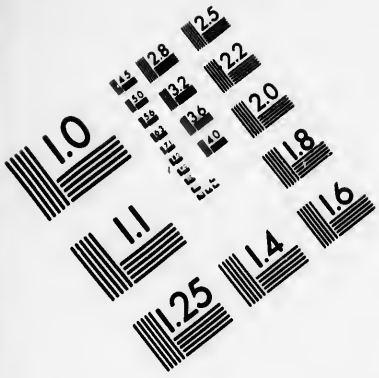

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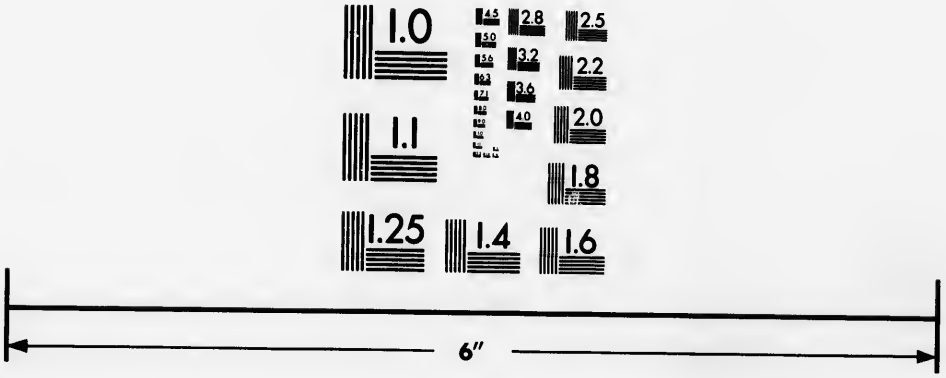

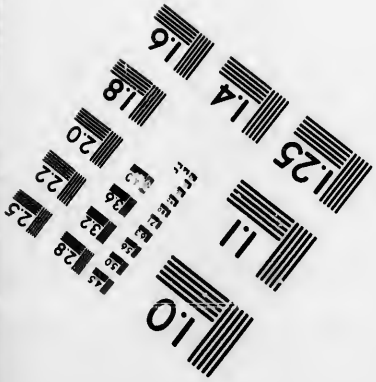

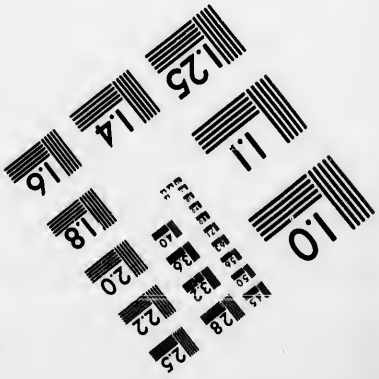

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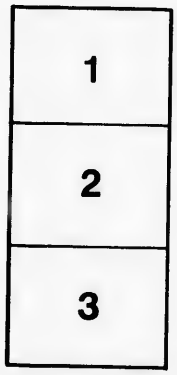

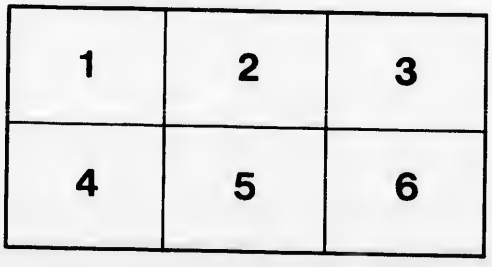

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IRON AND STEEL.

A Brief Historic Sketch of their Manufacture and Use.

A PAPER READ BEFORE THE HAMILTON ASSOCIATION, MARCH 23, 1882, BY A. T. FREED.

It is customary to speak of the stone, the bronze and the iron ages of the world, as if they were distinctly marked epochs. It is a mistake so to regard them, for whilst our fathers undoubtedly abandoned stone weapons and implements for bronze, and bronze for iron, the change took place at widely remote periods in different countries, and the periods in which the several materials were used in the same country overlapped each other. National intercourse was slow and restricted in the early ages of the world, and one nation would be in full possession of an important discovery long before another not distant nation had heard of it. The bronze age had come and gone on the shores of the Mediterranean, and iron was in general use while as yet the Skandinavians and Britons were rudely carving deers' horns with flint knives and destroying their enemies with bludgeons. In the vast host which Xerxes led in to Greece were warriors bearing stone weapons, while the great majority were armed with bronze and a few had advanced to the use of steel. So that to speak of the ages of stone, of bronze and of iron is as indefinite as if we should divide history into ages of absolutism, limited monarchy and republicanism.

