History of Haynes International, Inc.

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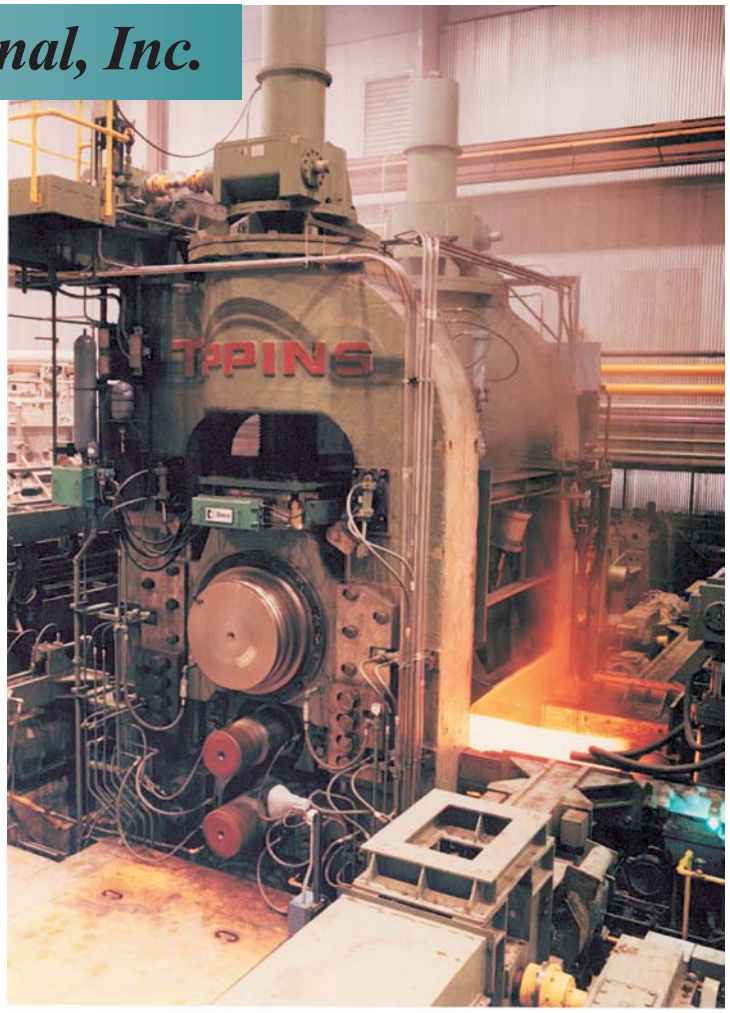
Haynes International, Inc.



The story of Haynes International spans almost a century. Intertwined with the 94 years of Haynes' continuous operation is the history of many nickel — and cobalt-based superalloys. Tracing the evolution of these unique materials, we will follow their applications in aerospace, rockets to Mars, world wars, the chemical industry, and medical prosthetics.

The company was formed in December, 1912 by Elwood Haynes in Kokomo, Indiana. Elwood Haynes was an inventor, teacher, experimenter, businessman, and philanthropist. He was born in Portland, Indiana in 1857 and received his education at Wooster Polytechnic Institute and John Hopkins University. His post graduate work at John Hopkins provided the basis for his successful metallurgical work that followed.

After a short early career as a teacher, Haynes entered the oil and gas industry. It was during this time that Haynes ideas for a "horseless carriage" were developed. Haynes moved to Kokomo in December of 1892 and found time to work on his "horseless carriage". His first automobile, the "Pioneer", was successfully tested July 4, 1894. While there is some dispute as to who the honor of the first automobile in the United States goes to, (J. Frank Duryea tested a horseless carriage in September, 1893), the success of the "Pioneer" led Haynes to form an automobile company producing high-end automobiles through the mid 1920s.

