

Medieval & Early Modern Europe

Iron & Milling Technology

Early Middle Ages

Early Middle Ages-New iron mines and smelting sites are established

- The first literature on mining and metallurgy appears.
- The furnace gains a small chimney of clay and sandstone; gas exit and two openings, one for introduction of the ore and one aperture near the bottom to allow extraction of the “bloom” of iron.
- The introduction of a draft supplied by a pair of bellows.
- The hinged flail, although invented in the fourth century, slowly begins to displace the simple stick for threshing grain.
- Iron use increases (plowshares, harrows, sickles, billhooks, church bells, long swords, battle axes, chain mail).
- The lathe is diffused more widely (2 types, pole lathe and bow lathe)
- Swords, axes, agricultural and household implements are sharpened with a rotary grindstone, as opposed to the earlier whetstone. The rotary grindstone employs a crank.
- The Roman Vitruvian mill and windmill, not generally used in Mediterranean world, are widely disseminated throughout the medieval world and technologically developed, advancing from a mere 3 horsepower yield to 40-60 horsepower.

10-11th century

10th century-The shortage of charcoal begins as a result of deforestation; laws limiting its production appear. Efforts to adapt coal for metallurgical purposes are intensified.

- Invention of the drawplate aids blacksmiths in fabricating wire for chain mail, until then painstakingly hammered out at the forge.

11th century-Water-driven bellows and hammers appear in the eastern Alps and Silesia.

Medieval & Early Modern Europe**Iron & Milling Technology****12th century**

Early 12th century-Guilds of craftsmen, including metalworkers, join guilds of merchants.

- The blacksmith's work is in higher demand as building and commerce increase. Carpenters required nails, saws and hammers; masons, mallets, picks, wedges and chisels; carters and wagoners, iron axles and parts; millers, iron components of mill machinery; shipbuilders, nails and fittings.
- Surface deposits of iron ore no longer suffice; pits, trenches and tunnels are driven into the earth.
- The long-handled scythe, developed in the Roman Empire, gains a short bar-handle projecting from its long haft.

1122-23-Theophilus Presbyter writes *De diversis artibus*.

Mid 12th century-The blacksmith moves from the castle as armorer to the village, as the demand for his services to agriculture grow.

1185-The earliest surviving written record of a post-mill is a rental note in Weedly, Yorkshire.

1195-Post-mills become popular enough to have the Pope levy a tithe on them.

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13th century

Early 13th century-The windmill becomes the prime-mover on the plains of eastern England, the Low Countries and northern Germany.
 Mid 13th century-Coal is used for the primary stages of iron smelting, although charcoal still predominates.
 -Water mill construction rapidly increases, as mill function becomes more specialized.
 -The combination of mills and weirs appears, to measure the flow of water to the millrace.
 -The technique of raising the carbon-content of iron to produce cast iron is discovered
 -Threshing begins to be done under cover, far into the winter in great barns, usually on monastic estates.
 Late 13th century-The use of wheelbarrow reduces the number of necessary laborers by half, particularly for mining ore.

14th century

1309-1377-The Papacy is at Avignon.
 1314-At the Battle of Bannockburn, Scotland regains independence under Robert the Bruce.
 1321-Death of Dante.
 1325-The Renaissance begins in Italy.
 -Muslim culture in Spain reaches its peak.
 -The small cannon is in use.

 1331-Nicaea falls to the Ottomans.

Early 14th century-Water-powered stamping mills appear in the Saar.
 c1325-Forged iron firearms appear in Germany.

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1337-1453-During the Hundred Years' War, English and French kings fight for control of France.

1340-Edward III, King of England assumes the French crown.

1347-1351-At least 25 million people die in Europe's "Black Death" (bubonic plague). The Plague reaches Genoa from Crimea.

-Calais is sieged and captured by Edward III.

1353-Boccaccio's *Decameron* is written.

1354-Turks invade Gallipoli.

1358-Peasants rise up in France.

1360-Edward III renounces the French crown.

1361-The second wave of the Plague.

c1370-1444-Life of Leonardo Bruni.

1374-Petrarch dies.

1376-1382-John Wycliffe, pre-Reformation religious reformer, and followers translate the Bible from Latin into English.

1377-1446-Life of Filippo Brunelleschi.

1378-1455-Life of Lorenzo Ghiberti.

1378-1417-The Great Schism has rival popes in Rome and Avignon fighting for control of the Roman Catholic Church. The papacy returns to Rome later that year from Avignon.

1386-1466-Life of Donatello.

c1387-Chaucer's *Canterbury Tales* is written.

1395-1441-Life of Jan van Eyck.

1397-Norway, Denmark and Sweden are united by the Union of Kalmar.

-Medici bank is founded.

1397-1475-Life of Paolo Uccello.

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c1350-The first cast iron cannons appear.

-The earliest known blast furnace is built in Europe, at Lapphytten, Sweden.

1351-The application of water-power to wire-drawing in Augsburg.

Late 14th century-The shortage of labor leads to a severe decline in the production of metals.