The dawn of history found iron in limited use. Chinese historians say that it has been employed in their country for many thousands of years. Pliny the elder, in the early days of our own era wrote that, "as many kinds of iron as there be, none shall match in goodness the steel that cometh from the Seres, for this commodity also, as hard ware as it is, they send and sell with their soft silks and fine furs. In a second degree of goodness may be placed the Parthian iron." India has made steel of the finest quality from times immemorial; and the method which was in use in prehistoric times is observed there to this day. A small clay crucible is made in which not more than two or three pounds of very fine soft iron are inclosed together with charcoal, and covered with leaves of a certain plant, when the whole is subjected to great heat till the iron is melted and the result is a button of very fine and pure steel which they call wootz. When Alexander defeated Porus, the latter gave the conqueror 30 pounds of this steel, which was highly prized by him. Malleable iron was also made in India in large quantities in very early times. There is in the gate of a mosque near Delhi a pillar of soft iron 60 feet high, 16 inches in diameter near the base, and estimated to weigh 17 tons. A sanscrit inscription is interpreted by some to affirm that this pillar was erected in the tenth century before our era, and by some it is understood to make its date 1400 years later. In the ruins of very ancient Indian temples wrought iron beams have been found, and metallurgists are puzzled to understand how these immense masses could have been handled and wrought by means known to have been in existence in those days. The Chalybians, a people inhabiting the southern shores of the Euxine, were famous among the ancients for their iron and steel. Herodotus speaks of them as "a people of iron workers," and from them steel was named.

Frequent mention is made of iron and steel in the Hebrew scriptures, but it is to be noted that when Solomon would build the temple, a thousand years before our era, he was obliged to send to the King of Tyre for a man skilled to work "in gold and silver, and in brass and in iron." Chaldean inscriptions

speak of iron as having been in use from time immemorial. Nebuchadnezzar in an inscription telling of his works of improvement in Babylon says: "With pillars and beams plated with copper and strengthened with iron I built up its gates." His daughter Nitocris built a bridge the stones of which were held together by bands of iron fixed in their places by molten lead. At Nineveh, Layard found numerous relics, including "a perfect helmet of iron, inlaid with copper bands," as well as many other articles of iron, "Two or three baskets were filled with these relics."

In Egypt iron was used in the earliest times. In 1837 a piece of iron was taken from an inner joint of the great pyramid at Gizeh, and is now in the British museum. The almost universal opinion of the best Egyptologists places the erection of that edifice at about 4,000 years before our era, so that this venerable bit of rusty metal is undoubtedly the oldest piece of manufactured iron of which men have any knowledge. Wilkinson copies an engraving showing the process of smelting iron by the aid of bellows in the shape of leather bags, trodden by a man who exhausts the air from one while with a string he raises the other and permits it to be refilled. Butchers are depicted on the monuments wearing steels such as are used to-day. Sickles and other weapons of steel are pictured in great numbers and colored blue to distinguish them from the bronze weapons which are colored red. Belzoni found an iron sickle under the foot of a sphynx at Carnac, and it is now in the British museum. Kenrick, in "Ancient Egypt under the Pharaohs" copies an account of a military expedition made by Thothmes I., who reigned about 1700 years before our era. From some of the Deltan Kings this monarch received as tribute or presents gold and silver, as well as "bars of wrought metal, and vessels of copper, and of bronze, and of iron." From the region of Memphis he received wine, iron, lead, wrought metal, animals, etc. When I read that the same King in a successful foray against "Chadasha" took much booty, including "iron of the mountains, 40 cubes," I was tempted to think that Jerusalem must have been meant; but I believe the Chadasha mentioned, is understood to be a city of the Khetae or Hittites, and not Jerusalem, the Khodesh or sacred city of the Jews, and El Khuds of the modern Arab.

