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IRON INDUSTRIES.

BY HENRY PRICE.

Every person knows the manifold uses of iron. It is capable of being cast in molds of any form; of being drawn into wires of any desired strength or fineness; of being extended into plates or sheets; of being bent in every direction; of being sharpened, hardened, or softened at pleasure. It accommodates itself to all our wants, our desires, and even our caprices. It is equally serviceable to the arts, the sciences, to agriculture and to war, the same ore furnishes the sword, the plough-share, the scythe, the pruning-hook, the needle, the graver, the spring of the watch, and the spring of the carriage, the chisel, the chain and the anchor, the compass, the cannon and the bomb. It is a medicine of much virtue, and the only metal friendly to the human frame.

A brief account of the manufacture of this metal in the early ages of the world's history, and in later times in those mother countries to

which we owe our own familiarity with the iron industry, should be of great interest to us.

THE EARLIEST USE OF IRON.

The oldest written history we have which is generally admitted to be authentic, is contained in the historical and prophetic books of the Old Testament, and in these we find frequent reference to iron and its uses. In the fourth chapter of Genesis occurs the well-known reference to Tubal-Cain, who was an iron worker. In the book of Job, which is supposed to relate to a period between Abraham and Moses, iron and steel are both mentioned. In the history of the wanderings of the children of Israel, who left Egypt about 1500 years before Christ, iron is frequently mentioned. The Egyptians in the days of Moses were undoubtedly familiar with the use of iron, and it is very probable that they were at this early period engaged in its

manufacture. Iron works certainly existed in Ethiopia and Arabia at a very early period. An iron sickle has been found under the feet of one of the Sphinxes of Karnak, and a piece of iron was taken, in 1837, from an inner joint of the great Pyramid at Gizeh.— Both of the relics are in the British Museum. Iron ornaments, iron armor, and various tools of iron have been found in the ruins of Nineveh, and iron ornaments have been found in Chaldean ruins. Inscriptions referring to the use of iron, have been found in Chaldea, and at Nineveh.

The Chinese claim great antiquity for the manufacture of iron and steel in their country. India with equal show of authority traces its iron industry, its manufacture of the celebrated Indian steel to a period before the christian era. In the ruins of the Indian Temples which were built during that period, large wrought iron beams have been found; and there is now standing at Delhi a wrought-iron pillar of great size, which is proved to have been forged as early as the beginning of the fourth century after Christ.

Damascus, the capital of Syria, was famous for many centuries after the beginning of the christian era for its swords, which were made of Indian and Persian steel.

It is clear that Asia, the birth place of the human race, and the African territory contiguous to, if not including Egypt, produced iron in the earliest ages of the world's history.

THE EARLY USE OF IRON IN EUROPE.

The earliest reference to the manufacture or use of iron in any Eu-

ropean country, we find in the Grecian fables which had their origin long before the beginning of authentic Grecian history in the eighth century before the christian era.

Homer frequently mentions both iron and steel. Hesiod refers to iron. And the story of Lycurgus requiring the Spartans to use iron as money is well known. Homer, Hesiod, and Lycurgus belong to an uncertain age of Grecian history, not later than the eighth century before Christ.

After this period the use of iron in Greece and its manufacture both on the mainland and on some of the islands of Greece can be definitely traced. Boeotia on the mainland, and the island of Euboea were centers of great activity in the manufacture of iron at an early day. The iron ores of Elba were worked by the Greeks as early as the beginning of the eighth century before Christ, and it is an interesting fact that these ores have been used in blast furnaces of Pennsylvania.

The finest edge tools were made of steel from these ores by the Greeks in the fourth century before Christ.

It is probable that Spain followed Greece, among European countries in acquiring a knowledge of the use and the manufacture of iron. To-day whatever prominence its iron industry possesses is derived from the large shipments of Spanish iron ores to Great Britain, Germany, the United States and other countries.

In the first and second punic wars, the Romans made use of iron in their attacks both by land and sea. The Roman Battering-Ram which was borrowed from the Greeks, had a head of iron, and its

beam was strengthened with iron rings. It was used by the Romans in the siege of Syracuse in the year 212 before Christ. Prior to this time tools of iron and steel were in common use among the Romans. At the beginning of the christian era, iron was in general use throughout the Roman empire, which then embraced almost the whole civilized world. It is proper to state in this connection that iron and steel were not extensively used as weapons of war until the third or fourth century before the christian era, although used in a limited way for this purpose before that period. As late as the second century before Christ the helmet and armor of the Roman soldier was made of bronze, but his sword was a cut and thrust blade of Spanish steel. At the battle of Cannæ in the year 216 before Christ the Romans learned from the Carthagenians at a very great cost, the value of the Spanish sword.

