

strain or cold hammering. This falling off in a perhaps unnecessary degree of hardness was more than compensated for by the metallic plasticity which rendered the manufacture of the new weapons much easier and consequently made a much greater output possible.

Long afterwards came the Iron age. But who shall pretend to differentiate between the Iron and the Steel Ages? Roscoe and Schorlemmer quote from Pope's translation of Homer's *Odyssey* the following lines:—

And when as armours temper in the ford
The keen-edged pole-axe or the shining sword,

and they very truly comment, "These remarks evidently apply to steel, as wrought iron cannot be thus tempered." Nevertheless, the use of such steel (probably of the kind now called "natural" or "puddled steel") was confined to cutting implements and knights' armour, and was unknown for structural purposes. This age, this very modern age, has been until quite recently dominated by those metallurgical products known as cast and wrought irons. For instance, to go back only to the 19th century, one of the fine bridges spanning the Tyne at Newcastle was built of cast iron, whilst Telford's delicate yet majestic and even awe-inspiring structure over the Menai Straits is almost entirely constructed of wrought iron.

The second cause which shrouded in obscurity the beginnings of the marvellous development of Sheffield—now, so far as quality is concerned, the first steel centre in the world—is in the writer's opinion to be found in the fact that iron and steel workers have from the first had a tendency towards secrecy and consequently an aversion to any written records of the methods by which they wrought, carburized, and bent to their wills that stern metal called iron. It is worthy of note that this reticence is not confined to the white man. In Zululand the iron, "steely iron," or "puddled steel" workers, who have certainly for about two centuries made the assegai heads of the warlike Kaffirs of their race, including those for the legions of the mighty Chaka, have preserved as family secrets the methods by which in their peripatetic wanderings round the iron ore belt of Zululand they have made for their fellows the heads of their weapons of war. Consequently an unfortunate writer of fact has to rely upon tantalizingly brief references in the poets and the ecclesiastical records of the Middle Ages for data upon which to found more or less trustworthy metallurgical history in an article like the present.

No mention of the iron industry of Sheffield is made in *Domesday Book*, though at Bradfield (near Sheffield) Hunter has recorded that Roman coins were found in the midst of a mass of iron scoria. The records of the monks of Kirkstead Abbey show that at Kimberworth (near Sheffield) they had "pretty extensive" iron works—viz., two plants for smelting the ore and two for working the reduced iron into bars. These works were obviously making wrought iron from the somewhat manganiferous ferrous carbonate (or clay ironstone) containing about 0.25 per cent. of phosphorus which occurs in the district. The fuel would be charcoal, since the country round was amply wooded. At the present time in outcrops of ore to the east of Sheffield can still be seen hundreds of workings where the monks had dug down for ore until stopped by an influx of water.

Probably the earliest reference to Sheffield blades is made by Chaucer in "The Reve's Tale" (1386). It is therefore quite evident that even in those days of difficult communication the fame of Sheffield knives was well known in London. It seems reasonable to suppose that these blades were of fine steel. Indeed, in 1590 Peter Bales in the "Writing Schoolmaster" recommends Sheffield razors and penknives for cutting quill pens.

What, then, was the source from which the Sheffield steelworkers of the 14th century obtained their steel? Its reduction from local ore seems very unlikely, as such fine steel could hardly be made from phosphoric ores. It is significant in this connection that in 1442 the Royal assent was given to a petition asking authority to render the Don navigable by making tow-paths. The Don strikes the Humber at Goole, and this suggests that basis materials were being imported over sea. It is quite certain that in 1557 Spanish and Scandinavian irons were being imported into Sheffield. The following extract is from the accounts of the church burgesses of Sheffield for that year:—"Paid to Robert More for one stone and quarter of Danske Yron XXIIId. Paid to ye same Robt. for X lib of Spanysche Yron XV." Hence "100" of Spanish iron cost 14s., whilst "100" of Danish (probably Swedish) iron cost 12s. In other words, the imported iron would in our present money cost about 146s. per cwt. The iron must therefore have been of surpassing quality, and such a costly basis metal would not have been imported if locally made irons could by any possibility have been employed for steel-making.

Hunter in his "Hallamshire" (p. 165) states that previous to 1615 Sheffield workmen could only make armour for the common soldiers. Knights' armour was always brought from abroad. That arch-antiquarian, Sir Walter Scott, had evidently come to the same conclusion. In "Ivanhoe," when he is describing the siege of Torquilstone (in the vicinity of Conisbro', near Sheffield), occur these words:—"Thrice did Locksley bend his shaft against De Bracy, and thrice did his arrow bound back from the knight's armour of proof." "Curse on thy Spanish steel coat," said Locksley; "had English smith forged it, these arrows had gone through an ass if it had been silk or sendal." There is little doubt that Scott located the opening scene of "Ivanhoe" near Woodhouse, about five miles to the eastward of Sheffield. Until quite recently wrought iron works known as the Rotherwood Iron Works were in operation at Woodhouse mill near the very site selected by Scott as a location for the homestead of Cedric the Saxon.

It is customary for writers who have made little or no research to assert that the reason why the steel industry originally developed round Sheffield was the proximity of beds of ore and of coal. But it has been already shown that the local ore was useless for the production of fine edged steel, and there is no record of coal having been employed until the time of Dud Dudley in the 17th century, three hundred years after Sheffield had firmly established her steel fame. Why, then, did the fine steel industry concentrate itself round what is now the premier city of Yorkshire? In the writer's mind there is no doubt that the main factor involved is the situation of the city itself. It lies at the confluence of four valleys, each having its small river—viz., the Sheaf, the Porter, the Loxley, and the Rivelin. All these rivulets fall into the river Don, which flows through the city. Each river has its own watershed, and runs throughout the year. Thus from Saxon times onward the steel artificers could get power for their tilt-hammers and grinding wheels at a nominal cost, and this fact constitutes the main reason why Sheffield hundreds of years ago became the centre of the cutting steel industry. A well-known Sheffield antiquarian, Mr. Thomas Winder, has produced convincing evidence, gathered by him from *Domesday Book* and other ancient documents, that the modern name Sheffield is the altered form of its original name "Escafeld," meaning "Field of Waters." In addition the carboniferous sandstone of the district still makes excellent grindstones, and refractory materials, such as ganister and fire-clay, are locally abundant.

It is certain that previous to the middle of the 17th century all Sheffield steel was of what may be termed plastic