Thesis by F. J. Rumold.

Subject:-
The Father of the Age of Steel.

Outline.

I. Parentage.

II. Early Ingenuity.

III. Removal to London.

IV. Invention of Government Stamp.

V. Invention of Process for making Bronze Powders.

VI. Experiments with Ordnance and Projectiles.

VII. Study of Process for Making Steel and Iron.

VIII. Improves the quality of Cast Iron.

IX. Blows Air into Molten Cast Iron.

X. Is given Privilege of carrying on experiments at Government Gun Shops.

XI. Invention of Bessemer Process.

XII. Reads a Paper on Process before British Iron Workers Association.

XIII. Failure of Experiments.

XIV. Process Condemned.

XV. Discovers Source of Failure.

XVI. Use of Spiegel Eisen.

XVII. Introduction of Process.

XVIII. Improvement of Telescope and Grinding and Polishing Lenses.

XIX. Death.

The true inventor, like the poet, is "born, not made". The subject of this thesis did not acquire the inventive ingenuity which characterized him thru life. It was an inherited faculty.

Sir Henry Bessemer's father was a Frenchman who was employed in the mints of France about the time that Robespierre became dictator of the country and was transferred from the mint to take charge of a public bakery that distributed bread to the mob which thronged the streets. Somehow the report got about that the loaves that were being made were light in weight. Bessemer was seized, placed in prison and would probably have shared the fate of many other victims of the reign of terror had he not escaped. He fled to England. Here his talent won for him an appointment in the mints of England. He spent a good deal of his time in investigation and invention. He improved the microscope. He also was interested in type founding, and, as his son says, was the founder of "True Alchemy".

Sir Henry Bessemer, the youngest son was born in Charlton, Hertfordshire England, in 1813. His boyhood was spent in his native village, and his rural life afforded him ample time though little incentive, to carry on his youthful experiments. While still quite young, his father purchased for him a small five inch foot lathe and with it he received a book of instructions.

Henry began doing very ordinary work with this little machine, and rapidly advanced to more difficult and intricate work. At this time a man named Perkins caused some sensation by some peculiar turning applied to the engraving of bank-notes. Henry took his work to this man in order that he might, while in his shop, study his methods. Henry carefully examined a great many of the models and specimens, but could not detect how they were made until he discovered one with a false division — this gave the secret away. He went home and in three months by the simplests methods reproduced all the difficult forms used by Perkins.

While thus developing his inventive genius, he was getting the rudiments of an education in the neighboring town of Hitchin.

At the age of 18, he came to London. "Knowing no one" and myself unknown, — "myself a mere cipher in a vast sea of human enterprise". Here he worked as a modeler and designer. He engraved on steel with a diamond point for patent medicine labels. At 19, he exhibited one of his beautiful models at the Royal Academy, then held at Somerset House. About this time he was working toward the invention of a stamp for the government.

The government was being robbed by unscrupulous persons at the rate of £100,000 per year. The old stamps would be removed from worn out documents and placed on others, or they would become faded and often obliterated by being exposed for some months to a damp atmosphere. After learning how easy it was to use old stamps and defraud the government, Sir Henry set himself to work to invent a stamp that could not be used again. This he soon accomplished, and finally it was accepted by the government and a position was given to Sir Henry at a salary of from £500 to £600 per year, as a compensation for his invention.

Shortly after the invention was accepted by the government the inventor called on the young lady who afterwards became his wife, and showed her the stamp. She at once suggested that if the stamp had a place for a movable date it could never be used again. He made this improvement, and later the stamp was still further improved, so that any one could stamp the documents presented at the office.

Sir Henry now lost his position in the office, and having no patent received almost no compensation.

This unjust treatment by the government fell with terrible force on the young inventor. He was almost penniless, and had intended to soon set up housekeeping for himself. When he suggested to the officers that he had a right to some compensation for his invention he was told that since he had offered his invention to the government without asking for renumeration, he would not now receive any. Sometimes he was promised something, only to be disappointed time and again. He at last gave up all hope of securing anything, but resolved that whatever he invented hereafter should be patented.

Sir Henry now turned his attention to the making of patterns for Utrecht velvet and a little later made some improvements in type founding. After this, his attention was accidentally turned to the making of bronze powder. He was struck with the high price of the finished product. On inquiry, he found that it cost 1125 per pound while the raw material cost only 11 d per pound. He rightly guessed that the high price was due to the cost of making it. He at once bought some of the raw material and began experiments in making the powder. Many devices were tried. Eighteen months were spent in fruitless efforts to produce the powder by a better process. Discouraged and disheartened, he gave up the experiments for a time, without having accomplished any thing. But after resting for a short time he took up the work determined to succeed, and succeed he did. He kept the process a secret and worked it for a time himself, making immense profits. After a time he told the secret to a friend who agreed to put £10000 into the enterprise. Bessemer drew up the plans for the new works, and the machinery was made in various parts of the country and put together by himself. The new plant was put into operation and the process kept secret, and is even now a secret.

