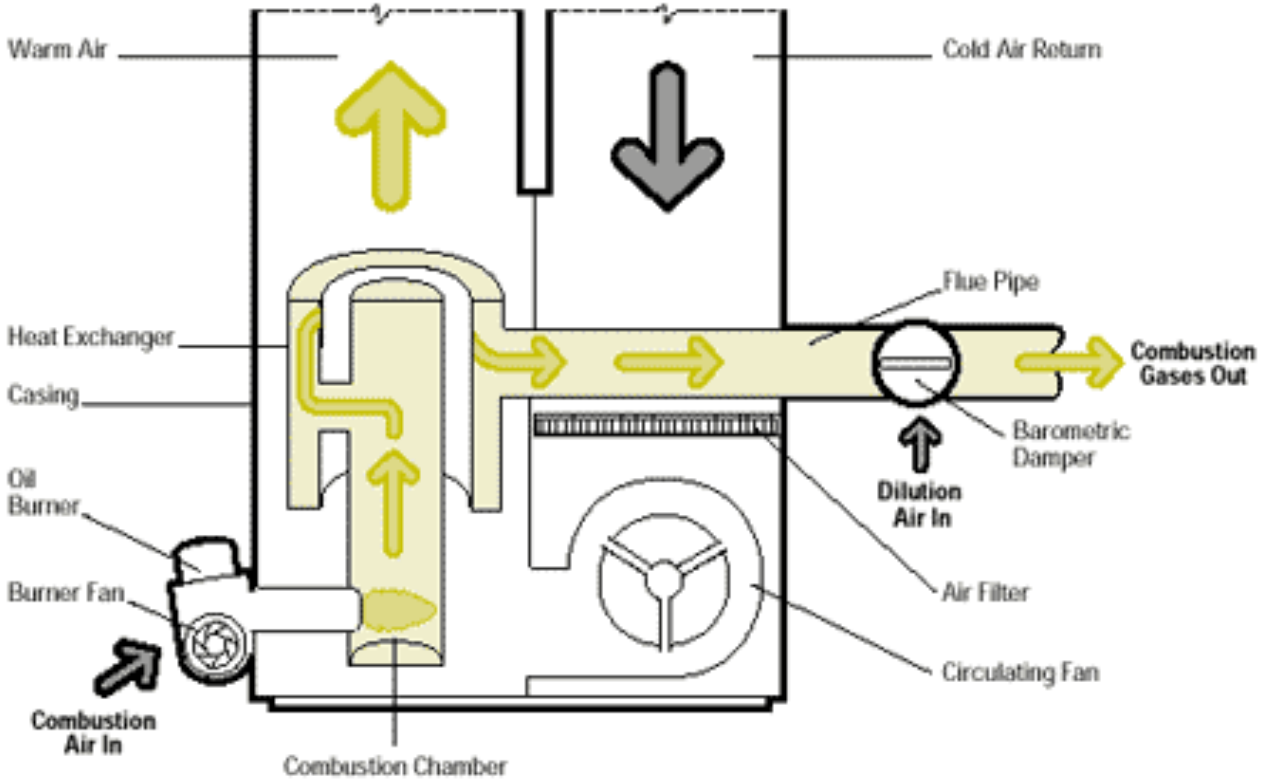
Oil Forced-Air Furnace Characteristics

- One heat exchanger
- May have a draft assist Located in the flue
- Over fire Draft is important
- 1920s: Oil burner is invented — enabling people to be kept warm and cozy with Oil heat.

