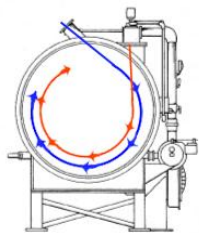
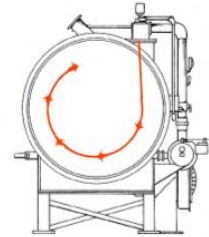




Technical Description of the Firebird V-3™ Vortex Combustion System

The process begins by injecting a flame produced by a gas-fed (natural gas or propane for remote applications) burner into a horizontally positioned cylindrical chamber tangentially to the side wall, simulating a vortex, or a “flame tornado.” Next, waste material is shredded or chipped, reducing it into pieces small enough to be efficiently conveyed by a pneumatic conveying system which carries the size-reduced material in a primary air stream and transports it into a combustion chamber. The burner then ignites the waste material as it enters the chamber and as it gets entrained in the vortical path.



Continuous injection of a mixture of size-reduced waste material and air into the chamber, establishes a vortical flow of the waste material which travels from the front end wall toward the rear end wall in a clockwise direction. Under conditions where a mixture of waste material and air is continuously fed into the chamber, the burner may be turned off after ignition of the waste material is accomplished, since the material becomes its own fuel source. This self-sustaining and self-fueling method is important in that the overall process only relies on an exterior fuel source for very small periods of time.

In order to enhance combustion of the waste material and to maintain the energy of its vortical flow in a predetermined and controlled manner through the entire length of the combustion chamber, controlled quantities of high velocity secondary air are introduced into the chamber during the burning process and at spaced regions throughout the length of the chamber.

With the described arrangement, the combustible waste material is substantially completely burned in suspension in a free vortex with the heavier solid waste fragments and non-combustible material traveling in a vortical path along the inner surface of the chamber walls and migrating toward the rear end wall. The solid material is forced toward the outer regions of the vortex by the tangential component of velocity of the vortex, whereas the radially inward component of velocity creates high relative velocity between the air and burning material which greatly accelerates the combustion rate.

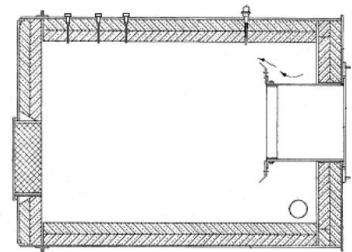
Additionally, in the described arrangement, the tangential injection of the secondary air through the openings at spaced points along the length of the chamber has the beneficial effect of periodically contributing to the vortex energy in the chamber. Thus, compensation is provided for losses in vortex energy or for effectively sustaining the vortex as the waste material progresses vertically along the length of the chamber. The periodic or spaced tangential injection of secondary air and the resultant sustenance of the vortex along the entire length of the chamber enhance the efficiency of the waste burning process. Also, it eliminates any tendency of combustion material particles, such as fly ash, to drop out of the vortex and settle on the bottom of the chamber. The total pressure available from the primary and secondary air entering the chamber is utilized to introduce energy into the vortex for obtaining high combustion rates.

There is a second discharge port for discharging from the chamber during the burning process any non-combustible material including heavy metals that are entrained in the outer region of the vortex as previously described. The material discharged by the second port is conveyed through a conduit to a separator which separates the gases and the solid material and means are provided to introduce the separated gases and any solid particles suspended therein back into the combustion chamber.

Most if not all of any non-combustible material will enter the conduit as it initially reaches the rear end wall. However, in the event that such material does not enter the conduit when it initially reaches the rear end wall, this material becomes entrained in the stream of hot gases which normally flows along the inner surface of the rear end wall toward the open end of the flue pipe where a low pressure area exists. If the open end of the flue pipe were flush with the end wall, a considerable portion of this material would enter the flue pipe thus making it necessary to use flue gas cleaning apparatus, commonly known as exhaust scrubbers, to avoid pollution of the surrounding atmosphere.

This relative positioning of the second discharge port and one of the secondary air openings results in the injected secondary air from that opening being effective in assisting in the direction of fly ash and other waste materials through the second discharge port. Also it serves effectively to prevent waste material from accumulating in front of, and obstructing passage through, the discharge port. The hot gases separated out by the separator are introduced back into the chamber. This is very advantageous in that it maintains the vortex within the chamber, further cleans such gases by removing residual fly ash, and dries out wet waste material within the chamber. These gases are preferably introduced into the chamber at an area downstream from the area of introduction of the secondary air.

As the residual combustible material (any particulate material that still has mass, including microscopic dust) moves in a vortical path towards the rear end wall of the chamber, it is forced to travel back along a portion of the flue pipe that extends into the chamber from the rear end wall. This not only increases the residence time, but it allows for the material to be caught up in the low pressure area. Unique to this design is the use of a baffle, positioned adjacent the open inner end of the flue pipe. The arrangement is such that material moving along the flue pipe engages the baffle and is deflected outward to the outer regions of the vortex for further burning and movement toward the rear end wall repeating this process until the material is fully combusted.



The nature of the free vortex flow field is influenced strongly by the ratio of the diameter of the opening of the baffle to the inside diameter of the chamber. With proper dimensions, the strong free vortex flow field provides an increasing tangential velocity with decreasing radius. The tendency of the particles to be drawn to the center of the chamber by the drag forces imparted from the radially inward flow is counterbalanced by a stronger centrifugal force field. Therefore, the particles are maintained in suspension until complete combustion has occurred or until they are withdrawn from the chamber through the conduit leading to the separator.