-The price of iron and charcoal rises.

1370-Iron needles (with no eye but a closed hook) are produced at Nuremberg.

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15th century

1400-Chaucer dies.
 1404-The University of Turin is founded.
 1406-Florence conquers Pisa.
 1407-Casa di San Giorgio, one of the first public banks, is founded in Genoa.
 1409-The University of Leipzig is founded.
 1412-31-Life of Joan of Arc.
 1415-Henry V defeats the French at the Battle of Agincourt. Jan Hus, Bohemian preacher and follower of Wycliffe, is burned at the stake in Constance as a heretic.
 1418-1460-Portugal's Prince Henry the Navigator sponsors exploration of Africa's coast.
 1420-Brunelleschi begins work on the Duomo in Florence.

Early 15th century-Casting directly from the furnace into the mould is achieved.

1428-Joan of Arc leads the French against the English, is captured by the Burgundians (1430) and turned over to the English, and burned at the stake as a witch after an ecclesiastical trial (1431).
 1434-Cosimo de Medici begins his 30-year domination of Florence.
 1435-1488-Life of Andrea del Verrocchio.
 1442-Naples and Sicily come under the rule of the Spanish House of Aragon.
 c1444-1510-Life of Sandro Botticelli.
 1444-1514-Life of Donato Bramante.
 1447-The Vatican Library is founded.

1430-The Dutch invent the “wipmolen” or hollow post-mill.
 Mid 15th century-Eyed iron needles are produced in Low Countries.
 - More attention is paid to the legal aspects of mining, smelting and raw material consumption because the manufacture of bronze and iron contributed powerfully to a state’s warlike potential. Wars subsequently increase the demand for and price of iron.
 -The scythe replaces the sickle as the primary tool for harvesting grain.
 -Attempts are made to make milling simpler and more efficient.
 -Post-mills begin to be built to drive two pairs of stones placed fore-and-aft in the mill, rather than only one pair of stones, as before.

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c1450-Gutenberg invents the moveable type printing press.
 1450-Florence becomes the center of Renaissance arts and learning under the Medicis.
 -Francesco Sforza conquers Milan.
 1452-1519-Life of Leonardo da Vinci.
 1453-Constantinople falls to the Turks, under Mehmed II, ending the Byzantine Empire and beginning the Ottoman Empire.
 1455-The Wars of the Roses, civil wars between rival noble factions, begin in England (to 1485).
 -Johann Gutenberg completes first printed Bible.
 1456-Ottoman Turks capture Athens.
 1462-The Platonic Academy is founded. Ivan the Great rules Russia until 1505 as the first czar and ends payment of tribute to the Mongols.
 1463-Venice begins a 16-year war with the Turks.
 1469-1522-Life of Nicolo Machiavelli.
 1471-The University of Genoa is founded.

1473-1543-Life of Nicolaus Copernicus.
 1475-1564-Life of Michelangelo Buonarroti.
 1478-Pope Sixtus IV authorizes the Spanish Inquisition.
 1479-Venice is defeated by the Turks.
 1483-1520-Life of Raphael.
 c1488-1576-Life of Titian.
 1492-The troops of Ferdinand and Isabella conquer the Moors in Spain.
 -Columbus becomes the first European to encounter the Caribbean islands, and returns to Spain (1493). His second voyage is to Dominica, Jamaica, Puerto Rico (1493-1496). His third voyage is to Orinoco (1498). His fourth voyage is to Honduras and Panama (1502-1504).
 1494-Charles VIII invades Italy; Medici is driven from Florence.
 1494-1534-Life of Corregio.
 1497-Vasco da Gama sails around Africa and discovers a sea route to India (1498). He establishes a Portuguese colony in India (1502). John Cabot, employed by England, reaches and explores the Canadian coast.
 -Michelangelo sculpts the *Bacchus*.

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c1450-Saigerhuetten are first erected.
 1460-1530-The iron industry booms.
 Late 15th century-*Kriegsbuecher* and *Ruestungsbuecher*, describing metalworking in terms of warfare and armament, and *Bergwerkbuechlein* and *Probierebuechlein*, essays on mining and assaying, become widespread with the use of the printing press
 -The most agriculturally advanced region in Europe, Flanders, develops a scythe with a small half-circle of bent withy attached near the base of the handle, to gather together the cut grain stems.

1489-94-Duerer's paints his watercolor of a wire mill.

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16th century

1503-1566-Life of Nostradamus.

c1503-Leonardo da Vinci paints the *Mona Lisa*.

1504-Spain conquers the Kingdom of Naples. Michelangelo sculpts the *David*.

1506-1626-St. Peter's Church in Rome is constructed, designed and decorated by such artists and architects as Bramante, Michelangelo, da Vinci, Raphael, and Bernini.

1509-Michelangelo paints the ceiling of the Sistine Chapel.

-Erasmus' *Praise of Folly* is written.

1512-Medici power is restored in Florence.

1513-Balboa becomes the first European to encounter the Pacific Ocean.