Natural Draft Oil Forced Air

Category I Natural Draft

Oil-Fired Furnace



Graphic courtesy of Natural Resources Canada, www.nrcan.gc.ca

Inspect the Chimney

Down Chimney

Up the Chimney

Exhaust System

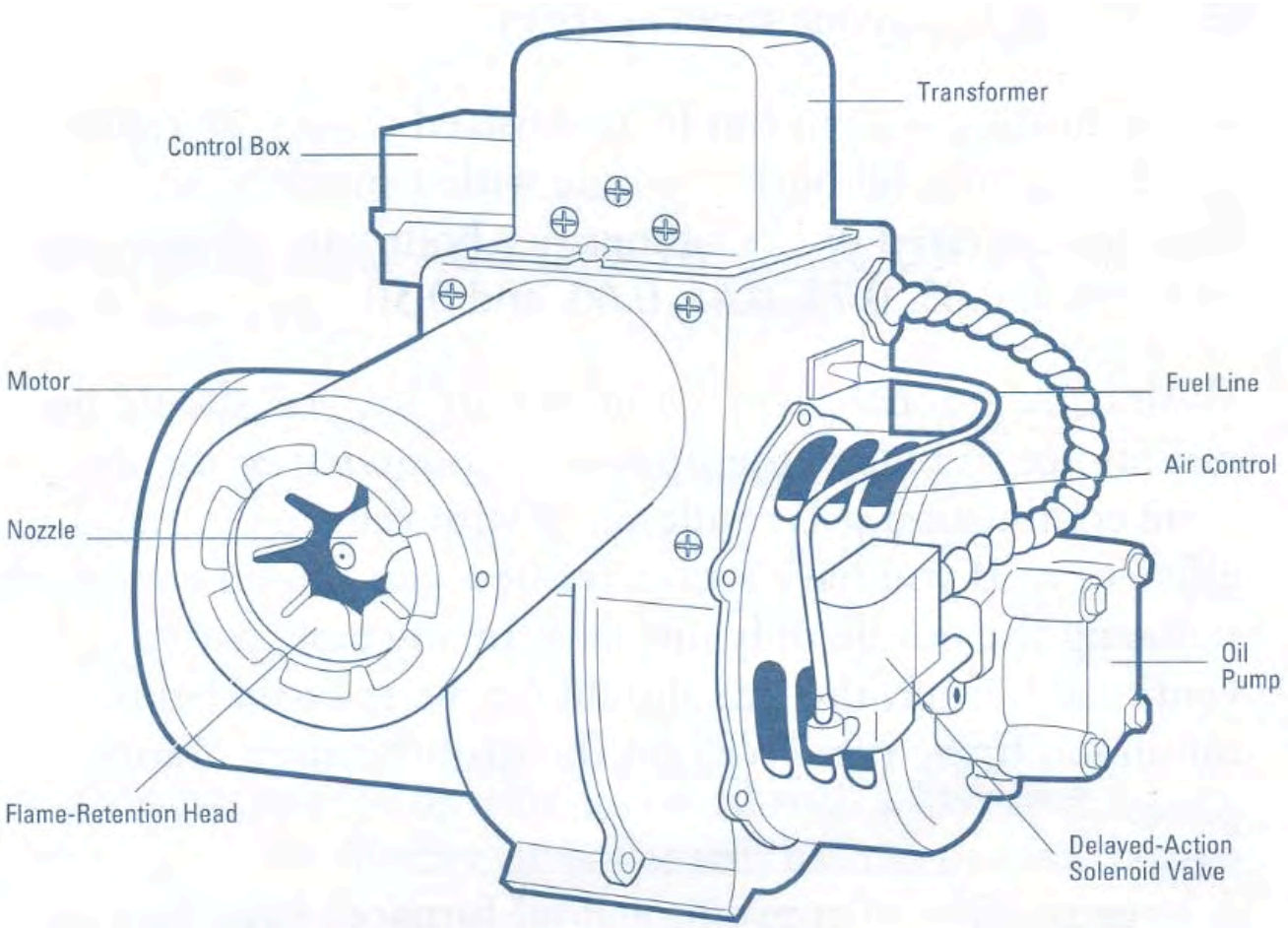