The dawn of history finds iron in use among the Greeks. One legend, and the most probable, says they derived a knowledge of it from the Phœnicians, while another says that the burning of the forests on Mount Ida smelted the iron ore exposed to the flames, and revealed the secret of working in iron. That such could have been the case is next to impossible.

Homer speaks of iron and weapons of iron and steel—rarely in the Iliad, frequently in the Odyssey. I leave the Wolfian and other Homeric scholars to decide whether any particular significance attaches to that fact. Nor will I pretend to say whether or not Homer had historic knowledge enabling him to decide that iron implements and weapons were used during the siege of Troy, say about 1,200 years before our era, or whether he simply supposed conditions similar to those he saw around him to have existed in the days of which he wrote, just as Shakespeare supposed cannon to have been used in the days when the Danes governed England. Homer mentions axes of steel. Gladstone, in his Homeric Synchronisms, says: "Iron is in Homer, exceedingly rare and precious. He mentions nothing massive that is made of this material." Among the prizes offered at the funeral games of Patroclus is "a mass of shapeless iron from the forge," and Achilles says:

> Stand forth, whoever will contend for this;
> And if broad fields and rich be his, the mass
> Will last him many years. The man who tends
> His flocks or guides his plow need not be sent
> To town for iron; he will have it here.

We may infer from this that iron was very valuable, for the mass in question was no more than a man might lift; and that it was used in agriculture before it was utilized for the manufacture of arms or armor.

As early as 760 years before Christ the iron ores of Elba were worked by the Greeks, who called the island Ethalia, "from the blazes of the iron works." Strabo says that at the beginning of our era the iron mines of Eubœa were exhausted. Glaucus of Chios made a silver cup, inlaid with iron about 560 B. C. Sophocles, 400 B. C., speaks of the tempering of iron in water, and it is certain that steel swords were made about the same time. The father of Demosthenes made steel arms. When Xerxes invaded Greece, the Assyrians who accompanied him were armed with clubs, "knotted with iron." Daimachus, a Greek writer of Alexander's age, mentions four kinds of steel, the Chalybdic and Synopic, from which ordinary tools were made. The Lacedæmonian, from which were made files, augers, chisels and stone-cutting implements; and the Lydian, which was used in the manufacture of swords, razors, and other surgical instruments. Iron sickles and other agricultural implements were common in the time of Alexander.

The Romans were not workers in iron, though they encouraged the industry among the peoples whom they conquered. The mines of Elba, which had successively been worked by the Phœnicians, the Greeks and the Etrurians, continued their operations under Roman rule; but we do not learn that any improvements in processes of manufacture were introduced. The bellows were substantially the same as the blacksmith's bellows in use in our day, and the first reduction of the ore produced a small loop or bloom of spongy malleable iron, which was beaten on an anvil into the shape most suitable for the transportation to market or for the blacksmith's use. That iron weapons were in use at an early day is proved by the fact that king Porsenna, 500 years before our era, imposed upon the Romans as a condition of peace that they should use iron only for agricultural implements. The best iron brought to Rome at the beginning of our era came from Noricum, corresponding to parts of Styria and Carinthia, and it is believed that the mines now worked at Erzberg and Huttenberg are the same that were worked twenty centuries ago. The Quadi who lived north of Noricum in what is now Moravia, were then spoken of as a nation of iron workers; and it was from Moravia, that fifteen centuries later one of the most valuable discoveries in connection with iron—that of coating it with tin—was derived.

The Spanish iron industry flourished during the Carthaginian occupation, and probably before. The Romans attributed Hannibal's success at Cannæ in part to the fact that his troops were armed with Spanish swords of superior quality. Diodorus Siculus speaks of Spanish two-edged swords "exactly tempered with steel," made from iron which had been buried in the ground "to eat out all the weaker particles of the metal, and leave only the strongest and purest." The notion is not yet quite extinct that rust first attacks and destroys the poorer and baser parts of the iron, leaving the finest and the best. The manufacture of Toledo blades, begun in prehistoric times, has continued till our day, attaining its greatest proportions, as the weapons attained their greatest celebrity, in the fifteenth and sixteenth centuries.