About this time the manufacture of the celebrated Toledo blades was established, and it has been continued until the present day. The country immediately surrounding Rome did not contain iron ore, but in the northern part of Italy just south of the Alps, iron was made by the Romans in the first and second centuries before Christ.

In the first century* of the christian era iron was made in Hungary. Iron slag has been discovered in Hungary at a depth of about one foot from the surface of the ground, and in the midst of the most beautiful vineyards.

France undoubtedly made iron centuries before the christian era, but from what we know of the present character of its iron resources,

it was probably not so prominently engaged in the manufacture of this metal as its neighbor, Spain.

It is historically established that the Gauls confronted the Romans with iron weapons several hundred years before the christian era, and Julius Cæsar frequently refers to their use of iron in his wars with them. He says that the Veneti who inhabited the southern part of Britany, used iron spikes in fastening the benches of their ships, and that their anchors were attached to iron chains.

Iron was made in Belgium in the time of Julius Cæsar and subsequently. In the tenth century the valley of the Meuse was actively engaged in its manufacture, and in the twelfth century we are informed that iron was made to perfection in the Netherlands.

Great Britain which is now and has long been the foremost iron-making country in the world, does not appear to have either used or manufactured much iron at the time of the invasion by Julius Cæsar, in the year 55 before Christ. Cæsar says of the Britons that they used either brass or iron rings determined at a certain weight as their money. He nowhere mentions the use of iron weapons of war by the Britons. After the Romans had established their authority in Britain the manufacture of iron was gradually extended into many districts of the country, and it was prosecuted with more or less activity under the Anglo-Saxons and their successors. But it was not until the close of the seventeenth century that Great Britain became the leading iron-making country.

Down to that period it is proba-

ble that Spain first, and Germany afterwards had occupied this position. The prominence of Great Britain was achieved mainly through the introduction of mineral fuel, and more powerful machinery, in these improvements taking precedence over all other countries.

THE EARLY PROCESS IN THE MANUFACTURE OF IRON.

The methods employed in the manufacture of iron in the early ages of the world's history, and of which we have any positive knowledge, were exceedingly simple. Wood in a charred or uncharred state was the only fuel that was used in smelting iron ore, or in refining iron itself, down to so late a period as the second quarter of the last century. The primitive furnaces or more properly bloomeries, were sometimes small excavations in the ground, and sometimes low structures above the ground and built of clay or stone. The blast was in some instances supplied by the winds of heaven, elevated positions being usually selected when this agency was relied upon. In other instances it was supplied by bellows, or log cylinders of wood or bamboo having valves and pistons, and worked like a pump.

When bellows were used they were made of goat skins or of skins of other animals, and were worked by the feet or hands. Homer mentions the use of twenty pairs of bellows in forging the shield of Achilles, and as so many were used the bellows must have been small.

The manufacture of iron without the use of artificial blast still exists in Burmah and this method was employed in Belgium and England about the time of the christian era

as is proved by modern discoveries of the remains of ancient iron works in these countries. The same method was in use for smelting lead in Derbyshire, England in the seventeenth century. Goat skin bellows are in use in India and in the interior of Africa to-day. Blowing cylinders of wood or bamboo are in use in India, China, Japan, Borneo and Madagascar, both these means of producing blast being applied to low furnaces or shallow excavations. In 1760 John Smeaton, an Englishman, invented the cylindrical cast iron bellows and nine years later the steam engine which had in the mean time been perfected by James Watt, a Scotchman, was used in supplying the power to Smeaton's cylinders. Down to this period water power was exclusively used in operating the leather and wooden bellows. These tubs have been in use in the State of Pennsylvania within the recollection of the writer of this article.

All steel that was made in Europe down to a few hundred years ago was made in the Catalan forge directly from the ore or in a refinery from pig iron. The conversion of bar iron into blister steel by the cementation process, an invention which doubtless originated in Germany, was next generally introduced, and about the middle of the last century Benjamin Huntsman, an English clock-maker, invented the process of manufacturing steel in crucibles, the more important of the Bessemer process, and the open hearth belongs to our time.

THE MANUFACTURE OF IRON IN THE AMERICAN COLONIES.

The aboriginal inhabitants of America do not appear to have

been familiar with the use or manufacture of iron. The inhabitants of Mexico and Peru were unacquainted with the use of iron at the time of the Spanish conquest, copper serving them as a substitute.

