

History of Metal Casting

A Brief Timeline

Metal Technologies

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History of Metal Casting

Metal Technologies has compiled a brief timeline of metal casting to give you an overview of the long and proud history of our industry. Since its discovery, metal casting has played a critical role in the development and advancement of human cultures and civilization. After 5000 years of technological advances, metal casting plays a greater part in our everyday lives and is more essential than it has ever been.

Origins of Metal Casting

- 3200 B.C.** A copper frog, the oldest known casting in existence, is cast in Mesopotamia.
- 2000 B.C.** Iron is discovered.
- 800-700 B.C.** First Chinese production of cast iron.
- 645 B.C.** Earliest known sand molding (Chinese).
- 233 B.C.** Cast iron plowshares are poured in China.
- 500 A.D.** Cast crucible steel is first produced in India, but the process is lost until 1750 when Benjamin Huntsman reinvents it in England.

Middle Ages to 1800

- 1455** Dillenburg Castle in Germany is the first to use cast iron pipe to transport water.
- 1480** Birth of Vannoccio Biringuccio (1480-1539), the "father of the foundry industry," in Italy. He is the first man to document the foundry process in writing.
- 1642** [Saugus Iron Works](#), America's first iron foundry (and second industrial plant), is established near Lynn, Massachusetts. The first American iron casting, the Saugus pot, is poured there.
- 1709** Englishman Abraham Darby creates the first true foundry flask for sand and loam molding.
- 1720** Rene Antoine de Reaumur develops the first [malleable iron](#), known today as "European Whiteheart."
- 1730** Abraham Darby is the first to use [coke](#) as fuel in his melting furnace in Coalbrookdale, England.
- 1750** Benjamin Huntsman reinvents the process of cast crucible steel in England. This process is the first, in which the steel is completely melted, producing a uniform composition within the melt. Since the metal is completely molten, it also allows for alloy steel production, as the additional elements in the alloy can be added to the [crucible](#) during melting. Prior steel production was accomplished by a combination of forging and tempering, and the metal never reached a molten state.
- 1776** Foundrymen Charles Carroll, James Smith, George Taylor, James Wilson, George Ross, Philip Livingston and Stephen Hopkins sign the American [Declaration of Independence](#).
- 1794** First use of the [Cupola](#) in iron founding. Invented by John Wilkinson of England, the original had metal-cladding and utilized a steam engine to provide the air blast.

The 19th Century

- 1809** Centrifugal casting is developed by A. G. Eckhardt of Soho, England.
- 1815** The [cupola](#) is introduced in the United States in Baltimore, MD.
- 1818** First cast steel produced by the [crucible](#) process in the U.S. at the Valley Forge Foundry.
- 1825** Aluminum, the most common metal in the earth's crust, is isolated.
- 1826** Seth Boyden of Newark, NJ, is the first to develop a process for and produce "[blackheart](#)" malleable iron.
- 1831** In Cincinnati, OH, William Garrard establishes the first commercial crucible steel operation in the U.S.
- 1837** First dependable molding machine is marketed and used by the S. Jarvis Adams Company in Pittsburg.
- 1845** The open hearth furnace is developed.
- 1851** Sir Henry Bessemer and William Kelly both invent a simple converter that uses blasts of air to burn out the impurities, silicon, manganese and excess carbon in pig iron. Although Kelly is the first to use a converter, Bessemer obtains the U.S. patents. Kelly proves patent priority in 1857.
- 1863** Metallography, the etching, polishing, and microscopic evaluation of metal surfaces, is developed by Henry C. Sarby of Sheffield, England. It is the first process to physically examine the surface of castings for quality analysis.
- 1867** James Nasmythe develops a gear-tilted foundry ladle, increasing worker safety and operational economy.
- 1870** Sandblasting is first used to clean large castings by R. E. Tilghman of Philadelphia.
- 1880-1887** The Sly tumbling mill is developed. It is the first cleaning machine for small castings. This mill greatly reduced the time needed for hand-cleaning operations and produced a finer finished product.
- 1896** American Foundrymen's Association (renamed American Foundrymen's Society in 1948 and now called the [American Foundry Society](#)) is formed.
- 1897** [Investment casting](#) is rediscovered by B.F. Philbrook of Iowa. He uses it to cast dental inlays.