When Cæsar invaded Britain, 55 years before our era, he found iron in use there. Most accounts represent that the natives who met the Romans employed chariots armed with iron scythes. I have looked carefully through Cæsar for confirmation of that statement; but, though I find many references to the chariots, I find no account of the iron scythes. It is certain, however, that the Britons had iron. Some writers think they did not make it, but obtained what they had from the Belgæ, with whom they had considerable intercourse, and who certainly manufactured iron. Others maintain that the Britons themselves made iron. Cæsar says of them: "They use either brass or iron rings, determined at a certain weight, as their money. Tin is produced in the midland regions; in the maritime iron; but the quantity of it is small: they employ brass, which is imported." Cæsar's stay on the island was brief, and his knowledge of it far from extensive or accurate. My own belief is that at the time of Cæsar's visits iron had been made in Britain for centuries, and in considerable quantities. At various places in England, but chiefly in the weald of Kent, the weald of Sussex, and in the Forest of Dean in Gloucestershire, have been found vast beds of cinder or slag, the remains of iron works which existed there in very early times. That these operations were carried on during the Roman occupation or later is evidenced by the fact that Roman coins and pottery have been found in the cinder. But I believe they were also carried on before the arrival of the Romans. The smelting operations were to a large extent conducted in wind bloomaries, without any artificial blast. These bloomaries were built on the tops of hills, with openings in the direction of the prevailing winds. The ore, mined with infinite patience and toil, was carried up to these furnaces on men's backs, and the operation was wasteful of metal as of labor; for so little of it was extracted from the ore that in late years the slag has been remelted in modern furnaces, and the operation found remunerative. Now, the Romans had for centuries been accustomed to the use of the bellows in smelting iron; and if they had introduced the industry into Britain they certainly would have adopted the methods known to them and not have reverted to a ruder, more wasteful and more laborious one. I am therefore compelled to believe that when the Romans invaded Britain they found the wind bloomary in use. The hearths of more modern bloomaries have been found, with Roman coins and remains among the ashes; and these are pretty good evidences that during the Roman occupation, improvements, based upon Roman knowledge, were introduced. Andrew Yarranton says that "within a hundred yards of the walls of the city of Worcester there was dug up one of the hearths of the Roman foot blast, it being then firm and in order, and was seven foot deep in the earth; and by the side of the work there was found a pot of Roman coin to the quantity of a peck." Strabo says that in his day

rion was exported from Britain. In the year 121 a great Roman military forge or fabrica was established at Bath, the iron used at it being obtained in the Forest of Dean. At the time of the Conquest the same region was noted for its iron industry. Camden says that "in and before the reign of William the Conquerer the chief trade of the city of Gloucester was the forging of iron, and it is mentioned in Doomsday book that there was scarce y any other tribute required from that city by the King. than certain dicars of iron (a dicar containing ten bars and one hundred rods) for the use of the royal navy. In 1112 there were in the Forest of Dean 72 *forgeae errantes* or moveable forges, each of which paid a license of 7s. to the crown. The Scotch at this period made no iron, and had none but that which they imported from the continent or stole in England. We are told that in a predatory expedition which they made in 1317, they found no iron worthy of notice till they came to Furness in Lancashire, where they seized all the manufactured iron they could find and carried it off with the greatest joy, though so heavy of carriage, and preferred it to all other plunder." Soon after the Conquest English iron began to be highly prized, and it was exported even to Spain. It was very dear, however, and highly prized. Thorold Rogers says that "no direct information about the seasons, is so frequent as that found in the notices which the bailiff gives about the great cost of iron." It was the custom for the farm bailiff to buy the year's supply of iron at the great annual fair and to dole it out as needed, a blacksmith being employed to mend or make the necessary implements. The articles most frequently mentioned are plow shoes, or points to wooden plows, horse shoes and nails. Sheffield was already noted as a seat of the hardware manufacture in Chaucer's time, for of one of his characters the poet says "a Sheffield thwitel bar he in his hose." Birmingham was famous for its production of swords, tools and nails

Up to this time no great improvement had been made in the manufacture of iron. The furnace was a small square bloomary furnished with leather bellows, worked by manual power, and the product was a bloom, or loop, or wolf of malleable iron. A few of these furnaces yet remain in Spain and Hungary, and Overman says that they are from 10 to 16 feet high, 2 feet wide at the top and bottom and 5 feet at the widest part. An opening in the front, called the breast, was kept open until the furnace was heated when it was closed with brick, the ore and fuel were put in at the top and the blast was supplied by "two bellows and nozzles, both on the same side." The product was called a salamander of mixed iron and steel weighing from 400 to 700 pounds, which was taken out of the breast and reduced to bars by hammers.