The first mention of iron in connection with European settlements within the United States, occurs in Thomas Horiot's history of the expedition fitted out by Sir Walter Raleigh and commanded by Ralph Lane, which made, in 1585, on Roanoke Island, in North Carolina, the first attempt to plant an English colony on the Atlantic coast. This expedition discovered iron ore on the main land, in two places at least, as stated by Horiot, but as the colonists soon quarreled with the Indians and returned to England, the ore was allowed to remain in the ground undisturbed. In 1607 the first permanent English colony in the new world was founded in Jamestown, Virginia, and in 1608 the company's ship, commanded by Christopher Newport, sailed from Jamestown for England, loaded with iron ore and other products of the country. This ore was smelted in England and produced iron of a good quality. It was undoubtedly the first iron made by Europeans from American ore. In 1619 the founders of Jamestown sent to Virginia a number of persons "to set up three iron works" in the colony. The enterprise was undertaken that year on Falling Creek, a tributary of the James River, which it enters from the south about sixty-five miles above Jamestown and about seven below Richmond. In 1620 the works had been so far completed that "proof of good iron ore" was

made, but from various causes further progress was delayed. In 1622, when the works had probably been entirely completed the colony was visited by an Indian band which destroyed the works and killed the workmen. This disastrous pioneer enterprise probably embraced a blast furnace and a refinery forge. Almost a hundred years elapsed before another attempt was made to make iron in Virginia. Soon after the Pilgrims and Puritans settled in Massachusetts, iron ore was found in various places, probably bog ore. In 1642 specimens of bog ore from Lynn were taken to London, and in the same year a company was formed to establish iron works at Lynn. In 1645 a blast furnace had been erected at Lynn, and in 1648, a refinery forge had been added. The works at Lynn continued in operation for many years, the furnace making castings and pig iron, and the refinery converting the latter into bar iron. These works were the first that were successfully established in America. For more than a hundred years after its settlement in 1620, Massachusetts was the chief seat of iron manufacture on this continent, the industry being confined to its eastern countries. In 1676 the first iron was made in New Jersey, which was made from bog ore. In 1710 a rich deposit of magnetic iron ore was found in northern New Jersey, in Morris county. A bloomery was erected. This forge was speedily followed by many others. At the beginning of revolution, New Jersey was a large producer of iron, and much reliance was placed upon its iron resources throughout the subsequent struggle. No State in the Union has devoted as much attention to the

manufacture of iron in Bloomaries as the State of New Jersey. In 1802 the State had 150 forges, nearly all of which were Bloomaries, but their total annual capacity was only 3000 tons of bar iron.

New York became engaged in this great enterprise in 1740. The first iron was made on Ancran creek in Columbia county. In 1756, furnaces were erected in Orange county. The charcoal used was carried on the back of horses.

The manufacture of iron in Pennsylvania was established in 1716. Sir William Keith, then Governor of Penn's province established iron works on Christiana creek in New Castle county.

About 1715 the iron industry was revived in Virginia by Colonel Alexander Spotswood and others. Colonel Spotswood was Governor of the colony from 1710 to 1723, and in the first year of his incumbency of the office, he called attention to the value of the mines of iron ore which had recently been discovered at the Falls of James River. The first furnace the Colonel erected was built of stone. Another furnace, in which Colonel Spotswood was interested was situated about 25 miles south-west of Fredericksburgh. This furnace was built of brick, and was blown by two mighty pairs of bellows. The limestone used at this furnace was brought from England as ballast. Their water wheels were 26 feet in diameter. The pig iron was taken to a forge in Cecil county, Maryland, where it was converted into bar iron. As late as 1732 there was no forge in Virginia.

The iron industry commenced in North Carolina as early as 1728 when a small quantity of pig iron

was exported to England from this colony. In 1734 a small quantity of her iron was also exported. It is a curious fact, illustrative of the lapsed enterprise of North Carolina in the manufacture of iron that it partly supplied New York with hoes before the revolution, as did also Virginia.

South Carolina does not appear to have made iron until 1773, when iron works were erected by Mr. Buffington, in the north-west part of the colony. These works were however destroyed by the Tories during the Revolution. It has no iron industry, though it has iron ore.

Georgia has no colonial iron history, and we do not hear of any iron being made within its borders until 1810 where there was a bloomary in Warren county, a forge in Elbert county, and a nailery in Chatham county. These enterprises were on, or near the Atlantic coast. Since 1810 the iron industry of Georgia has been slowly extended.

RESTRICTION BY THE MOTHER COUNTRY IN THE COLONIES.

In 1750 it prohibited the erection in the colonies after that date, of any mill, or other engine for slitting or rolling of iron, or any plating forge to work with a tilt hammer, or any furnace for making steel. Every such mill, engine, forge, or furnace erected in violation of this prohibition being declared a common nuisance, to be abated by every Governor, Lieutenant Governor, or Commander-in-Chief of any of his Majesty's colonies in America. This action by the mother country was intended to compel the colonists to buy their

nails, hoops, blister-steel, &c., in England.

INTRODUCTION OF COAL IN THE MANUFACTURE OF IRON.

About 1840 an important revolution in the manufacture of iron occurred in this country by the introduction of anthracite and bituminous coal as a substitute for charcoal. Anthracite was the first to be largely used in American blast furnaces, and for many years after its adaptability to the smelting of iron ore was established, it was in greater demand for this purpose than bituminous coal. In recent years the popularity of these two fuels has been reversed.