In 1851, at the great exhibition he displayed 14 kinds of machinery which were considered marvels of invention.

In 1853, while the public mind was much exercised with the thought of war with Russia. Sir Henry devoted his time to the improvement of ordnance and projectiles. He soon constructed elongated projectiles to which a rotary motion was given during their passage thru the air without the aid of rifled grooves which still continue in use. This was accomplished by means of passages thru the projectiles and open at the end nearest the breach of the gun. He also used in the gun an enlarged powder chamber, this was another new feature. He found that he could get no material suitable to withstand the great stress required of it, so he began a long series of experiments with the intention of securing iron which could be cast, and which would at the same time have a great tensile strength. The process then in use for the manufacture of steel was one used by a man named Huntsman. Steel made by this process cost from £100 to £50 per ton.

Steel was made from ordinary iron imported from Russia and Madras. The bars were subjected to a process known as cementation. A furnace is built for this purpose. In the center of this, are placed two chests on troughs which are heated all around by holes in the flues. What is technically known as cement is simply charcoal made from hard wood, sometimes soot was used. This is sifted into the troughs to the depth of a few inches. The bars are then put in on their edges with a space of half an inch between, powdered charcoal is sifted into these spaces and over the bars to a depth of an inch and then another layer is put in. In this way the troughs were filled to within about six inches of their tops. Above the iron is placed a covering of damp sand and powdered cement in order to thoroughly exclude the air. The trough now being closed fire was applied for a few days until the iron had absorbed the proper percent of carbon. To produce certain kinds of steel, the bars were subjected to two or three cementations. By means of an opening in the side a bar could at any time be taken from the trough and the progress of the process could be noted. The process was considered complete when the bars were covered with blisters.

The texture of the metal thus produced is granular instead of fibrous, the fracture is white like frosted silver, and the crystals are large in proportion to the amount of carbon absorbed.

After the bars have been exposed to cementation, they are put thru the "shearing process". The bars are broken up into lengths of about 18 inches and four of them are bound up in a bundle with a ring, to this "bundle, or "faggot" a long handle is attached. It is now raised to a welding heat and subjected to the action of a hammer which works at the rate of one hundred fifty to three hundred sixty strokes pro minute. The different pieces thus become united. The heat is revived by the rapid blows of the hammer and sometimes the metal is ignited. This treatment made the steel fit to be forged into shears, edge tools, and cutting instruments. It is known as shear steel.

Huntsman improved this process by melting the pieces of blistered bars, and casting the molten metal in moulds. It usually took about four hours to melt 30 lbs, of this steel in a crucible placed in a furnace. Huntsman's process was considered the most perfect for a period of nearly one hundred years from the time it was invented until it was studied by Sir Henry Bessemer.

Sir Henry Bessemer had no knowledge of the steel trade or metallurgy. He applied himself to the study of methods of making iron and steel. He found that iron, in order to be malleable must be comparatively free from carbon. He found that steel of the best quality was, practically, pure iron mixed with 1 to 2 percent of carbon. Sir Henry read all the leading works extant on the process of making iron and steel, and added to this some practical knowledge by visiting the leading iron factories of England. The ores, manner, and processes of working the metal were closely examined by him.

Upon his return from London, he made arrangements to secure the use of the iron factory of St. Pancras. He converted this factory into a small experimental iron works in which his first object was to improve the quality of iron. To do this, he made many costly experiments without getting as good results as he had hoped for; but at the end of twelve months experimenting, he succeeded in getting an improved quality of Cast Iron which was almost as white as steel, but was tougher and stronger than the cast iron then being made. Of this metal he made a small model gun which was turned and bored. This gun he took to Paris and personally presented to the Emperor as a result of his experiments. His majesty encouraged him to continue his experiments, and desired to be further informed of the results.

As Sir Henry continued his experiments, he extended them to the production of steel and wrought iron. The idea struck him that blowing "Atmospheric air into the fluid metal would make it malleable". His first experiment in this direction was made in his laboratory and here he found that by blowing air into the liquid metal by means of a movable blower he could convert ten or twelve pounds of cast iron into the softest malleable iron in a very short time.