At the close of the 14th century the English blacksmith executed excellent work. Picton says: "Ironwork at this period was of the most elaborate description. The locks and keys, the hinges and bolts, the smith's work in gates and screens, exceed in beauty anything of the kind which has since been produced." The defensive armor made in England was also exquisitely wrought.

We are indebted to Germany for the development of the bloomary into the high furnace by which the product was changed from malleable to cast iron. The old bloomary had been gradually increased in capacity; but a limit was imposed upon that development by the impossibility of creating a strong blast by means of the bellows then in use. The same cause operated to render abortive early attempts in England to substitute mineral fuel for charcoal. Wooden tubs or cylinders in which a piston was operated by water power, expelling the air with considerable force, were invented by Hans Lobsinger in Germany in 1550. From that time the furnace grew higher and wider, and the blast stronger. At first a portion of the ore was reduced to a bloom of malleable iron, or mixed iron and steel, and a portion flowed to the bottom of the hearth as cast iron. As the furnace grew still larger the ore absorbed more carbon from the fuel till the whole of it was melted. The old furnace was then known in Germany as a stuckofen and the high furnace a blauofen or flussofen, that is a blast furnace, because of the strong blast from the improved bellows, or a flowing furnace because the product was withdrawn in the shape of a stream of molten iron. In England, however, bellows of wood on the old pattern were made of great size and operated by water power, and these supplied a blast strong enough for the conversion of the ore into cast iron.

In Elizabeth's time the iron industry had so reduced the forests by the great consumption of charcoal, that repressive laws were passed, and the production of iron was greatly lessened, and the industry continued in a low state till the use of mineral coal was introduced.

Still during that very period, nearly all the improvements in connection with the iron industry were made in Britain, and it was the ingenuity and originality of her inventors no less than the enterprise of her business men which gave to England the pre-eminence in iron manufacture which she enjoys to-day. A highly important invention was that of rollers for converting bloome into rods, bars, or plates

instead of performing that work by the slow and laborious manipulation of the hammer. It is customary to say that Cort invented rolls in 1783; but I found in the library of the Franklin Institute at Philadelphia a copy of a patent granted to John Payne nearly half a century earlier. This patent is dated Nov. 21, 1728. The first part is for the conversion of cast into malleable iron by the application of ashes, salt, etc., to pig or sow iron while in the refinery fire, "which," the patent says, "will render the same into a state of malleability as to bear the stroke of the hammer, to draw it into barrs, or other forms at the pleasure of the workmen, and those or other barrs being treated in the said melted ingredients in a long hot arch or cavern, as hereafter described; and those or other barrs are to pass between two large mettall rowlers (which have proper notches or furrows upon their surfass) by the force of my engine hereafter described, or other power, into such shapes and forms as shall be required." In this document we have a faithful description of grooved rolls, and also an account of the decarbonization of cast iron in a reverberatory furnace – that is a process of puddling iron, instead of reducing it to nature by the slow and expensive process of repeated heatings and hammerings, as had theretofore been practiced.

Another candidate for the honor of having invented rolls was Major John Hanbury, who professed to have made the discovery in 1729, a year after Payne's patent was granted. About 1680 Andrew Yarranton was sent into Saxony to learn the art of coating iron with tin. The knowledge of that process is said to have been carried into Saxony from Bohemia by a clergyman, but its origin is lost. Yarranton succeeded in his mission, and brought the art into England, where the manufacture of tinned plates soon assumed considerable proportions, not only for home use, but for export. After the introduction of rolls the English plates were considered superior to those made on the continent, because they were rolled and not hammered, and were consequently of equal thickness throughout.