Mechanical Controls

Fan Control with
High Limit

Primary Control

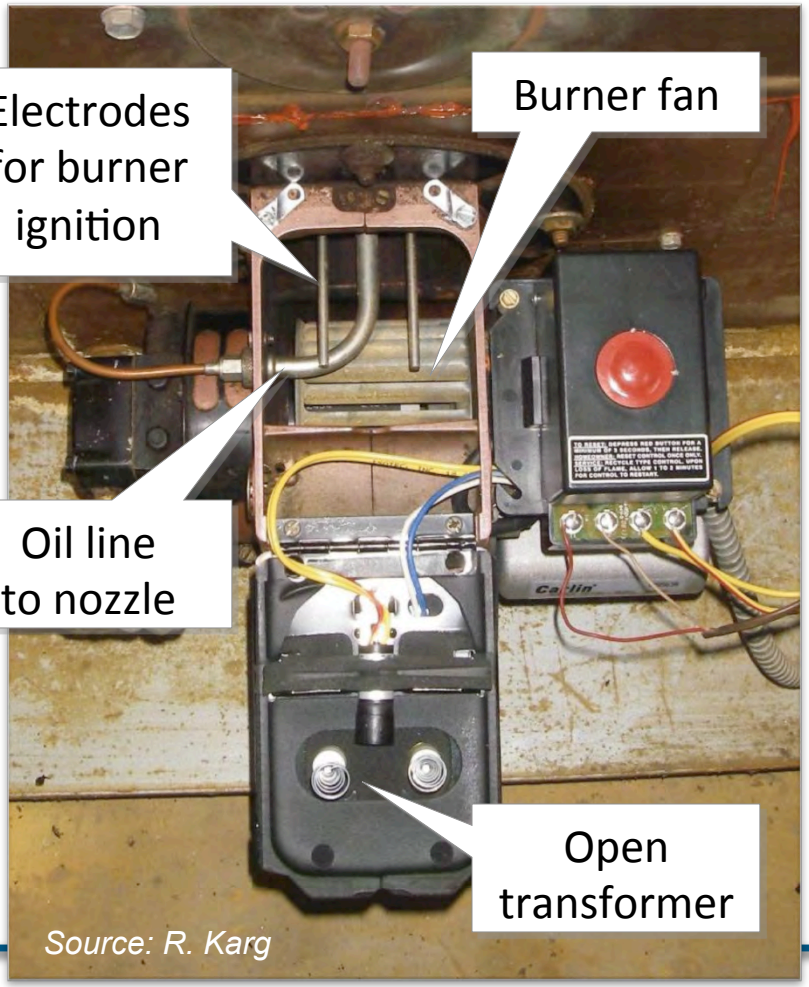
Heat Exchanger

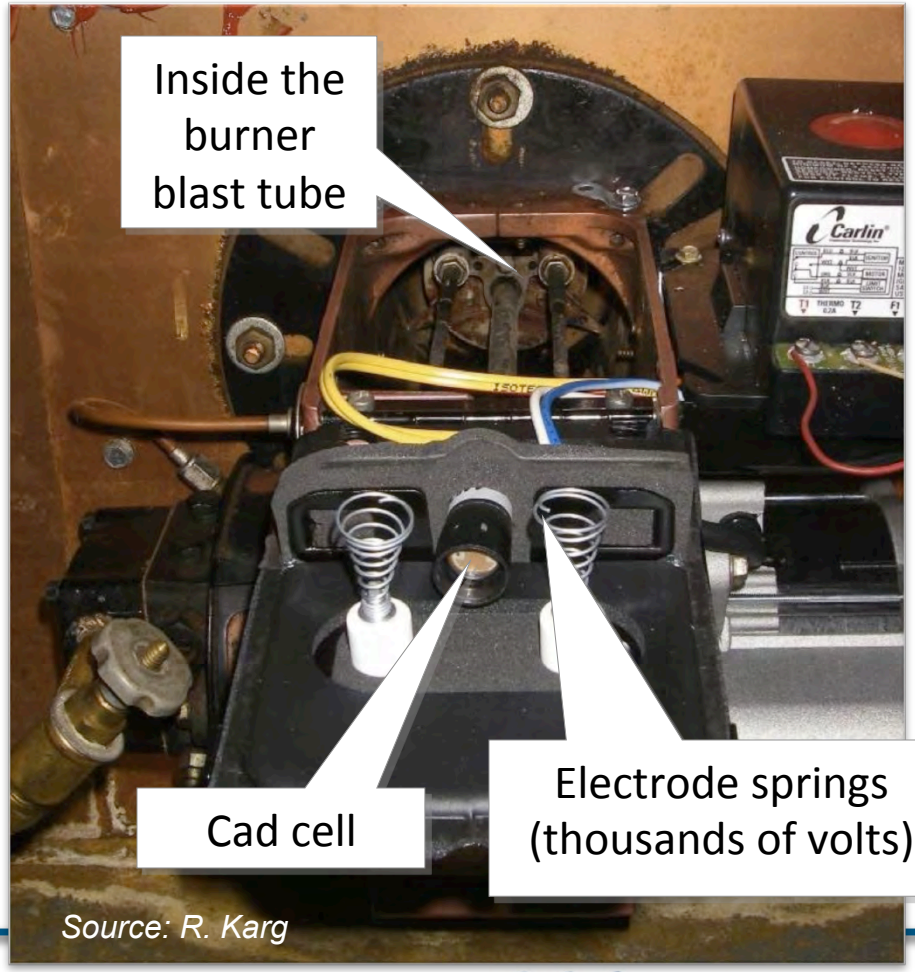
Oil Burner Components #2



Source: Heating with Oil, Natural Resources Canada, 1998.