The samples were so satisfactory in their tests that he took them to Col. T. E. Wilmot the, then Superintendent of the Royal Gun factories, who was astonished and at the same time delighted by the samples and tests. Wilmot offered him facilities for carrying on his experiments and a Chemist connected with the factory furnished with numerous analyses.

Here he could use the testing machine for trying the strength of his metal. He repeated the experiment of blowing air into the molten mass and obtained most flattering results. Now it was that he began to wonder whether this principle could be practically applied, and if so could the air be forced up thru the molten mass from the bottom of an egg shaped vessel?

He fitted up a circular vessel 3 feet in diameter and five feet high and capable of holding seven cwt. Then he ordered a small but powerful air engine and some crude iron delivered at the Baxter House which has been famous ever since. The apparatus was put into place, the air engine set up and started and as soon as enough cast iron was melted in a separate furnace, it was poured into the converter. The converter was lined with fire clay and streams of air under pressure were coming up thru the bottom. As the metal struck the bottom of the converter there was a miniature volcanic eruption. The dangling pot lid dissolved in the gleaming volume of flame and the chain by which it hung grew red then white as the various stages of the process were passed thru. The cock to regulate the air was beside the converter and no one dared to go near it much less close it. It was soon apparent that the decarburization was complete and the combustion had expended its fury, and most wonderful of all, the metal was steel! The new product was tested. Its quality was good. At last the great end had been achieved. The inventor was elated. He now went to the patent office, and hunted up the records to see if anyone had applied for a patent on anything like it. He could find no record of air being used in the same way but found an instance in which steam had been used thus. Bessemer too tried steam, but without success. Nevertheless, he specified both steam and air in his patent less the inventor of the steam process should claim his too. The first experiments taught him that by introducing air into the fluid cast iron a temperature could be obtained which was higher than any temperature previously known in the arts. Sir Henry experimented with the process six or seven months more, and then got the opinion of expert iron men on the process.

After watching a "Blow" Mr. Ramie said, "Whatever your difficulties are in working the details, the moment a practical iron master sees this wonderful invention, he will supply all those details and the thing will be done. This must not be hid under a bushel. The British Association meets next week at Cheltenham. If you have patented your process, draw up an account of it in a paper and have it read in section "G."

Acting on this suggestion, Sir Henry wrote a description of his process, entitling it, "The manufacture of malleable iron and steel without fuel". When this paper was read before the association it produced a perfect sensation. Some pronounced it a perfect impossibility; others spoke in favor of the plan, and said they believed it entirely possible, and expressed great satisfaction to know that at last a really good and cheap way of making iron and steel had been invented. After hearing the paper read, one man who before the meeting had ridiculed the idea of making steel without fuel, now admitted that he was convinced that it was possible. All were willing to see the process tried, and many went from the convention to see Bessemer make steel. Several experiments after the convention were successful in every respect, and steel of good quality was produced.

Bessemer divided the country into five principal iron districts, and offered to sell the exclusive patent right to the first iron master who would come to him and pay £10000 for one year's Royalty. He would then be allowed the use of the process for the remaining 13 years of the life of the patent free of charge. This proposition was accepted by five different iron masters. Two of them paid £10000 each, and within three weeks of the reading of the paper before the association, the licenses sold amounted to £25000.

The Dowlais Iron Co. was the first company to take out a license, and it was arranged that Sir Henry should look over their plant and draw up plans for the erection of the additional apparatus necessary to the working of the process. This he did, and the converters were put in so the molten cast iron could be run from the storage vessel into the converter. This company had been making iron rails. So now as soon as the apparatus was in, the molten cast iron was run into the converter and when the "blow" was finished the metal was run into moulds and as soon as it was cool it was tested and was found to be worthless for rails. More tests followed, but the steel was no good. It could not be used. Bessemer was unable to account for the failure of the process. Within a few weeks after, accounts were given of it before the convention, many iron workers had tried the process, following the directions accurately without success. Soon the papers and industrial Journals all over the country were denouncing the process, and many of them even called Sir Henry an impostor who had succeeded in deceiving the people and had swindled some of the iron masters out of large sums of money. In just six weeks after his first description had appeared in the Times; a meeting of the iron masters of South Staffordshire was called, and the new process was condemned as a practical failure. Bessemer felt these unjust accusations and charges very keenly. He had made many successful experiments, had produced good steel, had tested it in the severest possible manner and demonstrated that it was equal and even superior to steel that had been made by any other process; but now when he tried the process, going thru it in the same way, it would not work.