A great impetus was given to the iron trade in England by the labors of Henry Cort toward the close of the 18th century. He greatly improved the rolls and brought them into general use; and he perfected the process of puddling, bringing it substantially to its present perfection. It will be remembered that the product of the low bloomary was malleable iron, the carbon in the fuel was all burned away by a strong blast of air directed through the tugeres upon the bloom as it formed. The process was slow and expensive, though it is to be noted that bloomaries only slightly improved are in use to-day and produce high grade malleable iron of first rate quality in competition with modern furnaces. When the high furnace was introduced it made the first production of iron much cheaper, but the iron was cast iron, and the expense of converting it into malleable iron in the finery was tedious and costly. Cort by the puddling furnace made the operation simple and very much cheaper.

Another highly important improvement introduced into England about the middle of the eighteenth century was the substitution of mineral fuel for charcoal. The attempt had been made a century earlier by Dud Dudley, a cousin I believe of the unfortunate husband of Lady Jane Grey, but though he demonstrated the practicability of it, he achieved for himself only ridicule, disappointment and great pecuniary loss. Revived in 1735 by Abraham Darby at Coalbrookdale in Shropshire, it proved immediately successful, and restored to Britain her iron industry, which had fallen into a great decline through want of fuel. The first iron cylinders for supplying a blast to the furnace were constructed by John Smeaton at the Carron Iron works in Scotland, and steam was first used at the same works to furnish the power through the influence of Dr. Roebuck.

Since then the only important improvements introduced in the productive iron industry have been the application of the hot blast, first employed by Neilson in Scotland in 1728, and the withdrawal of unconsumed gases from the top of the furnace, and their utilization for the production of heat. I think France is entitled to credit for that discovery.

Iron is of two kinds; cast iron containing from 2 to 5 per cent of carbon, which is brittle and granular in its construction; and malleable or wrought iron, which is ductile and fibrous, and contains little or no carbon. Between the two lies steel, containing from a quarter of 1 per cent to 2 per cent of carbon. If you ask me for a technical definition of the word steel, I shall tell you frankly that I cannot give it, and I have heard some very expert metallurgists express a dislike to be put to the same test. A few years ago you would be told off hand that steel was an article which would forge, temper and weld; but if you demand these qualities to-day you will relegate to the iron heap a great many articles which the world calls steel, including all metal produced by the pneumatic process, and I shall be compelled to tell you that there are not a thousand tons of steel rails in existence. I believe the article produced in the

Bessemer converter, however, to be a true steel, but it will not weld.

In former times steel was sometimes obtained as part of the product of the bloomary united in certain proportions with soft iron in the bloom or loop. But when it was desired to produce steel from iron, very fine bar iron was arranged in layers in a fire-brick oven, each layer of iron being overlaid with charcoal. All openings were then carefully closed with clay and the whole oven was heated to redness and kept at that temperature for from seven to ten days. This process is still employed, and the product is variously known as cement or blister steel, or, if the bars are rolled together to secure homogeneity, as shear steel. Reaumur described this process in 1722; and it is not known how long before his time it was employed or where, when or by whom it was introduced. About the middle of last century Benjamin Huntsman, in England introduced the modern method of making crucible cast steel substantially as it is practiced to-day.

Steel was also sometimes made by dipping bars of soft iron into molten cast iron, from which they absorbed a portion of the carbon and were converted into steel; and sometimes malleable and cast iron were fused together in a close chamber producing steel of inferior quality.

Siemens Martin steel is made by the decarbonization of cast iron in a reverberatory furnace heated with gas, the flame of which assists the reaction; and the subsequent recarbonization of the bath by the addition at the close of the process of white iron, spiegileisen, or ferro manganese. The operation requires from four to eight hours.

The Thomas Gilchrist process is simply an improvement upon the Bessemer or pneumatic process. A chemical lining is put into the converter, which absorbs phosphorus and other objectionable minerals from the melted metal, and permits the use of a lower grade of iron than is possible in the Bessemer process.

