By an unknown writer

The development of stainless steel

The inventor of stainless steel, Harry Brearley, was born in Sheffield, England in 1871. His father was a steel melter, and after a childhood of considerable hardship, he left school at the age of twelve to get a job washing bottles in a chemical laboratory. By years of private study and night school he became an expert in the analysis of steel and its production. Having already established his reputation for solving metallurgical problems, Brearley was given the opportunity in 1908 to set up the Brown Firth Laboratories, which was financed by the two leading Sheffield steel companies of the day. This was a highly innovative idea for its time; research for its own sake on the problems of steel making.

In 1912 Brearley was asked to help in the problems being encountered by a small arms manufacturer, whereby the internal diameter of rifle barrels was eroding away too quickly because of the action of heating and discharge gases. Brearley was therefore looking for a steel with better resistance to erosion, not corrosion. As a line of investigation he decided to experiment with steels containing chromium, as these were known to have a higher melting point than ordinary steels. Chromium steels were already at that time being used for valves in aero engines. Iron has an atomic weight of 56, chromium 52, so chromium steel valves are lighter than their carbon steel counterparts, another reason why they were adopted so quickly by the emerging aircraft industry.

Using first the crucible process, and then more successfully an electric furnace, a number of different melts of 6 to 15% chromium with varying carbon contents were made. The first true stainless steel was melted on the 13th August 1913. It contained 0.24% carbon and 12.8% chromium. Brearley at this time was still trying to find a more wear-resistant steel, and in order to examine the grain structure of the steel he needed to etch (attack with acid) samples before examining them under the microscope. The etching re-agents he used were based on nitric acid, and he found that this new steel strongly resisted chemical attack. He then exposed samples to vinegar and other food acids such as lemon juice and found the same result.

At the time table cutlery was silver or nickel plated. Cutting knives were of carbon steel which had to be thoroughly washed and dried after use, and even then rust stains would have to be rubbed off using carborundum stones. Brearley immediately saw how this new steel could revolutionise the cutlery industry, then one of the biggest employers in Sheffield, but he had great difficulty convincing his more conservative employers. On his own initiative, he had knives made at a local cutler’s, R.F. Mosley. To begin with, Brearley referred to his invention as “rustless steel”. It was Ernest Stuart, the cutlery manager of Mosley’s who first referred to the new knives as “stainless” after in experiments he had failed to stain them with vinegar. “Corrosion resisting ” steel would be really the better term, as ordinary stainless steels do suffer corrosion in the long term in hostile environments.

Other claims have been made for the first invention of stainless steel, based upon published experimental papers that indicated the passive layer corrosion resistance of chromium steel or patented steels with a 9% chromium content intended for engineering purposes. Brearley’s contribution was that having come to a conclusion

by purely empirical means he immediately seized on the practical uses of the new material.
Within a year of Brearley's discovery, Krupp in Germany were experimenting by adding nickel to the melt. Brearley's steel could only be supplied in the hardened and tempered condition; the Krupp steel was more resistant to acids, was softer and more ductile and therefore easier to work. There is no doubt that but for Brearley's chance discovery, the metallurgists at Krupp would have soon made the discovery themselves. From these two inventions, just before the First World War, were to develop the "400" series of martensitic and "300" series of austenitic stainless steels.

The First World War largely put a halt to the development of stainless steel, but in the early 1920s a whole variety of chromium and nickel combinations were tried including 20/6, 17/7 and 15/11. Brearley fell out with his employers regarding the patent rights to his invention of stainless steel, and he left to join another Sheffield company, Brown Bayleys. His successor at the Brown Firth Laboratories was Dr W.H. Hatfield, who is credited with the invention in 1924 of 18/8 stainless steel (18% chromium, 8% nickel) which, with various additions, still dominates the melting of stainless steel today. Dr Hatfield also invented 18/8 stainless with titanium added, now known as 321.
Most of the standard grades still in use today were invented in the period 1913 to 1935, in Britain, Germany, USA and France. Once these standard grades became accepted, the emphasis changed to finding cheaper, mass-production methods, and popularising the use of stainless steel as a concept. This tended to stifle the development of new grades. However, after the Second World War, new grades with a better weight-to-strength ratio were required for jet aircraft, which led to the development of the precipitation hardening grades such as 17:4 PH . From the 1970s onwards the duplex stainless steels began to be developed. These have far greater corrosion resistance and strength than the grades developed in the 1920s and are really the future for the increasing use of stainless steel.