

CENTENARY OF BESSEMER, WHO REVOLUTIONIZED STEEL

His Invention Added More to the Wealth of the World Than Any Since the Steam Engine—Had 120 Patents to His Credit—What the Process Bearing His Name Accomplished.

No centenary of the year 1913 will be of more interest to the people of the United States and the world at large than that of Sir Henry Bessemer on the 13th of this month. Bessemer is the man commonly referred to as the inventor of the Bessemer process of making steel, by which process steel is produced so cheaply that it can be used for rails, bridges, skyscrapers, warships, cars, and in a thousand and one other ways.

This centenary is of special interest to the United States, for to the use of the Bessemer process this country owes a large portion of its wealth and industry. The United States to-day produces about one-half of all the steel made. American railroads have as many miles of steel rails as all the other countries put together. Three-fourths of this steel is made by the Bessemer process.

A generation ago the percentage of iron which was converted into steel was insignificant. Now it is about 66 2-3 per cent. "a change due largely to the introduction, in 1855, of the Siemens-Martin, or open-hearth, process; but mainly to the tremendous development of the Bessemer process."

Robert H. Thurston of Cornell says: "The world has been advanced perhaps more by the invention of Bessemer, which gives us cheap steel and which has enabled us to make of steel almost every product once made of iron, than by any other device in the history of industry."

The history of the manufacture of iron naturally falls into three parts. The first part takes one up to the date of the introduction of coal, the second to the time of the discovery of the Bessemer process, described by Bessemer as a mode of manufacturing malleable iron and steel without fuel.

Henry Bessemer was English born, the youngest son of a French inventor. His father, Anthony Bessemer, was of such ingenuity that he was a member of the French Academy of Sciences at twenty-five; but when Robespierre became Dictator he was obliged to flee for his life, and settled in England. He made improvements in microscopes and type-founding and alchemy.

The father early perceived the superior powers of his son's mind and did all he could to develop them. The boy's principal toys seem to have been a turning lathe and clay for modeling. At eighteen he went to London, a poor boy, "a mere cipher in a vast sea of human enterprise."

He began by engraving patent medicine labels. Soon he had worked out his first invention, which was an attempt to make a mechanical process replace manual toil—in short, a labor-saving device. It was an improved method for stamping deeds, or a process for copying bas reliefs on cardboard, by which he could produce embossed copies of such works in thousands at a small expense. By this means any office boy with average intelligence could forge almost any expensive stamp affixed to a document, and it was from the sale of these stamps that the English Government obtained an important part of its revenue, the stamps often selling for \$25.

However, a large business was being done in second-hand stamps, by which the Government was losing about \$500,000 a year.

After several months spent in experiment, Bessemer produced a stamp which could neither be forged nor removed from the document. The Chief of the Stamp Office agreed to adopt it. Bessemer was given a position for life at \$4,000 a year for his invention; but when he told his good luck to his fiancée, explaining the impossibility of any one's using one of his stamps the second time, she replied:

"Yes, I see; but if all stamps were dated they could not be used again."

Struck with the advantage of this idea, young Bessemer perfected his machine so that it would date, and when the Stamp Commissioner was advised of this improvement he had no use for a Supervisor of Stamps. The inventor lost his position, and was allowed to go unrewarded. No doubt at this time he would have agreed with Watts that of all things in life there is nothing more unprofitable than inventing. Embittered by this injustice, henceforth he was most careful in protecting his rights. His process of manufacturing gold paint, he kept a secret from the world for forty years, only five men besides himself knowing how it was done. During the three years he was perfecting his steel process he took out thirty patents in England, besides numerous foreign patents.

He was one of the most prolific of inventors, having 120 patents to his credit, among them a velvet machine, improvements in type-casting machinery, (his first three inventions were not patented,) then came his fourth invention, a bronze powder process. He worked at this for a year and a half; but when he finally succeeded, it brought him a profit of 1,000 per cent. for years. Later followed a mine ventilator, a telephone improvement, a glass polisher, revolving projectiles, a method of compressing into a solid block the graphite from which lead pencils are made, a system of rollers for embossing and printing paper, and a ship with stationary cabin, which latter is the only notable failure in his long list.