Oil Burner Components

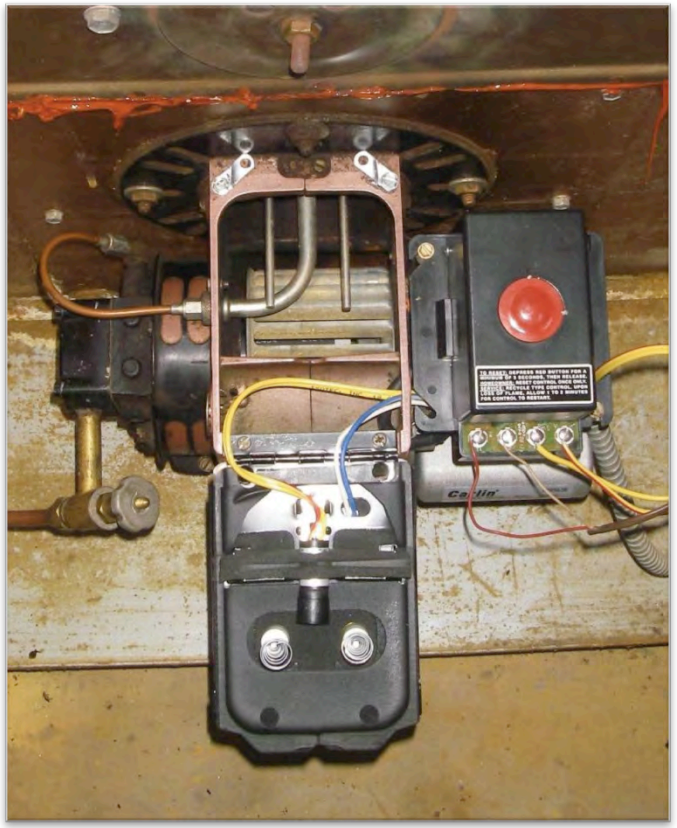




Burner

Inspect the Outside

Inspect the Inside



Air Handler

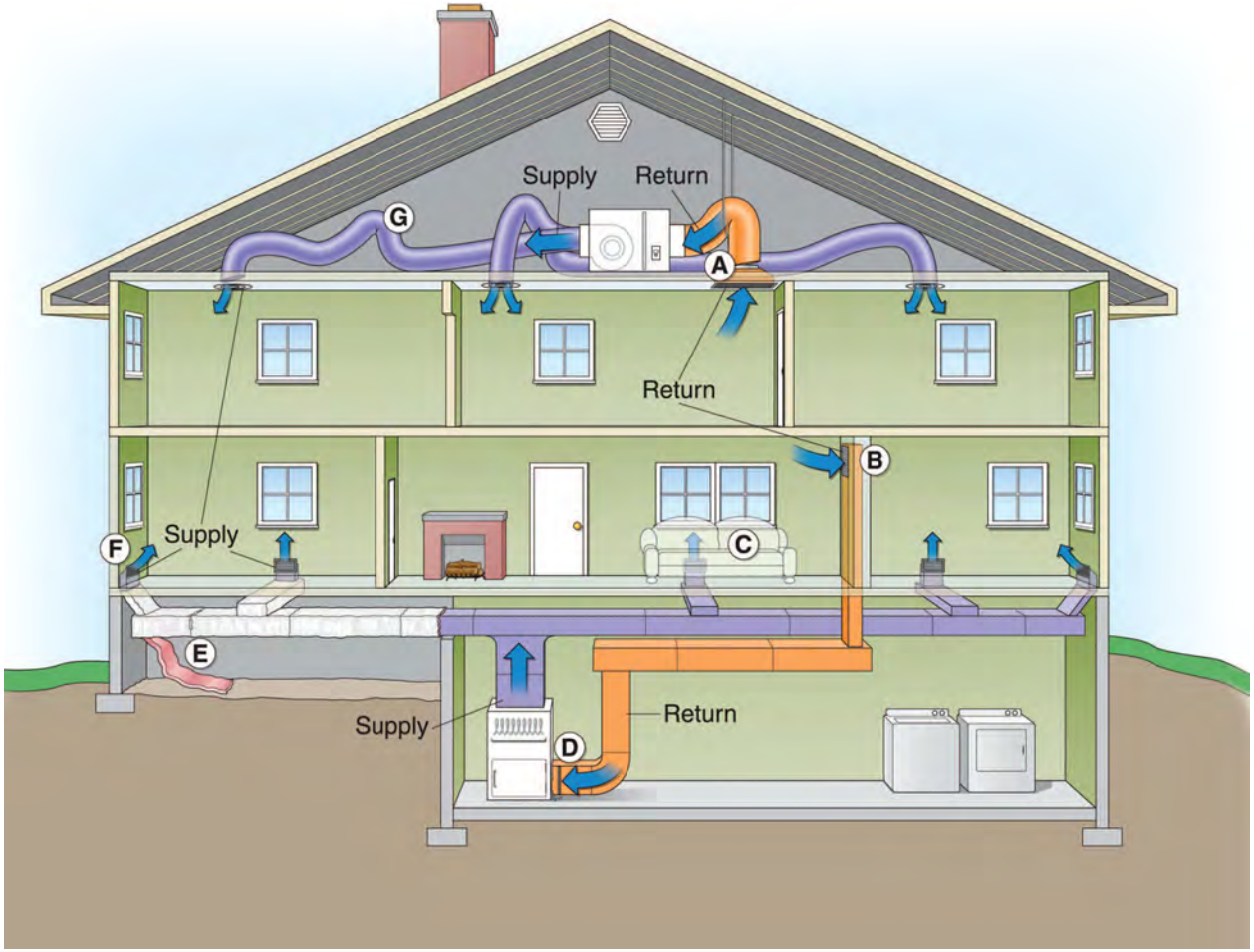
Belt Drive

Air Handler

