



## WHAT IS BELL ANNEALING?

Rev. 1 DEC 2005

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### What is Annealing?

**Annealing** is a softening process for metal that reduces internal strain caused by work hardening and facilitates recrystallization and grain growth. When metals are formed or processed, strain hardening occurs, decreasing ductility and increasing hardness. This hardening leaves metals brittle, often causing cracking or breaking during successive operations. For many applications, these residual stresses within the structural makeup of the molecules must be alleviated. Annealing returns the ductility to the metal allowing for future operations and processing.

Both ferrous (iron-based alloys such as steel and stainless steel) and non-ferrous metals (such as bronze, copper and aluminum) use this process. This raw material is cleaned to eliminate rust, scaling, dirt, and other impurities. Cleaning can be performed using acid pickling or mechanical methods, depending on the application. The metal is then placed in a furnace where it is heated to meet metallurgical requirements. Variations exist within the process depending on the type of metal being annealed and the desired outcome. It is frequently advantageous to heat the metal within a controlled atmosphere, such as nitrogen or hydrogen, to prevent chemical reactions from occurring between the metal and elements in the air. The furnace heats the metal, usually through convection and radiation, to a desired level where it is either held constant or cycled. After the heating, a controlled cooling brings the metal back to room temperature.

### What is Bell Annealing?

Bell Annealing is a type of annealing that derives its name from the shape of the furnace used during the process. Bell Annealing heats batches of metal which are placed on a base assembly, enclosed by an inner cover, and covered by the furnace. An overhead crane is used to load the base and move the equipment—when the furnace is suspended from the crane, it looks like a “bell”. The base assembly is the source of convection and the main method of heat transfer to the charge. The inner cover seals in the desired atmosphere and protects the charge from the burners’ direct heat. Keeping contaminants out of the annealing atmosphere prevents chemical changes as well as eliminating the formation of oxides and soot on the metal. The furnace brings the charge to the desired temperature to allow for the metallurgical changes to occur. Direct fired, tangentially fired, radiant tube, and electrical resistance are furnace types related to the method used to heat the charge. After heat treatment, cooling is performed by removing the furnace—leaving the inner cover in place to maintain the protective atmosphere. If a bright finish is desired, the metal must be cooled to near ambient temperature before exposing the metal to air. In this case, another piece of equipment is utilized: a forced-cooler. The forced-cooler replaces the furnace at the end of the heating cycle and uses air and sometimes spray water to accelerate the cooling of the outside of the inner cover.

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The main advantages of a Bell-Type annealing furnace are:

- Excellent temperature uniformity
- Consistent product quality
- Good production rates
- Low operating costs
- Efficient use of furnace asset by cooling with inner cover
- Savings in shop floor space requiring less capital investment and reducing material handling

Bell furnaces are used to anneal both strip and wire coils. Furnaces designed for strip are generally of a "single-stack" configuration. The base diameter accommodates on coil centered over the base fan. The strip coils are stacked on top of one another, separated by convector plates. The circulated atmosphere flows up the sides and back down to the fan through the center of the coil.

