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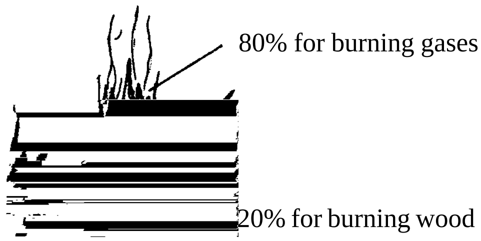
To understand wood stove efficiency, we must first understand the three phases of wood burning. First, the wood is heated to evaporate and drive off moisture, this occurs under 500°F. Above 500°F, the wood starts to break down chemically and volatile matter is vaporized. These vapors contain 50 to 60% of the heat value in the wood. The third phase of wood burning occurs above 1,100°F when these vapors and the remaining material (charcoal) burn. This high temperature must be maintained for maximum combustion efficiency.

All three phases of burning may and usually do occur at or about the same time. For efficient burning, the volatiles must be mixed with air and kept at 1,100°F or higher to burn completely within the stove. Wood burns with a long, yellow flame. By providing a long flame path within the stove, heat from these burning gases can be used before it escapes up the chimney. The flame path is lengthened in more efficient stoves in one of the following ways: by using an interior baffle which causes the gases to travel in an “S” pattern rather than a straight line, by using a gas combustion

Figure 2. Air supply distribution.



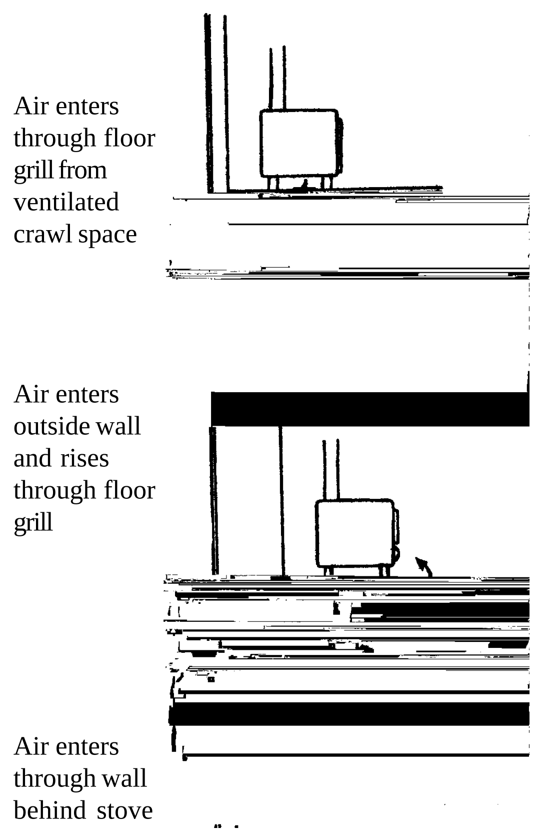
stoves have dual draft systems with a primary air supply for the wood and a secondary air supply for the gases. Pre-heating channels are often provided for one or both of these air supplies. These channels increase air temperatures before the air reaches combustion zones.

Since wood burning requires such large amounts of air and since many homes are now tightly weather-proofed, a supplemental air source should be provided to the stove (Figure 3). This air can be supplied through a duct from a crawl space or directly from outside of the house. The duct should have an outlet as near to the stove as possible. The size of the duct should be roughly the same as that of the stove flue. A damper should be installed on the duct to adjust air flow and to close it completely when the stove is not in use. If no ducts are provided, you may need to open a nearby window slightly in order for the chimney to draw properly and the fire to burn most efficiently.

Wood stove designs.

- *Box or chunk stoves* are the simplest and most common types available. They come in many forms including kitchen, Franklin, pot belly, and parlor stoves (Figure 4). These generally do not have very positive draft control and consequently burn excessive amounts of wood. Most introduce air under the fire. Some introduce additional air over the fire to help provide needed oxygen to burn escaping volatile gases. Unburned gases can carry large percentages of potential heat up the chimney.
- *Air-tight box stoves* (Figure 5) have controlled-draft damper systems, some with automatic thermostats, to give more positive control of both primary and secondary combustion air. Most introduce air below and above the fire. Some designs preheat incoming air. Others incorporate thermostatically-controlled heat exchangers to recapture heat for space heating.
- *Base-burning air-tight stoves* take the principles of the controlled-draft box stove one step further and add a second chamber for better combustion of the gases. These stoves bring secondary air through a pre-heating channel so it will not significantly cool the volatile gases. In addition, the flue outlet is located at the base of the fire box, forcing all exhaust products to pass by the hottest part of the fire before leaving the stove. Under proper conditions, these stoves can be fairly efficient but still need frequent tending.
- *Down-draft air-tight stoves* are relatively simple in design. Air is drawn down through air ports in the stove top, producing a blow torch effect. Volatile gases from fresh fuel are driven through the glowing coals. In some down-draft models, primary air enters above the fire but below the main load of wood. This primary draft flows down and outward through the glowing bed of coals,

Figure 3. Outside air supply for wood-burning stoves.