Oil Forced-Air Furnace Sequence of Operations

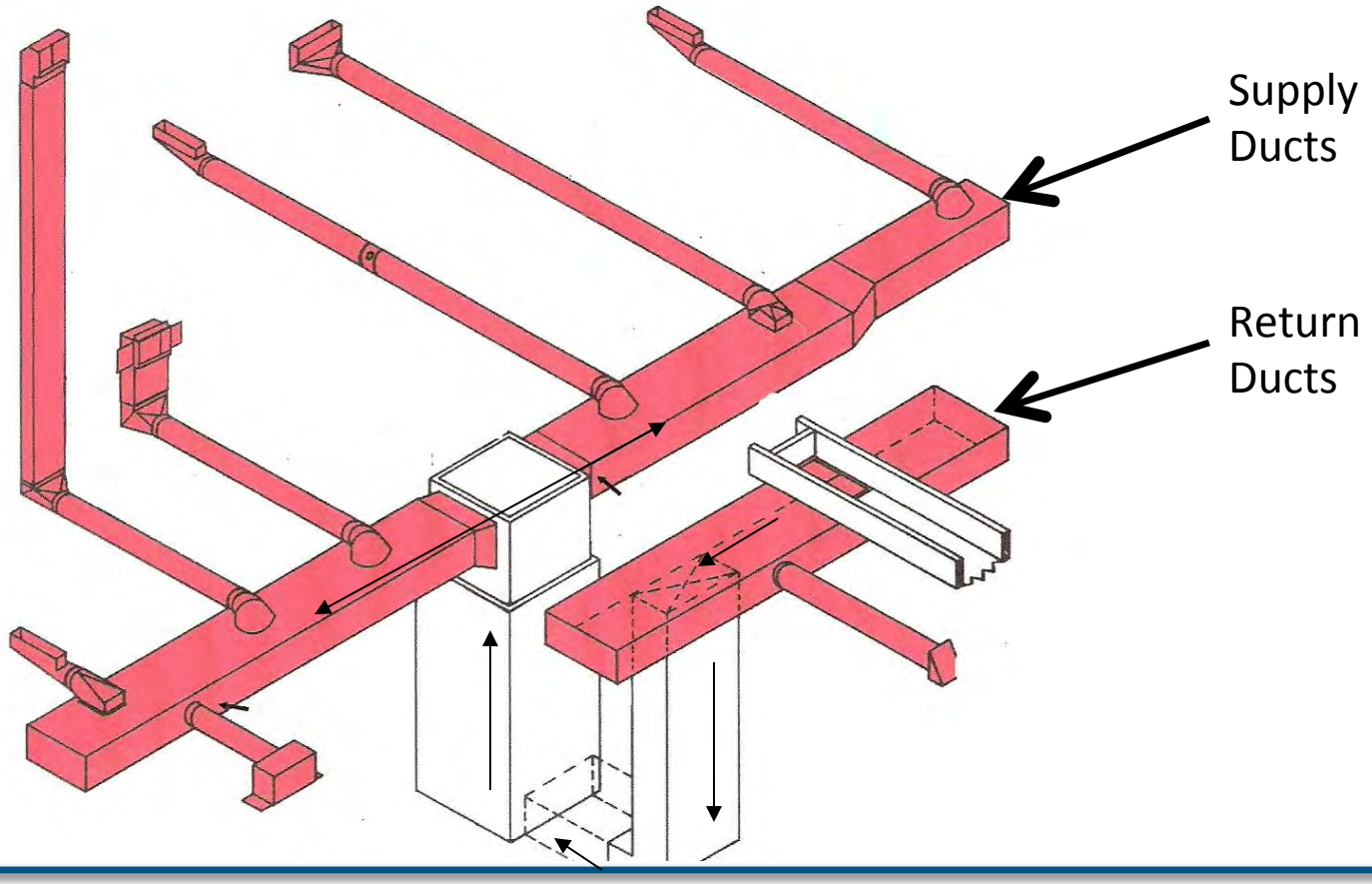
- Thermostat calls for heat
- Primary control on the burner energize the transformers which start the oil pump and the electrodes which produces flame
- When the unit comes up to temperature, the main blower turns on and delivers warm air to the residence.
- When the thermostat reaches temperature, the primary control turns off, shutting down the pump and electrodes