Puddled steel is made in much the same way as wrought iron is made from cast iron. That is, the iron is melted in a reverberatory furnace exposed to a strong draft of atmospheric air, and is kept stirred or puddled until the oxygen of air unites with the carbon in the iron and burns it out. If steel is desired the metal is withdrawn before all the carbon is consumed; if iron is desired the process is continued till the carbon is consumed, when the metal is brought to a spongy, pasty condition, is rolled into balls or blooms, and is lifted to the squeezer, where the slag and other impurities are squeezed out. Puddled, or open hearth steel, as it is generally called is growing in favor, and in England its production is increasing more rapidly than that of Bessemer or pneumatic steel.

The most important metallurgical discovery of the age was that of making steel from cast iron by the pneumatic process. This was the invention of Sir Henry Bessemer, and was made about 30 years ago. Bessemer's first idea was to produce wrought iron by forcing a strong blast of atmospheric air through the melted iron by which the carbon would be burned away and the iron reduced to nature. His earlier experiments were disastrous failures. The iron produced was so brittle as to be almost worthless, and no steel worthy of the name could be made. At length Mr. Robert Mushet suggested that if manganese were added to the iron good steel could be made. This was done and proved highly successful. Some improvements were also made in the lining of the convertera by which the amount of silicon in the iron was reduced. The Bessemer process requires a good quality of pig iron, reasonably free from phosphorus, sulphur and arsenic, and not containing a superabundance of silicon or titanenm. This is melted in an ordinary furnace and conveyed to the converter, which somewhat resembles an immense soda water bottle with the neck wrenched to one side. The ordinary converter contains from five to ten tons of molten iron, but is then not more than one fourth filled. A powerful blast of air is now conveyed to the bottom of the converter whence it rises through the iron uniting with the carbon and producing combustion and intense heat. The blow is usually continued for 15 to 20 minutes and manganese is added during the process generally in the shape of spiegileisen, but sometimes as ferro-manganese. When the operation has continued a sufficient time, which is determined by means of the spectroscope, the blast is stopped, the converter is tipped to one side, the metal flows into moulds, and the ingots so formed are known a Bessemer blooms. Sir Henry Bessemer's royalty amounts to only a shilling a ton, but is 1879 Mr. J. S. Jeans, secretary of the British Iron association, wrote that he had then received from his patent upward of £1,050 000 sterling.

A description of the first iron works established in Canada will not, I hope, prove uninteresting.

Colbert, the great French financier and Prime Minister to Louis XIV., was strongly impressed with the importance of the Canadian dominions of France, and he carried on a long correspondence with M Talon, the royal intendant, with a view to the discovery

and working of the mineral treasures of New France. Many of these letters are now in the Parliamentary library at Ottawa.

In 1650 Father Drouillettes, a member of that noble band of Jesuit missionaries who did so much to explore and develop not Canada alone, but the whole country as far as the Mississippi, settled among and converted to Christianity a tribe of Indians, the Attikamegues, living near Three Rivers, at the mouth of the St. Maurice, on the north bank of the St. Lawrence, about midway of Stadacona, Quebec, and Hochelaga, Montreal. It is probable, though not certain, that Father Drouillettes reported the existence of iron near that point, for in 1666, M. Talon, who had been sent by Colbert to Gaspe to look for silver and had failed, sent the Sieur de la Tesserie to Baie St. Paul, near Trois Rivieres, where he found iron ore which appeared to be rich. M. La Portardiere was sent from Quebec to inspect the mine, but his report was unfavorable, and nothing practical was done for seventy years.

In 1681 the Marquis de Denonville reported to his Majesty's Government that he was convinced a very fine iron mine existed at Trois Rivieres, where a forge could be profitably worked. He said he had sent some of the ore to M. Colbert, who tested it with favorable results. In 1686 the same nobleman reported that he had sent a sample of the ore to France, where the iron workers found it "of good quality and percentage," and desired fifteen or twenty "bariques" of it to give it a thorough trial. In 1672 the Count de Frontenac reported that he had begun to mine the ore and that "there are six piles of ore now lying at Cap Madelaine, which, according to the annexed report of the miner, would last for two castings per day for four months." He strongly urged the establishment of "forges and a foundry."