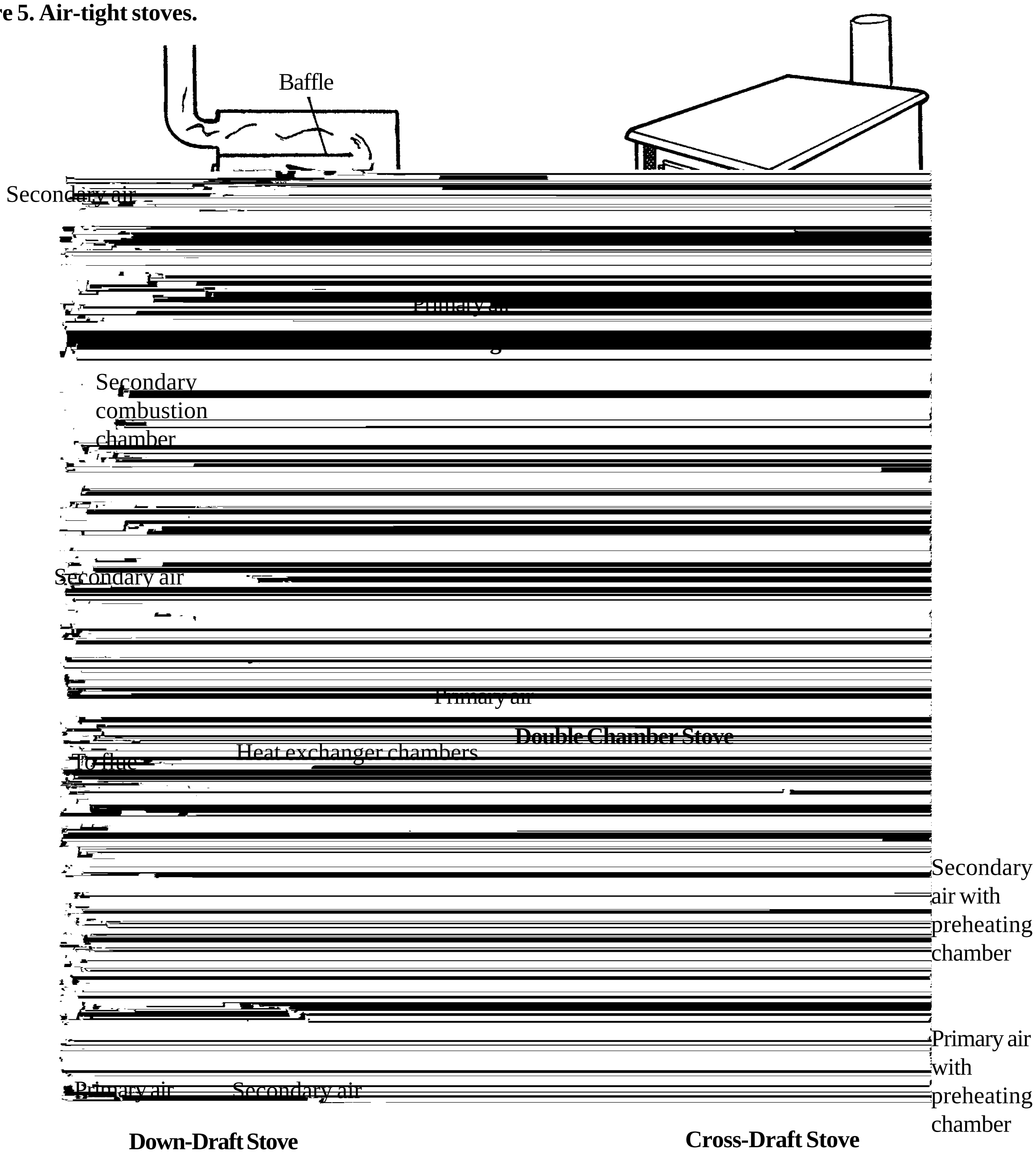


pulling volatile gases with it. Secondary air is introduced under the coals where it can oxidize these superheated gases. Gases continue to burn in the secondary chamber. This draft pattern prevents the heat of the fire from rising up through the fresh wood load (isolating it from the fire) until wood has dropped down into proper burning position. Thus, even a full load of fresh fuelwood will not cool the fire below. Volatile gases from the new fuelwood are also released more slowly for more efficient burning. Some down-draft stoves use a thermostoves have been bolted together rather than welded in order to reduce warpage problems. In many cases, cast iron doors, door frames, and cast iron or firebrick firebox liners have been used to extend the life of the steel stove.

- *Cast iron* has long been considered the best material for wood stoves. Cast iron stoves warm up slowly and have good heat-holding capability. Designs and texture cast into plates can increase radiating surface by up to 25%. Cast iron holds up well under heat, has a long life, spreads heat away from hot spots in the fire and generally does not warp.