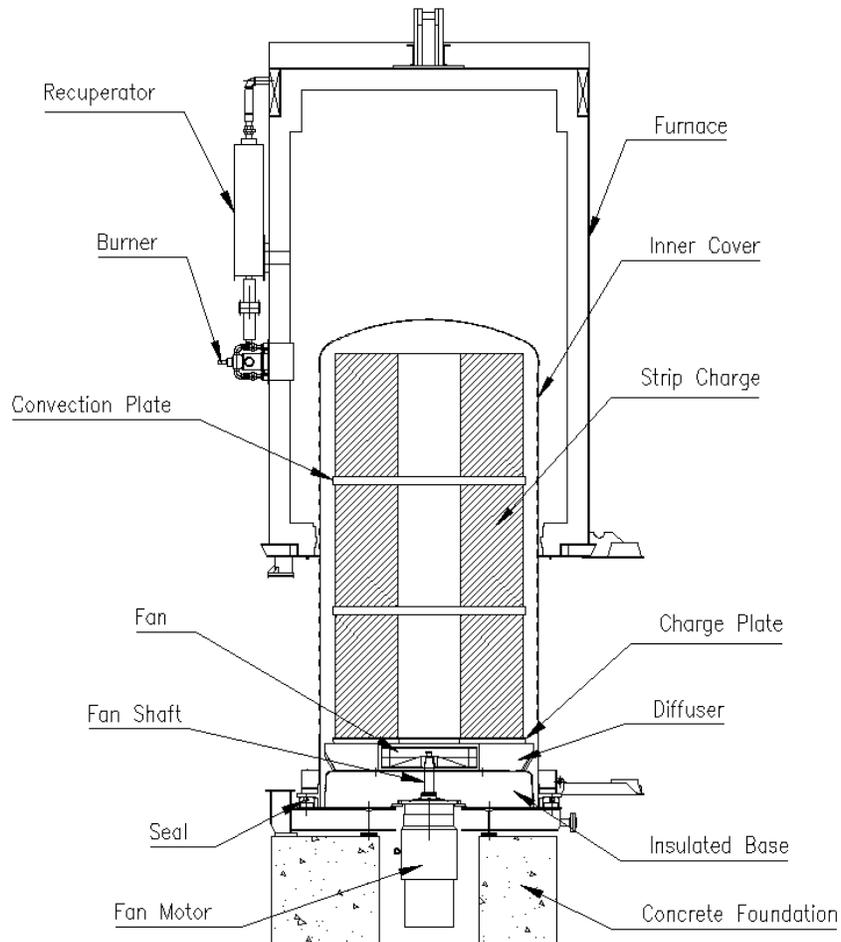


Figure 1. – Super-High Convection™ Bell Annealing Furnace for Strip Coils

To anneal wire, the coils must first be placed on a carrier, which is then loaded onto the annealing base. Furnaces designed for wire are generally of a “multi-stack” configuration. This requires a larger base, making the wire annealing furnaces short and wide compared to the strip counterparts. Like a strip furnace, the convection flow goes up on the sides and down the center. For multi-stack wire systems, a plenum is used above the diffuser to direct all the flow to the inner cover wall and provide a return path for flow to the large convection fan.

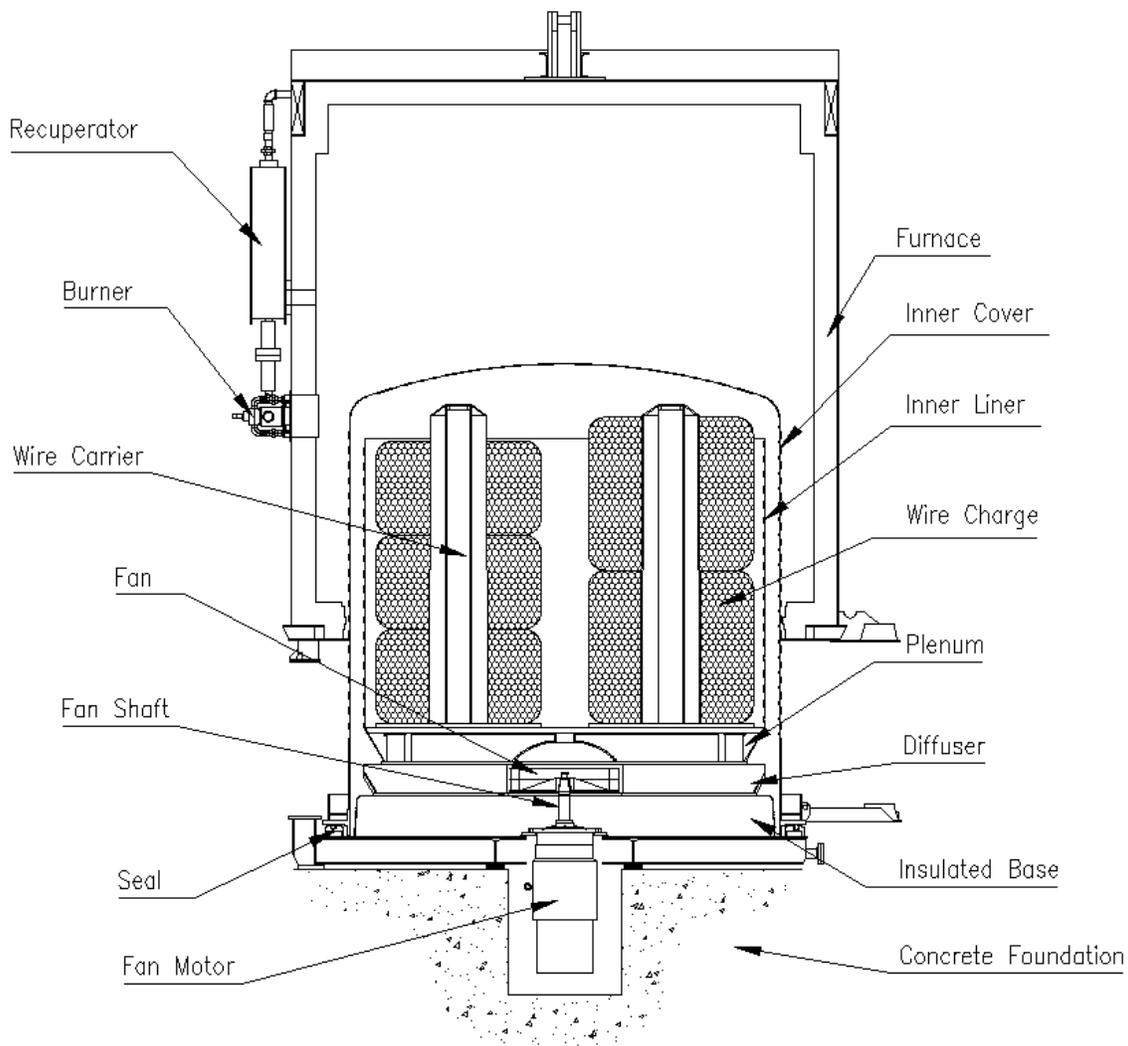


Figure 2. – Super-High Convection™ Bell Annealing Furnace for Wire Coils