Bessemer thought out many improvements which he never patented. He once said: "I have myself proposed to manufacture many things which I was convinced were of use, but did not feel disposed to manufacture or even to patent. I do not know of one instance in which my suggestions have been tried; but had I patented and spent a sum over a certain invention, and saw no means of recouping myself, except

by forcing, as it were, some manufacturer to take it up, I should have gone from one to the other and represented its advantages, and I should have found some one who would have taken it up on the offer of some advantage from me, and who would have seen his capital recouped by the fact that no other manufacturer could have it quite on the same terms for the next year or two. Then the invention becomes at once introduced, and the public admits its value; and other manufacturers, like a flock of sheep, come in. But the difficulty is to get the first man to move."

One writer has stated that Bessemer's inventions added more to the wealth of the world than any invention since Watts's steam engine.

But, strange as it may seem, Bessemer made his fortune and fame chiefly upon an invention which was thought out and demonstrated eight years before it ever entered Bessemer's mind, the so-called "Bessemer process" of making steel, which was really the invention of a Pittsburgh man, in 1847, one William Kelly, whose prior claim is recognized by the United States Patent Office; by Robert W. Hunt, the veteran steel expert of Chicago; by James Park, one of the "steel fathers" of Pittsburgh, and by James M. Swank, who for a generation has been the Secretary of the American Iron and Steel Association. M. Michael Chevallier affirms that this single metallurgical invention, conceived, perfected, and put into operation, has been of more value than all the gold of California. This was stated in 1882, when the State of California was estimated to have produced gold worth \$1,150,000,000.

In 1851 Dr. Whewell said: "Gold and iron at the present day, as in ancient times, are the rulers of the world; and the great events in the world of mineral art are not the discovery of new substances, but of new and rich localities of old ones." And in 1862 Cobden said: "Our wealth, commerce, and manufactures grow out of the skilled labor of men working in metals."

The pressing need of the world a half century ago was for a new metal, as strong as steel and as cheap as iron. This metal is what Kelly and Bessemer were able to give—"a material which revolutionized our constructive art, which could be produced in large quantities and at a moderate cost; a material of more than twice the strength of iron, which, instead of being fibrous, has its full strength in every direction, and which can be modulated to every degree of ductility, approaching the hardness of the diamond on the one hand, and the proverbial toughness of leather on the other."

The Irish-American and the French-Englishman devised a new method of refining iron by using air as fuel, and this made the iron and steel industry expand with almost the suddenness of an explosion, for in the last thirty years more iron and steel has been produced than in all the previous centuries of the world's history.

Bessemer was certainly great enough to have thought out the "pneumatic process" by himself. Kelly, however, thought out the same thing eight years ahead of him, and, as the iron men of this country were in constant communication with the iron men of England, it would be strange if Bessemer had not heard of "Kelly's air-boiling process."

Kelly's discovery took place at the Swanee Iron Works, near Eddyville,



Kelly, after he had burned up all the wood available within a seven-mile radius. To quote from Casson's "The Romance of Steel": "One day he was sitting in front of the 'finery fire when he suddenly sprang to his feet with a shout and rushed to the furnace. At one edge he saw a white-hot spot in the yellow mass of molten metal. The iron at this spot was incandescent. It was almost gaseous. Yet there was no charcoal—nothing but the steady blast of air. This was discovered while he was making 'Kelly kettles,' large sugar kettles. And yet Jeans claims, in his 'Creators of the Age of Steel,' (1884)

that "no one in the steel trade has ever assigned to Sir Henry Bessemer a secondary place. His priority is undisputed." It was seven years later that Bessemer had an interview with Napoleon III, during which he explained to him his new projectile, which was intended to revolve in its flight. When the new projectiles were being tested at Vincennes Commander Minie remarked to him: "The shots rotate properly, but if you cannot get stronger metal for your guns, such heavy projectiles will be of little use." This suggested a new invention, and

