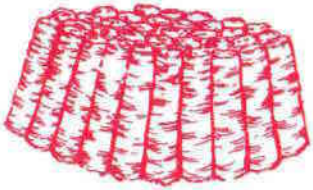


## Charcoal Clamp

Stage 1



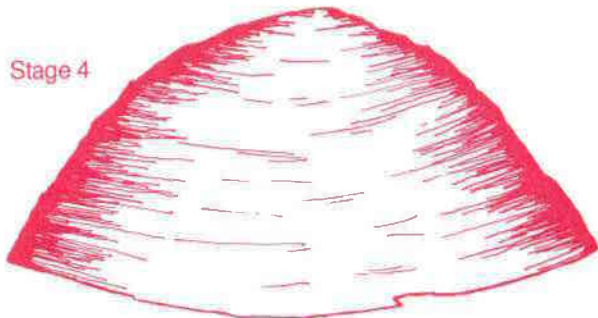
Stage 2



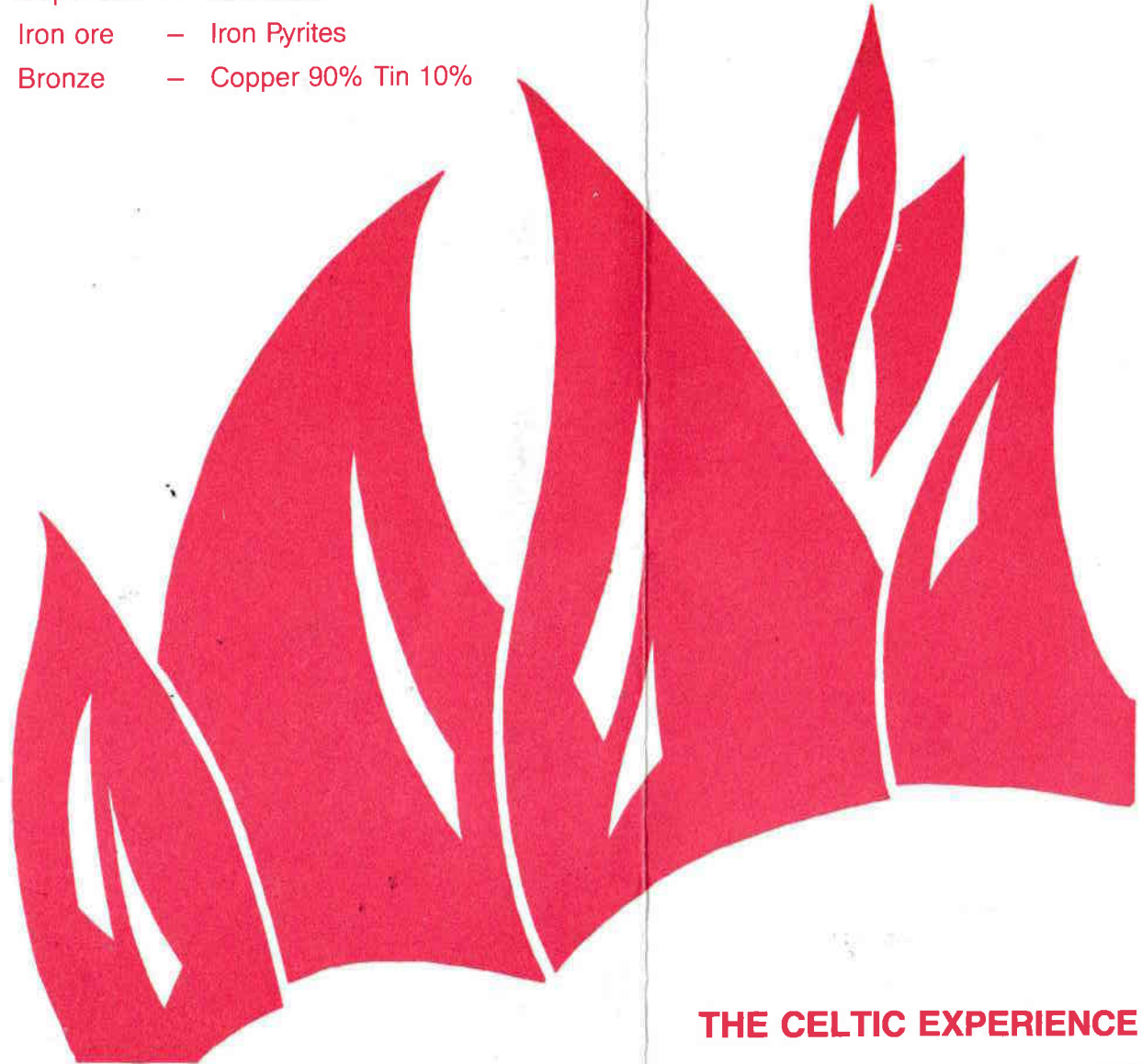
Stage 3



Stage 4



- Lead ore – Galena
- Tin ore – Cassiterite
- Coper ore – Malachite
- Iron ore – Iron Pyrites
- Bronze – Copper 90% Tin 10%



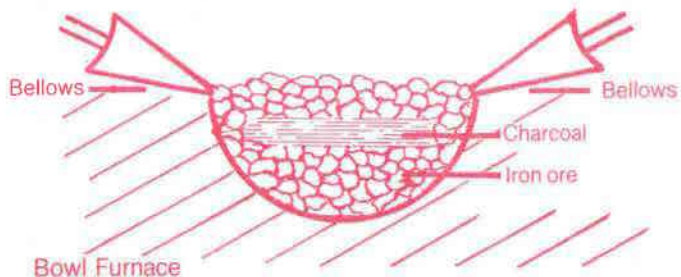
## THE CELTIC EXPERIENCE



This area is devoted to the investigation of metal production and processing along with allied industries. The archaeological remains from the Bronze and Iron Age in this country and Europe indicate an extremely high level of technological achievement not only with copper, tin and iron but also with silver and gold and alloys of these. Smelting and melting, the reduction of metal from the ore and its subsequent treatment, is our primary purpose, the crude work of the smelter and forger. However, the prehistoric period was distinguished by quite brilliant goldsmiths, silversmiths, bronzesmiths and blacksmiths. Wonderful adornments, torcs, bracelets and brooches, horse trappings, swords and daggers were manufactured from solid gold, gold and silver wire, bronze and iron and regularly inlaid with coloured enamel. Pervading all these beautiful objects is the distinctive Celtic art form which is dependent upon the open ended curve.

Metal production is basically a high temperature technology which requires a particular fuel. Exactly how and when charcoal was discovered to burn at much higher temperatures and for much longer than wood is unknown but it is certainly a pre-requisite for smelting metal from ore. Its production depends upon burning wood in a reducing atmosphere to turn it into pure carbon. Traditionally this is done in a clamp over many days. The combustion uses up the gases in the wood stack and leaves a charcoal residue. Once the stack is completely cool the earth is removed and the charcoal recovered.