It was during 1887 that Haynes began experimenting with metals in search of a material that would resist tarnishing and be suitable for cutlery. After a number of years of unsuccessful experiments, he began working with nickel-chromium and cobalt-chromium alloys. After much additional experimentation he was successful, and was awarded two patents in 1907, one for the nickel-chromium alloy and one for the cobalt-chromium alloy. Subsequent work produced other cobalt-based alloys with additions of molybdenum and tungsten. Patents on these new alloys were granted in late 1912 and Haynes began to set up a manufacturing site. Haynes called these alloys "Stellite". This name came from the Latin word "stella" for star because of their star-like luster. (Stellite is a registered trademark of Deloro Stellite, Inc., Belleville, ON, Canada.)

While Haynes was targeting usage in cutlery, dental instruments, and edged tools, their real value was found in lathe tools. Cutting tools made from "Stellite" would outlast other products, and most importantly would allow cutting speeds three times as fast as the best available high speed steel tools.

The first name of the company was Haynes Stellite Works. In the early years of the company, Haynes continued experimentation with cobalt-based alloys. He was granted a patent for a cobalt-chromium-molybdenum-tungsten-carbon alloy in 1913, now known as Haynes® alloy 6B, that has been in continuous production since its discovery. Patents were granted for other cobalt alloys as well.

The business was incorporated in October, 1915 as Haynes Stellite Company. Over the course of the next year revenues for "Stellite" alloy exceeded $1,000,000. The company began to expand rapidly and had 20-25 employees in 1916. By 1918 sales were about $3,600,000. The reason for the growth was the First World War and the demand for lathe cutting tools. By 1920 employment was up to about 125 people.

The business was sold to Union Carbide in April, 1920 and this marked the start of the second chapter of the company's history.

The first few years of Union Carbide & Carbon (UCC) ownership were difficult for all parties. Being owned by a "group of eastern capitalists" was a challenge in small-town Kokomo.

The Union Carbide Era

Union Carbide's interest in Haynes was a result of Haynes being a customer of various ferroalloys provided by UCC. After the First World War ended sales had fallen and profitability was restored by 1925. Research continued on the cobalt alloys, expanding into hard-facing products. New alloys included trade names such as J-Metal, Star-J, and Haynes Stellite 98M2. There was considerable competition in the hard-facing market with the Stoody Company during this time.

In the early 1920s research was also being conducted on nickel-molybdenum alloys for corrosion resistance. This research was carried out at Union Carbide's R&D facilities at Niagara Falls and marked the beginning of the nickel-based superalloy industry. A patent was obtained on a nickel-molybdenum alloy composition range in 1921. From this came Hastelloy® A alloy and two years later, Hastelloy B alloy. The unique composition of Hastelloy B is still being manufactured today. About 1926 work was beginning on nickel-molybdenum-chromium alloys for improved corrosion resistance in oxidizing environments. From this research Hastelloy C was born. Today the fifth generation of this alloy (Hastelloy C-2000®) is being supplied to the chemical process industry by Haynes International. Hastelloy D, a nickel-silicon-copper alloy was also invented during the 1920s.

The History of Haynes International, Inc. continued

The company weathered the depression years selling its hard-facing alloys in industrial and agricultural applications and the new Hastelloy alloys in the growing chemical process industry. During this time new melting technology was moved to Kokomo from Union Carbide's facility in Niagara Falls, NY. It was about 1940 that the first wrought versions of the Hastelloy alloys were being developed and rolled at Ingersoll Steel and Disc Company in New Castle, Indiana.

The 1940s were the beginning of a new era for the company. The second world war would alter the company's future much as the first world war had done. One of the growing applications for Stellite was investment cast turbine blades (or buckets). These blades were used in the superchargers for military piston engines on a number of planes. Over 25 million buckets were produced for the war effort. Haynes Stellite alloys 21 and 31, both cobalt-based, were used in this application about 1941. Haynes Stellite was the premier investment casting house in the US at this time and supplied about 70% of the turbine buckets used.