Bessemer instantly determined to master all that was known of iron and steel, to make "the better iron" referred to by Solon when he said to Croesus, upon being shown his treasures, "Yes, Sir; but if another should come with better iron than you have, he would be master of all this gold." Until Huntsman's invention in 1770, the best steel was made by the Hindus and sold for \$50,000 a ton. Huntsman's invention brought it down to \$500 and \$250 a ton, and Bessemer produced it for \$30 a ton. The fact that he knew little or nothing of metallurgy did not seem to

bother him in the least. He rather held it as an advantage. By the end of eighteen months of study and experiment he says that the idea struck him of rendering cast iron malleable by the introduction of atmospheric air into the fluid metal. His first experiment to test this idea was made in a crucible in the laboratory.

The result of my first experiment showed me that the highest temperature ever known in the arts could be produced by the simple introduction of atmospheric pressure into cast iron. After the experiments had been going on for six or seven months, and after having, in conjunction with my partner, Mr. Robert Longsdon, spent £3,000 or £4,000 in experiments, and diverted my attention from business pursuits for about two years and a half, I was anxious to get some other opinion on the process, and I invited the late Mr. George Rennie to inspect it at my works.

This man was so impressed that he insisted upon Bessemer reading a paper on his discovery at the next meeting of the British Iron and Steel Association, which met the following week.

In the reception room the next week Bessemer met Mr. J. Nasmyth of steam-hammer celebrity, and he said: "Now, Nasmyth, you are the first man who should see the result of this, because I have founded it on an idea of your own; your patent for steam puddling led me to this process."

Nasmyth was delighted when he inspected the specimen, and said: "You will reap a rich reward for this, and you thoroughly deserve it. That is a real British nugget."

Bessemer's first patent on this process was taken out Oct. 17, 1855; but the first public announcement of the discovery did not come until Aug. 11, 1856. Speaking of its reception twenty years later, Mr. Isaac Lowthian Bell said:

It is difficult to say whether science or art was more perplexed at the announcement of the Bessemer process. The former appears to have thought it prudent to remain silent, at all events in the Transactions of the British Association—for all the notice there bestowed on the discovery is the bare mention of the title of his communication. Art was less reticent, for I remember the ridicule with which the proposal was received.

The paper announcing Bessemer's discovery was read on Monday, and on Thursday it was published in The Times. Immediately the Dowlais Iron Works, the largest in the world, determined to test its usefulness; but the test was so admirable that within three weeks they were one of the five companies that had purchased the license to use this new method. Bessemer's plan was to have five plants in different parts of England pay him whatever they thought proper for the use of his invention, and then be exempt from any further royalty. In this way they would always act for him and not against him. The licenses in those three weeks brought him \$125,000. The Dowlais Iron Company tried his method first. Everything seemed to go splendidly until they attempted to work the iron, when it was found to be utterly useless for any purpose. The result was inexplicable. Experiments were repeated with the same result. In six weeks after the reading of the paper before the association a meeting of the ironmasters at Dudley, then the centre of the iron trade, condemned the new process as a practical failure. Bessemer knew there must be some

reason for these failures and with the magic patience of all geniuses he determined to ascertain the cause. The truth was this: His experiments most effectually removed the carbon and silica, but did not remove the pernicious phosphorus. The iron he himself had used by chance was Blaenavon pig, which was exceptionally free from phosphorus, while that used by the Dowlais Company was another grade which had much more of this substance.

At first he thought he would have to dephosphorize ordinary iron by puddling; but just about this time some Swedish iron arrived which was free from phosphorus, and his success with this was so good that he was satisfied. He had now succeeded in producing the purest malleable iron ever made, and by a quicker and less expensive process than any known. But he wanted to make steel, which is iron with just enough carbon in it to harden it.