Early 20th Century

- 1906** First electric arc furnace is used in the U.S. at Holcomb Steel Co. in Syracuse, NY.
- 1913** First true stainless steel melted by Harry Brearley in Sheffield, England.
- 1913** Crucible Steel Casting Co.'s Lansdown, PA plant installs the first low-frequency electric furnace for special melting.
- 1923** Formation of the International Committee of Foundry Technical Associations in Zurich, Switzerland.
- 1924** Dr. W.H. Hatfield invents 18/8 stainless steel (18% chromium, 8% nickel).
- 1930s** University of Michigan professors pioneer Spectrography for metal analysis.
- 1930** First high-frequency coreless electric induction furnace in the U.S. is installed in the Lebanon Steel Foundry in Lebanon, PA.
- 1940** Wood flour is introduced into foundry practice as a sand additive.
- 1947** The [Shell Process](#), invented by J. Croning of Germany during WWII, is discovered by U.S. officials and made public.
- 1948** Development of [ductile iron](#), a cast iron with a fully spheroidal graphite structure.
- 1949** U.S. patent granted to K.D. Millis, A.P. Gagnebin and N.B. Pilling of International Nickel Company for developing ductile iron.
- 1953** The Hotbox system of making and curing cores in one operation is developed, eliminating the need for dielectric drying ovens.
- 1958** H.F. Shroyer is granted a patent for the full mold process, the forerunner of the expendable pattern (lost foam) casting process.
- 1960s** Compactibility and methylene blue clay tests are developed for [green sand](#) control. Also developed at this time are high-pressure molding processes and fast-setting no bake binders for sand.
- 1964** The first [Disamatic](#) molding machine is introduced.
- 1965** The Scanning Electron Microscope is invented by the Cambridge University Engineering Department in England.
- 1965** Cast metal matrix composites are first poured at International Nickel Company in Sterling Forest, NY, by Pradeep Rohatgi.
- 1968** The [Cold Box Process](#) is introduced by L. Toriello and J. Robins for high production core

making.

Late 20th Century

- Early 1970s** The Semi-Solid Metalworking (SSM) process is conceived of at Massachusetts Institute of Technology. It combines aspects of casting with aspects of forging.
- 1971** The Japanese develop V-Process molding. This method uses unbonded sand and a vacuum.
- 1971** [Rheocasting](#) is developed at Massachusetts Institute of Technology.
- 1971** U.S. Congress passes the Clean Air Act and OSHA, the Occupational Health and Safety Act.
- 1972** The first production Austempered Ductile Iron (ADI) component is produced by Wagner Castings Company.
- 1974** Fiat introduces the in-mold process for ductile iron treatment.
- 1976** Compacted graphite iron (CGI), an iron with elongated graphite particles with rounded edges and roughened surfaces, is developed in the U.K. It has characteristics of both gray and ductile iron.
- 1982** The [Warm Box](#) binder system is introduced.
- 1993** First foundry application of a plasma ladle refiner (melting and refining in one vessel) occurs at Maynard Steel Casting Company in Milwaukee, WI.
- 1995** Babcock and Wilcox, Barberton, OH, patent a lost foam vacuum casting process to produce stainless steel castings with low carbon content.
- 1996** Cast metal matrix composites are first used in a production model automobile in the brake rotors for the Lotus Elise.
- 1997** Electromagnetic casting processes developed by Argonne and Inland Steel Corporation. Electromagnetic edge containment greatly reduces cost and energy expenditures in steel production.

Glossary

Blackheart: American type of malleable iron. The normal fracture has a medium gray outer rim and a very black interior.

Coke: Coal derivative resulting from the distillation of bituminous coal in the absence of air. The distillation process removes all of the volatile material from the coal so it can be used as a very intense source of fuel in cupola melting.

Cold Box Process: A rapid coremaking process which does not require application of heat to cure the cores. Hardening of the cores is accomplished by chemical reaction rather than by conventional baking. A phenolic resin is added to the sand used to make the core. This resin reacts chemically when exposed to an accelerator (typically an active organic gas) and hardens very quickly, forming an organic bond in the core sand. This reaction occurs at room temperature and does not require special coreboxes or equipment. Additionally, since the bond is organic, the sand collapses readily during shakeout and can be recovered easily from the casting.

Crucible: A ceramic pot with refractory properties typically made of clay in which metal is melted for casting.

Cupola: Vertically oriented, tube shaped melting furnace in which the metal is melted in direct contact with the fuel.

Ductile Iron: A type of iron in which the graphite content takes spherical rather than flake form. Ductile iron is produced by adding magnesium. The spherical form of the graphite provides greater tensile strengths and flexibility than other types of iron.

Green Sand: Natural sands combined with water and organic additives (such as clay) to proper consistency for creating molds.

Investment Casting: Method of casting using an expendable pattern of wax, plastic, or other material which is "invested" or surrounded by a molding medium in slurry or liquid form. After the molding medium has solidified, the pattern is removed by subjecting the mold to heat, leaving a cavity for reception of molten metal. Also called lost-wax molding.

Malleable Iron: Iron that may be altered in shape by hammering or by the pressure of rollers without exhibiting fracture or brittleness. The majority of the carbon content is in the form of graphite nodules rather than flakes.

Rheocasting: Also called flow casting. A metal forming process in which a semi-solid metal is used to make the casting. The solid metal is heated to a partly liquid, softened state and then pressed into the final form. The finished part has closer tolerances, better surface finish, higher strength, and lighter weight than a similar part made with traditional casting techniques.

Shell Process: Process in which clay-free silica sand coated with a thermosetting resin or mixed with resin is placed on a heated metal pattern for a short period of time to form a partially hardened shell. The bulk of the sand mixture inside the resulting shell is removed for further use. The pattern and shell are then heated further to harden or polymerize the resin-sand mix, and the shell is removed from the pattern. Frequently, shell cores are made using the Hot Box process.

Warm Box Process: Coremaking method in which the corebox is warm when the core sand is introduced. The warmth of the corebox initiates curing but does not complete it. Cores finish curing outside the corebox (sometimes in a separate dryer), allowing for faster core production cycles than with the Hot Box process. Cores created using this process must be solid- they cannot be shell cores.