Pennsylvania was the first State to make use of the anthracite in the manufacture of pig iron, and it was also the first to use bituminous coal for this purpose. In 1838, William Lyman, of Boston, made the first attempt to manufacture iron by the use of anthracite coal, and was successful for 100 days. For this achievement a premium of \$5,000 was paid to Mr. Lyman by Nicholas Biddle and others. This furnace did not long continue in operation.

In 1839 and 1840 a furnace was built at Catasauqua in Lehigh Co., and was successfully blown in by Daniel Thomas on the third of July of the latter year. This furnace continued in operation for many years under the management of Mr. Thomas. From its erection may be dated in a commercial sense the beginning of our anthracite pig iron industry. David Thomas was a native of South Wales. In 1835 William Fetherstone was successful in making good gray forge iron for one month at the end of a blast at Mary Ann

Furnace, in Huntington county, Pennsylvania, with coke from broad top coal.

This was the first pig iron made in the United States with this kind of fuel. Mr. Fetherstone was a native of Shropshire, England. In 1837 a small quantity of coke pig-iron was made by T. H. Oliphant, at his furnace called Fair Chance, near Uniontown, Fayette county, Pa. This was the first pig iron made with coke from the now celebrated Connelsville coke region. But coke did not come rapidly into use, as many experiments were attended with loss. It was not until after 1850 that its use began to exert an appreciable influence upon the manufacture of pig iron. In 1849 there was not one coke furnace in blast in Pennsylvania, but in 1853 there were 21 in that state and 3 in Maryland. Experiments in the use of uncoked coal in the blast furnace were made in Maryland, western Pennsylvania and Ohio as early as 1840; but the first successful use of this fuel was at Clay Furnace, Mercer county, Pa., in 1845, the furnace being operated by Hemrod and Vincent. The coal used was the now well known splint or block coal of the Shenango Valley. Mr. David Hemrod undertook and successfully accomplished the experiment. In the following year Messrs. Wilkeson, Wilks & Co. built Lowell Furnace in Poland township, Mahoning county, Ohio, expressly to use block coal, and on the 8th of August, 1846, this furnace was successfully blown in by John Crowther. Mr. Crowther was born in Shropshire, England.

David Thomas, of Catasqua, Pa., was the first person in the United States to fully realize the value of powerful blowing engines in the

working of blast furnaces. About 1852 he introduced engines at his furnaces in Catasqua, which increased the pressure to double that which was then customary in England. The results were surprising; but many years elapsed before Mr. Thomas' example was generally followed in this country. Within the past few years the superior results attained by our blast furnaces have been mainly due to the use of blowing engines of great power.

PERSONAL RECOLLECTIONS.

The author of this paper came to Pittsburgh about the year 1833. He recollects many incidents of the "Smoky City;" he saw the first rolling mill that was built there; it was about the beginning of the present century and continued in operation up to 1846, and possibly later. In that year I left the city, only making it an occasional visit since. This mill in my recollection was owned by R. Bowen, and was located on Penn street and an alley, the name of which I have forgotten. The second mill was the Union, on the Monongahela River. It was built by Beltzover, McNeekle & Robinson, about the year 1820. It was accidentally blown up and was dismantled and taken to Cincinnati, Ohio.

I remember the mill as though I saw it yesterday. What a contrast the machinery of that and the mill that is built on the same site—the old mill with its engine covered with grease, standing on end with its ponderous wooden walking beam, attached to the engine at one end by a pitman and at the other by a pitman to the driving wheel.

About the year 1833, or 1834 I saw the first blast furnace that was built in what is now the city of Pittsburgh. It was a failure for want of ore convenient to the furnace. There was nothing remaining except the stack, which was built round. The furnace was located on Two Mile Run, on the Monongahela River, near what is now called Lock No. 1.

I recollect seeing a primitive furnace in operation in Fayette county, Pa. I think it was the first ever built in that county. It was called Oliphant's Furnace. The blowing tubs were made of wood; I think they were bound with iron hoops, though they may have been wooden hoops. Having been in the habit of playing in streams of water and putting up little water wheels and drawing light weights on the ground by attaching a thread to the small shaft, the water wheel attracted my attention. I will try to describe it as it was. It was an over-shot wheel; crank, wrist and stop joint were made of wood; there was a blowing tub at each end of the water wheel and the screeching noise of the wooden tubs could be heard for more than one mile. I crossed the Allegheny mountains on foot at the age of eight years to the town of Brownsville on the Monongahela River. I rode on the first steamer that plied on the Monongahela between Pittsburgh and Brownsville. It required two days to make the trip. The steamer would remain all night at Williamsport, now Monongahela City, for the passengers to get supper, bed and breakfast.