

Practical  
**Blacksmithing and Metalworking**  
Second Edition



Percy W. Blandford

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## Introduction

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One of the longest established crafts known to civilized man has held its place of importance through all the changes of thousands of years, while civilizations have come, grown, and gone, and others have taken their place. The skills of the man who could work iron and steel were always needed, and the blacksmith always held an important place among his fellow men. The methods have changed little. Very early smiths mastered the principles and these still hold good today. Improvements are in detail. A smith described in the Holy Bible would be able to comprehend what was happening in a twentieth-century smith's shop, while a modern smith, provided only with the tools of 2,000 years ago, would know what to do with them and be able to achieve creditable results.

After thousands of years with little change, a good deal of change has come to blacksmithing in the last 100 years or so, due to the Industrial Revolution. When the automobile replaced the horse, a smith was no longer essential to the community.

So where does that leave us? There are still blacksmiths able to earn a living primarily from smithing, but most have to broaden their scope to embrace metalwork that was not previously considered their work. There are still apprentices to blacksmithing. There are still manufacturers of the necessary equipment, although a smith is in the fortunate position of being able to make most of his own tools. There is still a demand for wrought-iron work that shows the mark of individuality and does not obviously come from a factory where hundreds of similar pieces have been made. Above all, there is still a place for men or women determined to express themselves through craftsmanship.

Many people looking for a craft turn to wood, but not everyone wants to work wood or is capable of becoming a competent carpenter, wood turner, or carver. Much work

in metal requires a considerable investment in equipment, but blacksmithing as described in this book need not be expensive. A small portable forge and an anvil of modest size (not necessarily new) are the essentials, then a few tools lead the way to making more tools. Much material can come from scrap sources. What other people throw away can be recycled by a smith into things of use or beauty or both.

Working on the anvil is a mixture of physical effort and artistic application. There is always a lot of satisfaction to be obtained from physical effort properly directed. Blacksmithing also offers this advantage: If it does not come out right the first time, it can usually go back into the fire for another attempt.

Blacksmithing can be an adjunct to another craft. A mastery of hot iron allows the making of many things that can be used with other metal or wood constructions. The smith's metalwork will be a fitting companion to the projects of other branches of craftwork.

I hope this book will show the way to a great many potential blacksmiths who will come to enjoy their work at the anvil and, in doing so, carry on a great tradition.

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# **SECTION 1**

## **BLACKSMITHING**



# 1

## Blacksmithing Traditions

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When Stone Age man first succeeded in separating metal from ore and making something from it, blacksmithing was born. The first metals were impure copper with traces of other metals; these have become known to us as bronze. Men of the Bronze Age made tools and weapons from this comparatively soft metal, and these were much more successful and convenient than their crude stone implements. But it was not until they discovered how to obtain iron from ore that tools and weapons of adequate strength could be made. In the Iron Age man learned to use heat to fashion iron and the foundations of smithing that were laid then have not changed in principle today.

The first evidence of smithing by hammering iron was found in Egypt and dated 1350 BC. It is a dagger, believed to have been made by a Hittite craftsman. It is fairly certain that the Hittites invented tempering and forging, then they kept their ironwork techniques secret. The Hittite empire was overthrown about 1200 BC, and a large number of migrants spread throughout what is now Europe and the Middle East, taking their ironworking skills with them first to Greece and the Balkans. This early Iron Age was from about 800 to 500 BC. Then ironworking spread further west in Europe and to Britain, during what is often called the Late Iron Age.

If was combining iron with wood that made possible the cultivation and clearing of land and the use of wheeled vehicles. Iron also made better weapons for hunting and warfare. Considering this, the smith was an important member of every community. By later Biblical times the smith was using an air-blown fire to heat his iron, and working in ways not much different from smiths today.

The smith finds a place in classical mythology—Roman and Greek, as well as Aztec and Phoenician. In Roman mythology Vulcan, son of Jupiter, is credited with being the founder of smithing. According to the stories, he made the axle for the chariot of the sun and the gates of dawn. He forged the thunderbolts his father used. In Norse mythology, Loki gave power to Thor as a smith. Quetzalcoatl of the Aztecs brought skill in ironworking and other crafts to the people. A similar story goes with Tuba-Cain of the Phoenicians.

In many mythologies, the smith is ugly or evil. Such has been the treatment in some countries of smiths in more recent times, possibly because they worked with fire in semi-darkness—things that were associated with the devil in the minds of superstitious people. Smiths were important in medieval times with the need for armor and weapons, but in some places they were almost outcasts. This did not apply everywhere; there are records of kings working with their favorite armorers. It must have made sense to take part in the production of something that had to be relied on to preserve life. Some smiths were artists in metal and proof of this is seen in surviving gates and other ornamental wrought-iron work (Fig. 1-1).