Forced-Air Distribution Systems



Courtesy of WAP Standardized Curriculum

Parts of the Distribution System

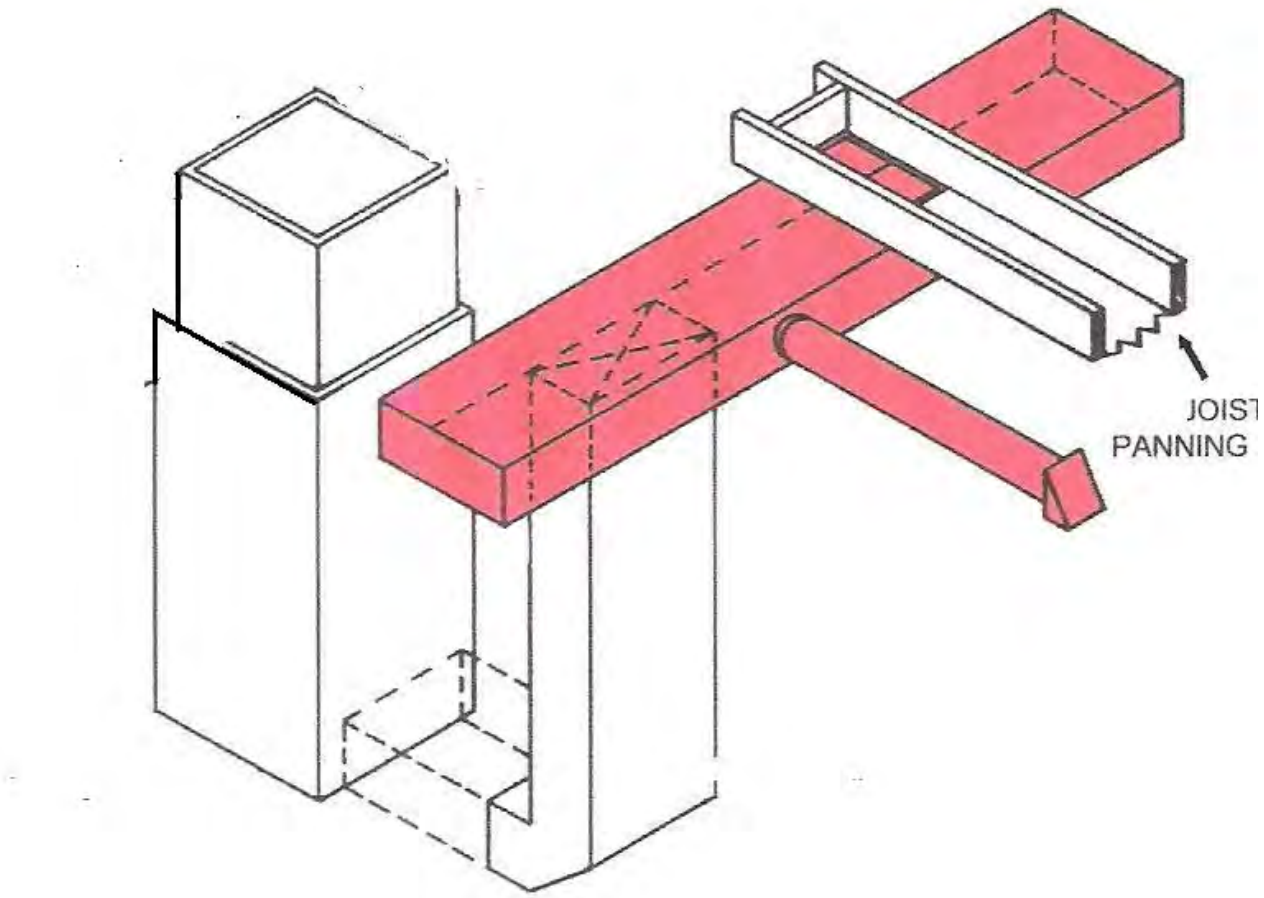


Understanding Forced Air Distribution Systems

Trainer: Adrian Scott, WECC

March 27-28, 2013

Return



Graphic Courtesy of Snappy Catalog

Return Air Traits

- Central return
- Most commonly found in homes that had coal or wood octopus type furnaces
- Rooms may have cold spots because of home's layout
- Opening or closing doors greatly affects air circulation

