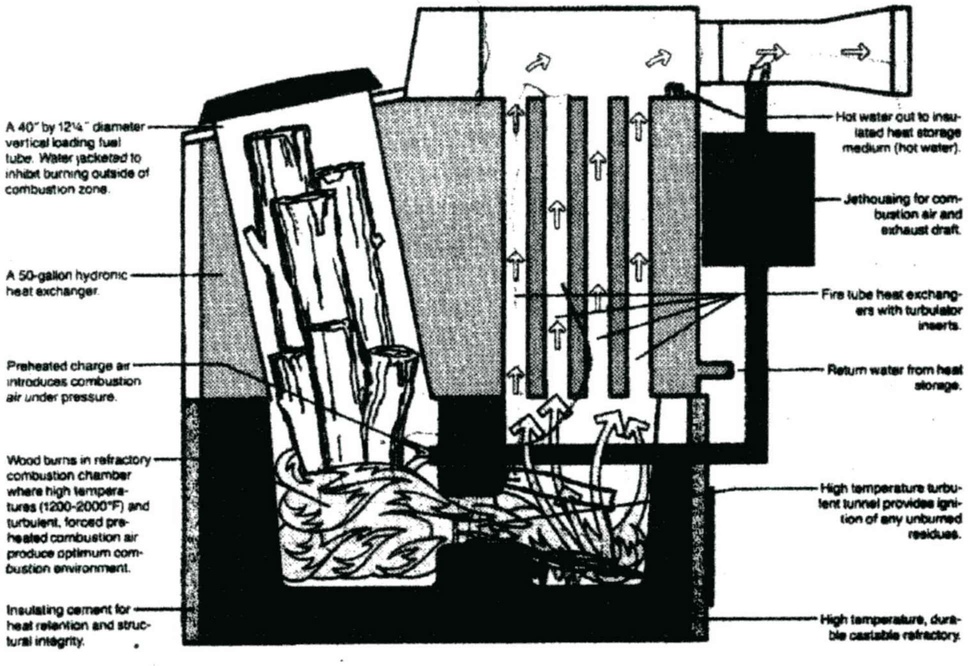
1.4 DESIGN CONCEPT of the JETSTREAM

THE PROBLEM OF BURNING WOOD

A series of very complex time and temperature dependent chemical reactions accompany the burning of wood. To supply the correct amount of air is difficult; to control the output to match a particular heating load is even more difficult. This difficulty in carburetion and control is compounded by difficulties in ignition. The pyrolysis gases (unburned gases formed when wood is burnt at low temperatures) generated from heating wood have ignition temperatures ranging from 385 degrees C. (725 degrees F.) (methanol) to 637 degrees C. (1178 degrees F.) (carbon monoxide). Since conventional stove or furnace surface temperatures do not operate in this range, many of the gases distilled from wood are vented to the chimney. This results in a loss of energy and the potential for condensation of tars which leads to chimney fires.

The Jetstream approaches the complex issue of wood combustion by providing proper carburetion and by keeping the combustion zone at a temperature well above that required to oxidize the complex products of pyrolysis. The introduction of a high speed jet of air under these conditions provides good mixing of oxygen and pyrolysis products. Analysis of stack gases has confirmed that the Jetstream achieves complete combustion of wood, and thus achieving its very low level of harmful emission release.



1.4.1 Air/Fuel Ratio (Carburetion)

A vertical feed, water-jacketed wood loading tube inhibits burning of the fuel charge in the loading tube and exposes only a 305 mm (12 in.) section of the wood to the burning process. Gravity feeding of the fuel to the combustion zone assures a relatively constant amount of fuel entering this defined area at any one time. Combustion air enters the combustion chamber at 152 mm (6 in.) of static pressure striking directly on the burning sticks, removing ash and scale as it forms. This ensures that new fuel is constantly being exposed to the combustion process.

1.4.2 Temperature

By separating the combustion process from the heat exchange area and insulating the combustion zone, temperatures required for the ignition of volatile gases are maintained throughout the combustion zone. The insulating cement surrounding the combustion zone holds the heat in this area. Actual combustion zone temperatures have been measured in the range of 650-1010 degrees C. (1200-1850 degrees F.), dependent on the moisture content of the wood being burned.

In the Jetstream design the heat exchanger fire tubes sit on top of the high temperature tunnel and gain the benefit of radiant energy. Since complete combustion has taken place before the hot gases leave the tunnel, quenching of the combustion process does not occur.

1.4.3 Turbulence

A jet of air enters the combustion zone through the stainless steel air tube. The geometry of the combustion chamber and the interference of the fuel on the path of air entering this chamber creates a turbulent zone within the combustion area. This process thoroughly mixes the gases released during pyrolysis with a metered amount of oxygen.

1.4.4 Time

Under the conditions of temperature and turbulence, and given the air/fuel ratio in the Jetstream, a certain residence time is required to allow the reaction to run to completion.

A refractory tunnel leads from the Jetstream combustion zone to the heat exchanger. During steady state operation this tunnel glows incandescently indicating temperatures of 650-1010 degrees C. (1200-1850 degrees F.) within the tunnel. All unburned gases, tars and solids must pass through this tunnel. The geometry and location of the refractory tunnel provide the proper residence time to assure complete combustion of all the volatile components associated with the pyrolysis reaction.

1.4.5 Heat Storage

Conventional solid fuel heating devices tie the combustion process directly to the heat load of the house. This is done by regulating the air supply to the fire much like using the choke to regulate the speed of an automobile.

Heat storage eliminates the problem of controlling combustion to match the varying heating load of a home. The Jetstream concept of capturing the heat energy of combustion in insulated heat storage offers three important advantages:

1. Thermal efficiencies of 75% - 84% are realized throughout the entire length of the firing period.

2. Precise amounts of heat are delivered to the house only when required. Overheating is eliminated.

3. By carefully sizing heat storage to the anticipated heat load , convenient intervals between firings can be expected.

$$\text{Minimum interval between firing} = \frac{\text{Useful capacity of Storage (BTU)}}{\text{House Heat Load (BTU/Hr.)}}$$

The useful capacity of storage is the amount of heat that can be stored in the heat storage tank. For example, if the Jetstream heats a tank to 195 F. and if useful heat can be supplied to the house down to a temperature of 120 F. in the tank, then 75 BTU can be stored for each pound of water in the storage tank. A 10,000 pound tank (1250 U.S. gallons or 1000 Imperial gallons) could then store 750,000 BTU. In a home that is using 20,000 BTU per hour, this stored

$$\text{heat would last for approximately: } \frac{\text{750,000 BTU}}{\text{20,000 BTU/Hr}} \text{ or 37.5 hours.}$$

Note: Calculations will vary depending upon the use of a domestic coil, thermal efficiencies of the tank and pipes, as well as the accuracy of the heat loss of the house on which calculations are based.,