The characteristics of a good cast iron stove are heavy, smooth castings, fully ground and fitted plates, tightly sealed seams, and tight-fitting doors with positive latches, internal baffles and side liners, tight and easily-adjusted draft controls and smooth, pit-free enamel finishes. Care should be used in handling cast iron because it cracks easily. In the long run, a finely cast, hand-fitted, well-designed

Figure 5. Air-tight stoves.



air-tight cast iron stove is a good investment. Lower quality cast iron stoves increase the likelihood of warping or breaking and in some cases may allow gases to seep through pores in the iron.

Other quality features include door and damper handles made of coiled metal so they don't get so hot, nickel plating on handles and trim, porcelain or tiled finishes if something other than bare metal surfaces that provides increased radiating surface as well as decoration.

General Considerations. All wood stoves should have sturdy legs, providing at least 4 inches, and preferably 8 to 10 inches, of air space between stove bottom and floor. Glass windows in wood stoves should be special safety glass designed to withstand thermal shock.

A stove designed to burn wood only should not be used to burn coal. Some stoves are designed to burn either. The excessive heat of coal will soon burn out the grate or bottom of a stove designed for wood only. Burn manufactured logs only in an open fireplace – they contain wax that burns dangerously hot.

Many manufacturers rate their stoves either by the number of cubic feet or the number of rooms the stove will heat. Any capacity rating must be used judiciously. As a general rule, 2.6 square feet of firebox bottom is required for each 1,000 square feet of room area. Unless the rooms are very open or a forced air duct/ system is installed between rooms, attempting to heat more than one room with a stove may well result in uneven temperatures and cold drafts along floors.

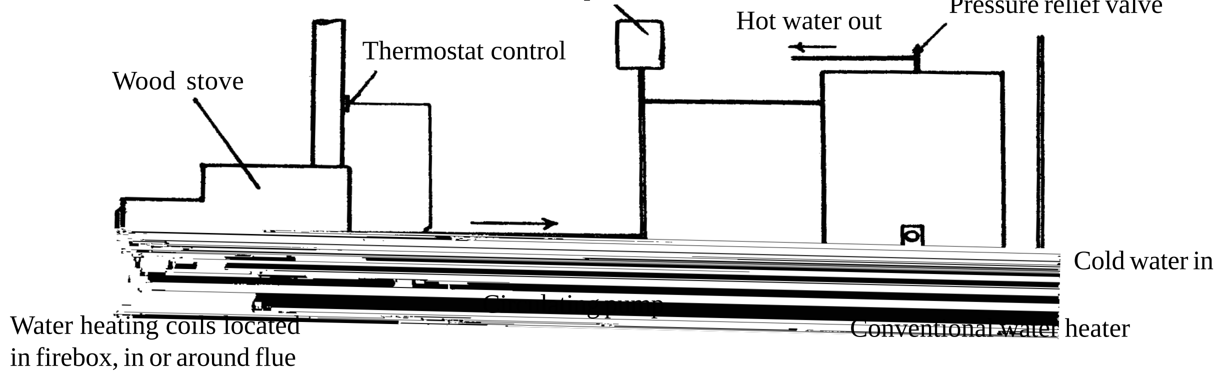
When a stove pipe has been installed, perform the tap test. Simply tap the pipe with your fingernail and remember the sound it makes. Repeat this procedure every week during heating season. If the "ting" sound changes to a muffled "thud", it is time for a creosote inspection. Creosote tends to build up more quickly in efficient air-tight stoves because more heat has been removed from the flue gases and the resulting lower chimney temperature encourages creosote condensation.

Wood Stove Installation. Many people purchase wood stoves without considering the necessary steps or additional costs for installation. Temporary expediencies such as running a single-wall, unventilated stove pipe through walls, ceilings, roofs, or windows, and using stove pipe as chimney do not meet fire codes and may result in a serious fire or cancellation of fire insurance. Install your wood stove in compliance with your local building code or fire department requirements and be safe rather than sorry. Then have your insurance company approve the installation.

Special Considerations. Increasing interest is being shown in home solar heating systems. However, the unpredictability of adequate periods of sunshine during winter months necessitate either an expensive heat storage unit or an auxiliary heating system. A combination of solar and wood heating could provide the benefits of low cost operational expense and total energy independence.

Many people are finding that an additional benefit from a wood stove is the capability to heat domestic water. Figure 6 shows a schematic layout of a stove water

Figure 6. Water heating with a wood stove.



heater supplementing a conventional hot water tank.

Additional heat can be extracted from combustion gases by using some type of flue heat exchanger. Two different kinds are shown in Figure 7. Make sure all flue connections are resealed. Remember that excessive cooling of gases decreases the drawing effect of the chimney and increases the likelihood of creosote deposits on interior surfaces of the flue and chimney. These units need to be cleaned often during the heating season because of the creosote and soot buildup.

Wood stoves can be installed to use a fireplace chimney and to gain improved performance above that of the typical low combustion efficiency of a fireplace

Figure 7. Flue Heat exchangers.

Increased surface area of the fins on the flue sleeve transfer heat to the air

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