Another application using both the Stellite alloys and the new Hastelloy alloys was search light reflectors for the US Navy. These metallic reflectors were shatterproof and maintained a high luster even in saltwater environments. These reflectors were made from plate rolled by outside conversion sources using billet melted in Kokomo. Another factor in the growth of the company during the 1940s was the large amount of Hastelloy alloy used by the Manhattan Project and the Chemical Warfare Service.

Production during the war years was at an all time high, with employment reaching over 2,000 during the second world war and 3,000 by the end of the Korean war.

A major milestone occurred in the late 1940s with the establishment of the wrought alloy plant in Kokomo. Prior to this, wrought products were finished by outside rolling mills. The new wrought alloy plant was situated on about 100 acres of land south of the main plant location. This new facility included rolling equipment for the production of plate and sheet products.

New high temperature wrought alloys were also being added. MULTIMET® (a nickel-cobalt-chromium-molybdenum-tungsten alloy) appeared in 1949 and in 1950 the cobalt alloy L-605 (now called Haynes alloy 25) was first manufactured. These alloys found increasing usage in aircraft superchargers and in the newly invented jet engine.

The invention of a new nickel-based alloy, Hastelloy X, in 1953 marks the beginning of the next chapter in the company's history.

The Expansion Era

In many respects the 1950s marks the beginning of significant change for the company. New alloys, led by Hastelloy X, were being invented, and new applications were being found. In the case of Hastelloy X, it was the right alloy at the right time. Just as the alloy was being introduced, Pratt & Whitney was looking for a replacement material for a failed combustor can in their new JT-3 jet engine. Hastelloy X was tested and performed very well. It was chosen for the JT-3 and the later JT-8D engines, which powered the first Boeing 727 aircraft. Fifty years later, Hastelloy X remains the largest volume nickel-based sheet alloy for gas turbine hot section components.

1957 saw the installation of 6 new vacuum furnaces in Kokomo. This melting technology allowed the company to manufacture more sophisticated alloys, particularly alloys with additions of aluminum and titanium.

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The 1960s were characterized by advances in superalloy metallurgy, particularly the introduction of Argon Oxygen Decarburization (AOD) and Electro Slag Remelting (ESR). AOD processing allows for the manufacturing of alloys with very low levels of carbon. This process is similar to decarburizing steel with an oxygen lance. The ESR process is a second melting operation that refines the cast structure and removes impurities. These improvements allowed the development of a new class of superalloys for both high temperature and corrosive applications. The most notable were Hastelloy C-276 and Haynes® 188 alloys. Hastelloy C-276 is now an industry standard alloy for use in the chemical and petrochemical processing. Haynes 188 remains the alloy of choice for jet engine afterburner components in engines like the Pratt and Whitney F-100. The invention of Haynes 188 allowed jet engine designers to increase the temperature in the engine by 300 degrees F, resulting in substantially greater thrust and performance.

Along with advances in melting technology and the subsequent refinement in superalloy capabilities, the 1960s brought a new cold strip mill to the company. This mill gave the company greatly expanded capabilities and capacity in the production of sheet, coil, and strip products. The growing aerospace market was a big user of sheet material and the new strip mill was the right capital expansion at the right time. As in past wars, the Vietnam conflict used substantial amounts of products produced in Kokomo, Indiana. Ironically, one of the major applications was for helicopter rotor shields made from Haynes alloy 6B, which was invented by Elwood Haynes *before* the first world war.

The Modern Era

In January, 1970 Union Carbide sold the company to Cabot corporation, ending fifty years of ownership by UCC. Following this transaction, alloy development work continued vigorously and took advantage of the advanced capabilities of the new melting and rolling technologies. New low carbon double melted alloys were being introduced into both aerospace and chemical industry applications. New markets, such as Flue Gas Desulfurization, were beginning to use superalloys such as Hastelloy C-276 in many critical applications.

Hastelloy B-2, the second generation of Hastelloy B alloy, was introduced. Hastelloy C-4, designed for the European chemical industry was also brought out.