In 1737 a firm known as Cugnet et Cie., was formed by royal charter, which acquired the mines and a tract of forest land, and at once erected two furnaces, a foundry and dwellings for the operatives. There was a French garrison at Trois Rivieres, and the soldiers were the principal workmen. The operations appear to have been unprofitable, for in a few years Cugnet et Cie. surrendered their charter to the local Government, and the works were carried on for some time by agents of the Crown. The fuel used was charcoal, the product of the furnaces was pig iron, and the greater part of this was cast into stoves, pots, etc., for local use; but some bar iron was made, though I can find no description of the method employed. It probably was the old method of repeated heatings and hammerings, as there was a trip hammer operated by water power.

In 1752 M. Bigot, who was at that time Intendant of New France, resident at Quebec, instructed M. Franquet to visit the St. Maurice forges, and his report is of great interest. After describing the locality he says: "The stream which drives the machinery of the establishment is dammed up in three places; the first dam drives the wheel for the furnace, the second and third each a trip hammer. . . . It is supposed that the stream or water power is sufficiently strong to drive two other hammers. . . . On entering the smelting forge I was received with a customary ceremony: the workmen moulded a pig of iron about 15 feet long, for for my especial benefit. The process is very simple: it is done by plunging a large ladle into the liquid boiling ore and emptying the material into a gutter made in the sand. After this ceremony, I was shown the process of stone moulding, which is also a very simple but rather intricate operation*. Each stone is in six pieces, which are separately moulded; they are fitted into each other and form a stone about three feet high. I then visited a shed where the workmen were moulding pots, kettles and other hollow ware. On leaving this part of the forge we were taken to the hammer forge, where bar iron of every kind is hammered out. In each department of the forges the workmen observed the old ceremony of brushing the stranger's boots, and in return they expect some money to buy liquor to drink the visitor's health. The establishment is very extensive, employing upward of 180 men. Nothing is consumed in furnaces but clean coal, which is made in the immediate vicinity of the post. The ore is rich, good and tolerably clean. Formerly it was found on the spot: now the director has to send some little distance for it. . . . This iron is preferred to the Spanish iron, and is sold off in the King's stores in Quebec at the rate of 25 or 30" per hundred pounds weight.

In 1760, Quebec having been taken by Wolfe, Canada was ceded to Great Britain, and among the stipulations in the treaty was one that the papers relating to the forges should remain in the possession of M. Bigot, the intendant, and should be transmitted to France without inspection of the British.

For seven years after that event the works lay idle, but in 1767, Christopher Pelisier formed a company which obtained a concession from Governor Carleton for the working of the forges for 16 years, at an annual rental of £25 lawful money of our said Province of Quebec. An indication of the relations so soon established between the French and

English people of Canada is furnished by the names of this company which embraced, Christopher Pelisier, Alexander Dumas, Thos. Dunn, Benjamin Price, Colin Drummond, Dumas St. Martin, George Alsopp, James Johnston and Brooke Watson. When this lease expired Conrad Gugy took the works at an annual rental of £17 15s. sterling. Various persons conducted the business down to 1801, when another firm took it at £850 sterling, which rental was reduced in 1810 to £500 currency.

In 1815 a visitor wrote: "The foundry itself is replete with convenience for carrying on an extensive concern; furnaces, forges, casting houses, workshops, etc., with the dwelling houses and other buildings, have quite the appearance of a tolerably large village. The articles manufactured consist of stoves of all descriptions that are used throughout the Provinces, large caldrons of kettles, that are used for making potashes, machinery for mills, with cast or wrought iron-work of all denominations. There are likewise large quantities of pig and bar iron export-d. The number of men employed is from 250 to 300. The principal foreman, engaged in making models, are either English or Scotchmen; the workmen are generally Canadians."

The ownership remained in the Government till 1846. In the year named the property was sold to Henry Stuart, who seriously embarrassed himself by large and ill advised expenditures. He then rented it; and it subsequently fell into the hands of Andrew Stuart and John Porter, of Quebec, who worked on a limited scale till 1859, when the fires were extinguished.

The only information, later than that in the narrative which I have been able to get is contained in a report to Parliament made in March, 1879, which says: "THE ST. MAURICE FORGES.—Owned by F. Macdougall & Son, Three Rivers; using a bog ore; making a very fine iron with charcoal fuel. The first furnace was erected in 1737. Still running with same fuel; capacity four tons."

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* Intricate simplicity was probably common in those days.

* The editor says "castors."—beaver skins.