There is a controversy as to whether Mushet or Bessemer really discovered how to regulate the amount of carbon. It was Mushet who suggested using ferro-manganese, or, in other words, after all the carbon had been blown out, or burned out, then to add just the amount required. Mushet claimed this idea to be of more value than the Bessemer process.

The process originally described by Bessemer was altered by this chemical change and by one mechanical change, namely, the moving on an axis of the vessel containing the fluid, which enabled the operator to cease blowing at just the right moment.

These changes made, Bessemer's troubles were by no means ended. The next step was to get an adequate supply of iron suitable for the converter, and then to convince the public that his "failure" was a success. Here his friend Galloway of Manchester came to his rescue by distributing a quantity of the new metal among his workmen, who pronounced it "no better" than what they had been using. But that was enough, as the new metal could be produced for one-tenth the cost of the old.

Full of confidence, Bessemer again read a paper, on May 24, 1859, this time before the Institution of Civil Engineers, and his description of the process is still considered the most graphic ever given. Specimens were exhibited and reports made of the tests tried. Still many doubted, but the impression made was favorable enough to give the inventor the Telford gold medal.

But it was not yet a commercial success. The public shrugged its shoulders. Not one of the five men who had purchased licenses and who would have an advantage of \$50,000 a year over his competitors came forward to touch it. Everything was lost unless Bessemer himself could form a company, and this he did with his partner, Robert Longsdon, and the aforementioned Galloway. They bought land at Sheffield and erected the Bessemer Steel Works. They also cleared the market by buying back the five licenses. Then they started a salesman out who quoted £42, or \$210, a ton, a price they maintained for two years. The first orders were for twenty-eight or fifty-six pounds. The original royalty had been 10 shillings. The men who wanted licenses now had to pay £2 a ton on everything but rails, and £1 a ton on rails. So was Bessemer steel introduced.

But what of Kelly over in America? In 1856 Kelly was told that Henry Bessemer, an Englishman, had taken out a patent in the United States for the "pneumatic process." National pride roused Kelly to file in the Patent Office his claim to priority of invention, which was granted him in United States Patent No. 17,628. (This was not the only time that steel men have contested claims of priority as witness Mushet and Bessemer over the regulation of the carbon; the question in this country as to who first successfully used Lake Superior ore, the Agnews of the Sharpville (Penn.) furnace or Frank Allen of the Clay Furnace, and who first made the T-shaped rail, Charles B. Vignoles of England or Robert L. Stevens of the United States.)

In 1870 both Bessemer and Kelly applied for renewal. Kelly's application was granted for seven years, while Bessemer was told that he had no right to one in the first place. The dread of paying higher royalties then led the steelmakers and railroad men of the United States to protest in such a chorus as was never before known in regard to a patent. Bessemer, whose right to royalties was now at an end, was lauded as the original inventor, while Kelly was vilified as an interloper. Bessemer was exalted, Kelly belittled; and England given the credit for one of the world's greatest inventions, when it should have belonged to America. Bessemer received ten millions, worldwide fame, and knighthood; Kelly half a million and comparative oblivion.

Although the original idea was apparently not Bessemer's, the commercial success of the new process was certainly due to him, and Lord Bacon has said that the introduction of great inventions appears to hold by far the first place among human actions.

In 1861 Bessemer proposed the use of steel rails. In 1865 the first locomotive boiler was made of Bessemer steel plates; the same having already been adopted in 1850 by the largest boilermakers for making boilers. In 1864 the first steamer was built of steel. At the International Exhibition of 1862 he exhibited a spherical steel cannonball.

In 1871 Bessemer was selected as President of the Iron and Steel Institute. One cannot attempt to name all the honors which the world conferred upon this man, this "mere cipher." But in America, which offers no titles, awards no decorations, grants no "freedom of cities," it is interesting to note that eight localities and one railway bear his name.