You might have noticed that the name of the craft has been given as *smith* and not *blacksmith*. The family name *Smith* indicates how many people were once concerned with the craft of smithing. Smiths in earlier times did all kinds of metalworking, as it was needed. Later developments brought specialists in working lead and other metals. In particular, the worker in lead became known as a *whitesmith*, so the worker in iron



Fig.1-1. This medieval anvil without horn or holes was probably used by an armourer.

became known as a *blacksmith*. That is the usual name today for anyone who uses heat and hammer to shape iron or steel.

To many people the name includes the craftsman responsible for the making and fitting of horseshoes. Strictly speaking, that craftsman is a *farrier*, although most smiths in the days of the great use of horse transport were also farriers. However, there was and there still is a distinction, and not every farrier or blacksmith could do the other man's job. There were other specialist smiths. A chain smith forged links in a chain. A nail smith (often a woman) did nothing but make nails. Today a blacksmith, whether professional or amateur, can expect to do all kinds of smithing and may need a knowledge of horseshoeing as well.

In the days when most countries depended on a rural economy, there was a blacksmith's shop wherever there was a cluster of dwellings. His customers were the farmers and workers who lived nearby. He probably farmed a piece of land himself. A comparable life was led by the village carpenter. Quite often they had adjoining shops and certain implements needed on the land or some piece of equipment to be used in a house would be a combined effort. Wagons and carts required both skills. In later years the wheelwright became a specialist craftsman, leaving the carpenter to other woodworking. There are many places in Europe where it is still possible to see the stone base (probably an old millstone) on which the blacksmith and the wheelwright worked together to assemble a wheel and draw the parts together with its iron tire.

There would also have always been blacksmiths working in towns, and some of them would have specialized in making gates and other wrought-iron work. There would have been armorers who made weapons as well as armor. Smiths were also employed on the great estates attached to feudal castles, and worked with other craftsmen on ecclesiastical buildings and furnishings.

Like most other craftsmen, blacksmiths were their own masters and independent, depending on payment from customers. Work might be done by barter for a share in the crop at harvest time or in return for some service rendered. These methods continued until the Industrial Revolution, not two centuries ago, when factory production began to replace the work of individual craftsmen. This affected blacksmiths in the same way as others who had enjoyed the independence of their craft. The need for individual smiths diminished, but many smiths were able to find places for their skills in industry. Many became factory workers.

The use of steam and other power introduced processes and techniques that would have been beyond the smith and his helpers, who had only their muscles for power. Gas and electric welding made possible the fabrication of parts that would have previously involved lengthy and laborious work at fire and anvil. Mass production had taken over and people had no use for the one-off products from the smith or other craftsman that cost more than the factory-made products.

Of course, horses were still being used at this time, and there was still need for rural smiths. The use of working horses did not really decline rapidly until the end of World War I. By then, the internal combustion engine in vehicles—particularly tractors—took the place of horses. Those smiths who wanted to maintain their independence had to broaden their scope. Some learned to maintain motor vehicles or they became agricultural engineers, with blacksmithing only a part of their activities.

Blacksmithing as a craft is no longer in great demand for its practical applications. Much of what a smith did for purely utilitarian purposes in the past can now be done more effectively by other means. However, there is still the need for a one-off product that would be better made by smithing, and there is still a place for the artist blacksmiths who can create wrought-iron work in a way that mass production cannot. There is no longer a need for a blacksmith in every community, but there is still a place for those who treat blacksmithing as a means of using craft skill in the same way that others may hammer a copper bowl, make furniture or pottery, carve wood, or weave a basket. Whether they do this for profit or just for the love of a craft, they will get a tremendous satisfaction out of forming iron, and carrying on one of the oldest crafts.

## DESIGN

Throughout most of history the majority of blacksmiths were concerned with producing implements for use. Design work was often directed toward making the thing as suitable as possible for its intended purpose; appearance was of secondary importance.

Sword hilts and similar items were decorated with cuts and punchings. Other products often obtained any artistic effect from their layout and proportions. The art of the blacksmith is geared more to large items than small ones, and the artistic ability of individual blacksmiths can be seen in railings, gates, screens, and ecclesiastical decorations. On a smaller scale were locks and hinges, where iron was wrought to shape and decorated with cuts and stamping.

There are still in existence in Europe elaborately scrolled hinges with rather rudimentary surface decoration made with punches. Twisting strip metal into scrolls is a feature of much early wrought-iron work.

Blacksmiths concerned with decorative ironwork were influenced by the Gothic style in architecture. In the 15th century tracery intended for stone was repeated in iron, sometimes more effectively. This continued into the 16th century, when much cast iron came into use.

Up to this stage, design was the concern of the individual. There are some surviving examples of excellent work, but not of any sort of design standard. This was also true in woodworking, particularly furniture making. Craftsmen might have copied good ideas from each other, but designs were comparatively local. The printing press altered this. Chippendale and other great furniture designers and makers published pattern books and other furniture makers were able to produce chairs, tables, and many other things to these designs.