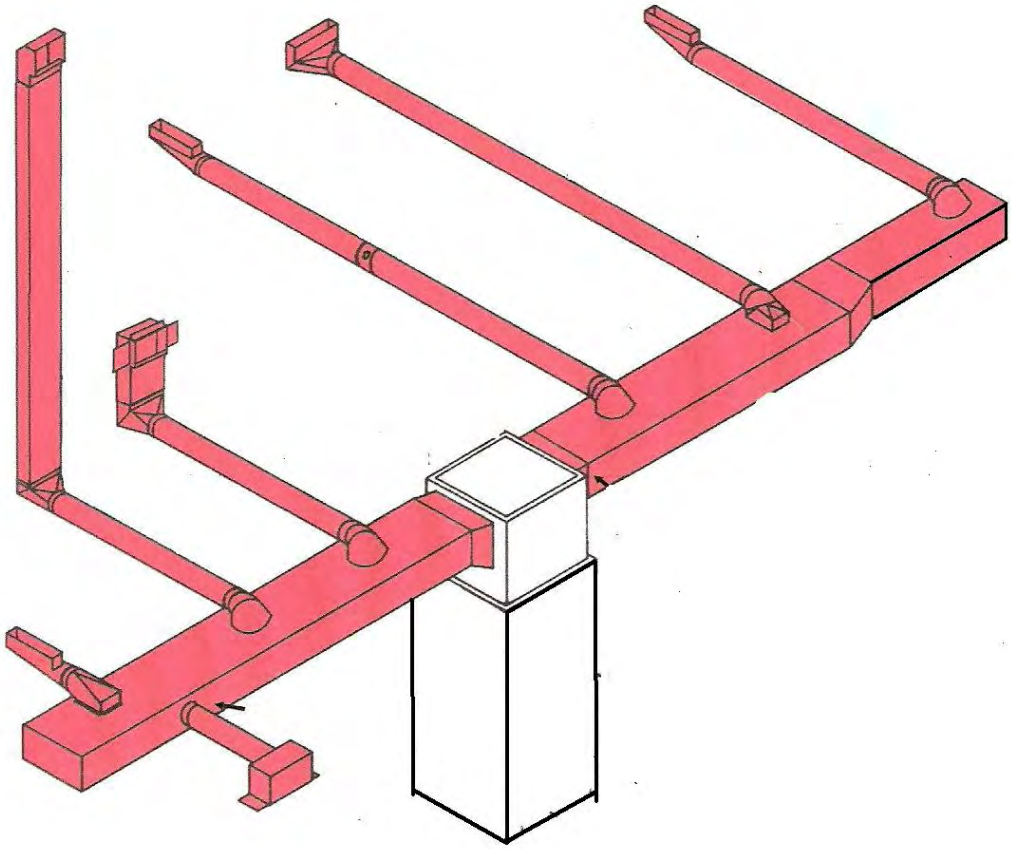
Returns to the First Floor

- Older homes commonly have returns on the outside walls
- Use joist pockets and joist panning for return air
- Sometimes located in the outside wall pockets
- Usually undersized for new systems
- Balanced by sizes of grilles and duct work

Returns

- Returns in newer homes located on inside walls
- Occasionally found up high in the interior walls
- Occasionally use round pipe back to the central return trunk; usually have floor registers
- Still common to use joist pockets and joist panning for return air-back to a central trunk.
- Return air grilles are generally located on

Supply



Graphic Courtesy of Snappy catalog

Supply

- Most commonly found on inside walls in older homes
- Commonly found on the outside walls in newer homes
- Usually there is a plenum with a trunk and the runs are standard six inch round pipe
- May be an octopus design
- Older homes may be undersized, typically five inch
- Should have balancing dampers

Air Handlers

- Move air
- Control temperature rise
  - Common range between 30 – 70 degrees
  - Temperature range is set by the manufacturer (PMI)

Air Handler Blower Configuration

Older Model Furnaces

- Single speed
- Belt driven
  - Speed adjusted by adjusting pulley
- Not compatible with central air conditioners

Assessing Heating Systems

- Start with a good visual assessment
  - Exhaust system
  - Fuel systems
  - Distribution

Important aspects of the overall system today is on just the “box”

Assessing Heating Systems
(continued)

- Visually inspect the “box”
- Furnace/Boiler/Stove/Space Heater
  - Condition of cabinet
  - Electrical systems
  - Heat exchanger
  - Controls

Assessing Heating Systems
(continued)

- Diagnostic testing
  - SSE
  - Temperature rise
  - Static pressure
  - Air flow
- Locate or estimate the age
  - Use serial number
  - Look at name plate data