The product was hot "Short" and cold "Short". It could not be worked or tempered. He did not give up in despair, but went to work to discover the cause of his failure. After long and expensive trials and tests, he found that by accident the pig iron which he had used in his first experiments had been remarkably free from phosphorus and that as soon as he put iron into the converter which contained phosphorus in any considerable quantity the iron could not be used. In other words, the presence of phosphorus spoiled the product. He observed that the puddling process used in making wrought iron removed this element.

He tried many experiments embodying in some form this principle but at last abondoned it as a failure. He decided that the best way to get rid of phosphorus was to use iron which did not contain it, so he imported Swedish pig iron which is remarkably free from phosphorus. This cost £7 per ton but steel was then selling for £50 per ton so that he could still realize a handsome profit on his finished steel. This pig iron, when used in the converter gave almost chemically pure iron. The first experiment with this iron gave a product in which the six impurities which usually impregnate iron formed only one part in 625 while in the best of other iron they formed 1 in 145 parts.

But there was now a very, very important task still to be accomplished, — he found that this iron was perfectly malleable, but could not be hardened. It was first class wrought iron, but was not steel; it lacked the necessary per cent of carbon.

Carbon may exist in iron in the

ratio of 65 parts of carbon to 10000 of iron without assuming the properties of steel. If the percent be greater than that, and any where between 65 to 10 000 and 2 of carbon to 100 of iron the alloy becomes steel. In cast iron, the carbon exceeds 20 percent. In the first experiment just mentioned the ratio of carbon to iron was 14 to 1,000,000.

Sir Henry's difficulty now lay in carburizing his iron and thus making it steel. In this dilemma Science came to his aid. About one hundred years before a man named Bergman had discovered that manganese iron or "Spiegel Eisen" as it is called, which contained a known quantity of carbon was introduced into the converter after the process was completed and thus he at once secured a product which contained the proper amount of carbon and which could be worked and shaped with wonderful facility.

Sir Henry found that if the blast did not stop at a particular period, the solid metal was ignited and much was lost in this way. Here again was a problem. If the blast was shut off, the metal would run out of the holes at the bottom. This obstacle was soon surmounted. He mounted the converter on axles fastened to the sides of the converter. One of these was hollow, and thru this he forced air and conducted it to the bottom of the vessel by means of a passage. Now when he desired the blast to stop he turned the vessel upon its side and the blast no longer passed thru the metal. The spigel eisen could be added and the metal was then ready to pour into the moulds. The process when described by Sir Henry Bessemer at Cheltenham was so complete that only two important changes were afterward made. One was the introduction of ferro manganese, the other was an improvement in the mechanical apparatus.

The process was now complete. High grade steel of the finest quality and of great homogeneity could easily and cheaply be made in large quantitire. Suitable crude iron could easily and quite cheaply be obtained from Sweden. A vast field was open to the new metal.

But Bessemer still had a hard struggle to get his steel introduced. The people were still suspicious of the process. He, together with a partner, erected a steel plant at Sheffield. It proved a very good investment for them and soon built up a good trade. Their steel was used for many purposes. After repeated failures, and after being laughed at for his credulity Bessemer got the railroads to try his steel rails instead of the iron ones then in use and every test more than convinced the railroads of the value of these steel rails. One of them would wear as long as six or eight iron ones under the same conditions. Specimens of the steel were given to the employers of other mills to use in making tools. These produced as good tools as steel made by other processes, and gave good satisfaction.

Bessemer now pushed the introduction of the steel. He knew that if his steel could be used for tools it could be used for a thousand other purposes. The iron masters were stubborn to take hold of the process. They had not yet forgotten its recent failure. Sir Henry at last succeeded in getting the iron masters to use his process, and he allowed them to use it for a very reasonable consideration.

A few figures will suffice to say what the Bessemer process has done for the world. In the twenty five years that elapsed after the process was first successfully worked, the production of steel amounted to not less than 25000000 tons and if we estimate the saving as compared with the old process which it superceded at £40 per ton the total saving would be one billion dollars times five. In 1882, the world's productions was over 4 billion tons. When Bessemer's patent expired, he had received as royalty for the use of his process £1,057,748. He was tendered honors from all countries, and finally from his own country. The freedom of London was conferred upon him, and also a knighthood. But altho the government did bestow these honors, its treatment of him was most shameful.

After the completion and introduction of the process, Sir Henry completed numerous other inventions. Among others, was a telescope, an improved method of grinding, and polishing lenses. He lived a long, useful life, and perhaps did as much for the human race and for the advancement of civilization as has any single human being.

We find him an ingenious youth an energetic, scholarly, though modest young man. At middle age we find him the most noted inventor of England and he did not lose his prestige until quite aged. He died on March 14, 1898. at the age of 85.

Finis.