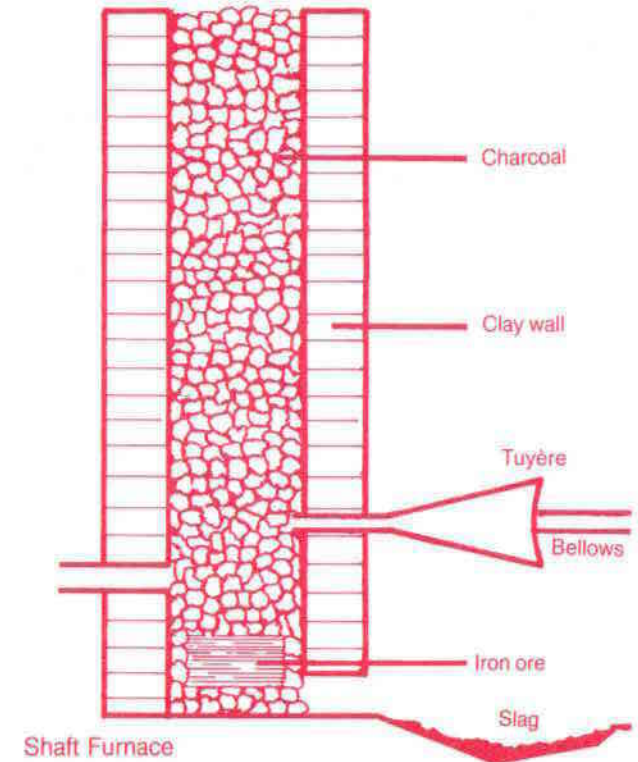
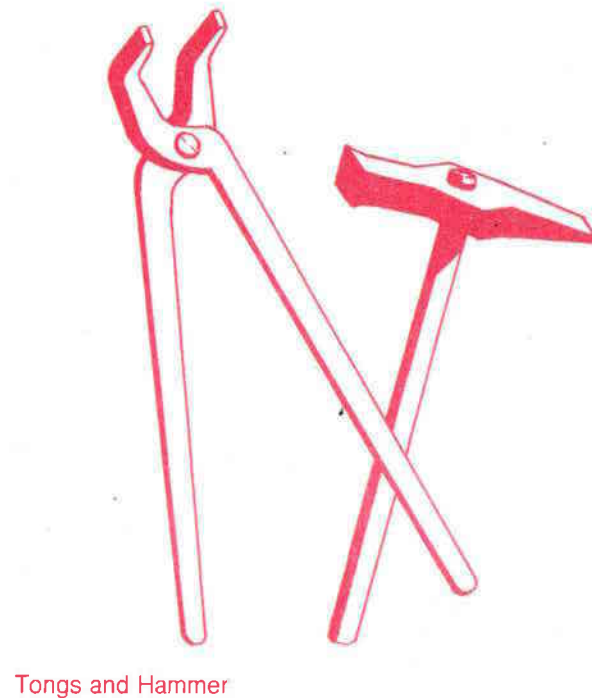
The earliest furnaces were simply clay lined depressions in the ground called bowl furnaces. The clay lining both limits the area of the furnace and inhibits heat loss. The ore is placed in the lower part of the bowl where it is kept in a reducing atmosphere and heated to over 1000° Celsius. To make the charcoal burn at this temperature a system of bellows has to be employed. The air jet from these, usually generated from a goatskin bag bellows or pot bellows, is directed into the furnace through a tuyère, a clay pipe



attached to a funnel. The use of such a funnel stops any back draught of hot gases into the bellows, a condition known as the 'Venturi effect'.

It is possible to smelt all the ores in this way but especially for iron an alternative system was devised to create even higher temperatures. This was the shaft or pipe furnace. In effect this was a thick walled clay shaft approximately one metre high with an internal diameter of c. 0.30m. The tuyère holes are set into the sides of the shaft just above the arched entrance which was possibly used for tapping off the slag or removing the final bloom of iron. This type of furnace enhances the bellows induced draught by virtue of its chimney effect.

In simple terms the objective of smelting is to heat the ore to a sufficiently high temperature in a non-oxygen atmosphere either to melt the metal from the ore like lead or to melt the impurities away from the ore like iron. After smelting the resultant metal has to be reheated to liquid state for alloying, bronze is a mixture of copper and tin, or for pouring into an open or closed mould, or to soften in order to beat and forge into an implement. The forging of iron in a charcoal furnace actually produces a mild steel end product.



A number of forging, smithing and smelting tools have survived from the Iron Age including anvils, hammers and tongs although such survival is rare simply because of corrosion. Crucibles, open and closed clay moulds are more common and indicate a remarkable level of craftsmanship. The closed mould is created by the 'lost wax method'. An original of the proposed object is carved in purified beeswax and then coated with finely prepared clay. Provision is made for pouring in the liquid metal and for the escape of hot gasses from the hardened mould. Before use the mould is gently heated to melt away the wax original. The resultant negative mould is only usable once since it is broken to release the metal cast thus making each object unique in its own right.

The log built structure which houses the metal working processes is based upon the typical Iron Age structures of Halstatt in Austria where iron working flourished in the early Iron Age. Parts of such buildings have been recovered in a remarkably good state of preservation from the Iron Age salt mines in the mountains above Salzburg.