Almost the same thing happened to decorative blacksmithing. A Frenchman named Jean Tijou was called to England to work under architect Sir Christopher Wren on the ironwork for the royal palace at Hampton Court, alongside the River Thames to the west of London. He was an outstanding designer of ironwork and a very skilled blacksmith, with techniques that were mostly new to English craftsmen. He was at work on the palace ironwork in 1690 and he remained in England to publish designs in 1693. These were used by blacksmiths all over the country, and spread via immigrants to America. Much of his work was rather elaborate and flamboyant. English smiths modified his style to give a more restrained effect (Fig. 1-2). However, Tijou can be credited with having raised wrought-iron work to classical perfection. His influence can still be seen today.



Fig. 1-2. This ornate example of early smith's work is a bell pull.

## 2

# Iron and Steel

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Almost all blacksmithing is done with iron and steel. None of the other common metals can be fashioned by hammering after heating in the same way. Iron is the base metal from which steel is derived. Iron ore is the source; iron as iron and steel has to be obtained from ore by heat. Fortunately, iron is plentiful: much of this earth is composed of iron. In some places the best ore has been used, but improved methods allow iron to be obtained from inferior ore. There is no fear of iron production coming to a halt because of shortage of supplies. The world supply seems inexhaustible.

When primitive man discovered how superior iron was to the previous bronze and stone for his weapons, tools, and implements, he must have tried many ways of building up sufficient heat to extract the desired iron from the ore. The wind might have been directed through channels in the side of a hill to a pit containing the fire and ore. Where there was no suitable hill, a stone and earth tower might have been built to contain the fire and ore, with a draft hole for the prevailing wind to enter. Early fires would have been fueled by wood and later by charcoal or coal. Bellows were developed to produce the draft and remove the dependence on a fickle wind. At the end of the process, the fire was raked out and the iron brought out of the bottom of the pit. Quality could not be controlled; luck decided what could be used for tools and what might have to be discarded or used in its cast form. Iron produced in this way would have contained many impurities, and to be suitable for smithing it has to be reasonably pure. An excess of impurities causes brittleness and other faults.

Modern iron is produced from furnaces that have developed primitive fires into great industries. What first comes from these blast furnaces is called pig iron. This pig iron

contains a great many impurities in small quantities. It may be about 95 percent iron, with up to 4 percent carbon and the remainder including such things as silicon, sulfur, phosphorous, and manganese. The impurities have a considerable effect on the quality and characteristics of the iron.

## **CAST IRON**

Cast iron is made from pig iron by remelting it and pouring it into molds. Its quality can be controlled by varying the contents and by cooling rapidly or slowly. It is possible to make ductile cast iron by a further process, but this is still unsuitable for smithing. Cast iron in its many forms is used extensively for machine parts, many domestic articles, and anything where weight and bulk are wanted or acceptable. The shape cannot be altered by heating and hammering. Ductile cast iron can be machined successfully, and this is the material used for parts that are turned or otherwise formed with cutting tools. Some decorative work is done in cast iron. Cast iron contains 2 percent to 4 percent carbon, plus whatever other elements are present in smaller quantities.

## **WROUGHT IRON**

Wrought iron has been favored by smiths throughout nearly all of ironwork history. It is produced by refining and rolling after further heating the first pig iron, so as to reduce the carbon and to remove most of the impurities. The resulting iron that has been rolled to produce strips has a fibrous nature that makes it particularly suitable for shaping by hammering. It is the most tough, ductile, and malleable form of iron. It also has a greater resistance to corrosion than most other types of iron. The first light rusting forms a protective film that reduces further corrosion.

Unfortunately, wrought iron is no longer readily available. It has been replaced by mild steel, which is iron with a small amount of carbon in it. For structural work, machining, and general engineering, this is a superior material. It is not however, as satisfactory for blacksmithing. Today there is very little wrought iron produced, and anyone engaged in blacksmithing has to use mild steel. This is fine for many uses, although mild steel is not as amenable to fine work because it is more difficult to weld by the smith's method.

The amount of carbon in mild steel does not affect its hardness, and there is no way that heat treatment can have any appreciable effect in hardening or softening it. If the proportion of carbon is increased, the characteristics of the steel are altered. If the carbon content is about 2 percent, this is high carbon or tool steel. Steel with this amount of carbon can be made harder by heating and quenching, in the processes of hardening and tempering described later. Another heat treatment removes the hardness. It is this steel from which tools are made by a blacksmith. It will make springs and was used for parts of armor.

The traditional blacksmith found that wrought iron and tool steel fulfilled all his needs. The modern smith has to use mild steel instead of wrought iron for much of his work. Although there are now many special steels available, it is still advisable for a smith to only use ordinary high-carbon steel for tools. Some of the other steels—which have been alloyed with small quantities of other metals to give special qualities and are used for some industrially-produced tools—require special precise heat treatments with equipment the ordinary blacksmith would not have available.