Changes in the commercial organization were occurring as well. More and more applications in the Chemical Process Industries and the Aerospace market were opening up in Europe. The company opened a service center in Corby, England in 1974 and one in Lille, France in 1978. Nickel Contor, a service center in Zurich, Switzerland, was purchased in 1977.

The Arcadia tubular manufacturing facility in Arcadia, Louisiana was started in 1977.

By 1980 it was clear that the company had to improve its sheet and coil manufacturing. New applications required better quality control and lower costs, and higher capacities were needed for growth. It was for these reasons that the company embarked on its most ambitious capital expansion project.

Installation of the "4-High"

In 1980 work began on the installation of a new 4-High combination plate/hot band Stekel mill. This facility would have the ability to hot roll superalloy plate product up to 2 inches thick and 72 inches wide and produce continuous 10,000 pound hot bands at widths up to 48 inches with a thickness of 0.250" or less. When installation was finished in 1982, Haynes had a state-of-the-art hot mill that is still the largest, most powerful 4-High Stekel mill in the world devoted to the rolling of nickel- and cobalt-based superalloys. This mill was designed and installed by George Tippins of Pittsburgh, PA and features a 12 million pound separating force. The two mill housings weigh 300,000 pounds each and were cast in Germany.

Alloy development was also moving at a fast pace. The early 1980s saw the introduction of several major alloys including Hastelloy C-22®, Hastelloy G-30®, Haynes 214®, Haynes 242®, Haynes HR-120®, Haynes HR-160®, and Haynes 230®. All of these superalloys are still in production and have become standard engineering materials in many applications.

The 4-High allowed the company to produce large continuous hotbands to feed the cold strip mill. Prior to the 4-High, hot bands were built up by welding long, narrow 0.250" plates together end-to-end to form a coil. This method of building up a hotband is still used for some small volume hard-to-make alloys where their metallurgical properties prevent 4-High hotband rolling.

Uses for superalloys continued to expand in the 1980s. Millions of pounds were specified for flue gas desulfurization units at coal-fired power plants. Removing sulfur compounds from the exhaust gases of coal burning boilers can be very corrosive and nickel-based superalloys are used in the "scrubbers", breeching ducts, and even chimney liners of power plants. Hastelloy C-276, C-22® and C-2000® alloys are standard engineering materials in these systems. Another interesting application involved the Abrams M-1 Main Battle Tank. This tank has a 1500 horsepower gas turbine engine and uses an air-to-air heat exchanger, often referred to as the recuperator, to heat intake air with the exhaust gases from the turbine. The recuperator is a plate type unit and uses several hundred pounds of superalloy for each engine. Haynes supplied millions of pounds for this application.

Today

Today Haynes International is a thriving developer and manufacturer of superalloys with 8 company-owned service centers around the world. The combination of primary manufacturing facilities with multiple service center locations is unique in the superalloy industry. The research and development commitment is also quite unique in today's highly competitive environment. The most recent inventions include a new nickel-chromium-molybdenum alloy, Hastelloy G-35®, designed for phosphoric acid service. Also just being introduced is a new high temperature alloy, Haynes 282™ which is an age-hardenable superalloy designed for hot section components in military and commercial gas turbines. This alloy appears to be a significant improvement over existing hot section alloys and will likely develop into a high volume aerospace alloy.

Often research and development can take several years to go from an idea to a viable alloy product. Even though the nickel and cobalt metallurgy field has been thoroughly researched over the last 100 years, there are still innovations to be found. R&D remains an important part of Haynes' business and new alloys will continue to be invented in Kokomo.

As the company approaches its 100th anniversary, Haynes International is a company that lives up to its slogan "A History of Innovation Spanning a Century".

This article was written with the help of many people. Many of the facts cited and many of the quotations come directly from the book STELLITE — A History of the Haynes Stellite Company 1912-1972, by Ralph D. Gray. Dr. F. Galen Hodge, associate director of the Materials Technology Institute, greatly assisted in the editing of the article and in the chronology of events. Numerous others also helped with the years after 1972, when Ralph Gray's book ends. Many thanks to all who helped.