-Machiavelli writes *The Prince*.

1515-Sir Thomas More writes *Utopia*.

1517-Martin Luther posts his 95 theses denouncing church abuses in Wittenberg, starting the Reformation in Germany.

1519-Ulrich Zwingli begins the Reformation in Switzerland.

-Hernando Cortes conquers Mexico for Spain.

-Charles I of Spain is chosen as Holy Roman Emperor.

-Portuguese explorer Ferdinand Magellan sets out to circumnavigate the globe.

1502-Boller proposes using mill-power to shake sieves, thus beginning the mechanization of bolting in milling.

1530-J.A. Pantheus writes *Voarchadumia contra alchimiam*, a book of alchemical nature, concerned with the metallurgy of the more precious metals and materials.

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1520-Luther is excommunicated by Pope Leo X. Suleiman I (“the Magnificent”) becomes Sultan of Turkey, invades Hungary (1521), Rhodes (1522), attacks Austria (1529), annexes Hungary (1541), Tripoli (1551), makes peace with Persia (1553), destroys Spanish fleet (1560), dies (1566). Magellan reaches the Pacific and is killed by Philippine natives (1521). One of his ships under Juan Sebastián del Cano continues around the world and reaches Spain (1522).

1522-Magellan’s ship returns from circumnavigation of the globe.

1527-Troops of the Holy Roman Empire attack Rome, imprison Pope Clement VII, ending the Italian Renaissance.

-Castiglione writes *The Courtier*.

-The Medici family is expelled from Florence.

1530-Medici is restored.

1532-Machiavelli’s *The Prince* is published posthumously.

1535-Reformation begins as Henry VIII makes himself head of English Church after being excommunicated by the pope. Sir Thomas More is executed as a traitor for his refusal to acknowledge the king’s religious authority.

1536-Henry VIII executes his second wife, Anne Boleyn.

-John Calvin establishes the Reformed and Presbyterian forms of Protestantism in Switzerland and writes his *Institutes of the Christian Religion*.

-Danish and Norwegian Reformations take place.

-Michelangelo completes his *Last Judgment*.

-Guicciardini writes *The History of Italy*.

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- 1541-John Knox leads the Reformation in Scotland and establishes the Presbyterian church there (1560).
- 1543- *On the Revolution of Heavenly Bodies* by Polish scholar Nicolaus Copernicus is published, giving his theory that the earth revolves around the sun.
- Vesalius writes *The Fabric of the Human Body*.
- 1545-The Council of Trent meets intermittently until 1563 to define Catholic dogma and doctrine and reiterate papal authority.
- 1547-Ivan IV (“the Terrible”) is crowned as czar of Russia, begins the conquest of Astrakhan and Kazan (1552), battles nobles (boyars) for power (1564), kills his son (1580), dies, and is succeeded by his son, Fyodor I.
- 1553-Roman Catholicism is restored in England by Queen Mary I.
- 1548-The University of Messina is founded.
- 1556-Akbar the Great becomes Mogul emperor of India, conquers Afghanistan (1581), and continues wars of conquest (until 1605).
- 1558-Queen Elizabeth I restores Protestantism and establishes the state Church of England (Anglicanism).
- The Renaissance will reach its height in England—Shakespeare, Marlowe, Spenser.
- 1561-The Edict of Orleans attempts to end persecution of the Huguenots in France. French religious wars begin again with the massacre of Huguenots at Vassy. At the St. Bartholomew's Day Massacre, thousands of Huguenots are murdered (1572). Amnesty is granted (1573). Persecution continues periodically until the Edict of Nantes (1598) gives Huguenots religious freedom (until 1685).
- 1568-Protestant Netherlands revolts against Catholic Spain; independence will be acknowledged by Spain in 1648.
- 1570-Queen Elizabeth I is excommunicated by the pope.
- Turks attack Cyprus and war on Venice. The Turkish fleet is defeated at the Battle of Lepanto by Spanish and Italian fleets (1571). Peace of Constantinople (1572) ends Turkish attacks on Europe.

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- 1540-Italian metallurgical engineer, Vannoccio Biringuccio, writes about water-powered wire-drawing mills in his *Pirrotechnia*.
- 1550-Wooden box-bellows are invented by Hans Lobsinger of Nuremberg, displacing the older leather ones.
- c1550-Blast furnaces reach sizes of around twelve to sixteen feet high and four-and-a-half feet wide.
- 1556-Georgius Agricola (Georg Bauer) writes the *De re metallica*, the great textbook on every aspect of mining.
- Late 16th century-The production of iron by the indirect process, using moulds, or pigs, comes into widespread use, particularly in northern Europe, in the Low Countries, in Sweden and in Britain.
- 1574-Lazarus Ecker writes his *Treatise describing the foremost kinds of Metallic Ores and Minerals*, adding to the previous printed knowledge on assaying.

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1580-Francis Drake returns to England after circumnavigating the globe and is knighted by Queen Elizabeth I (1581).
 -Montaigne's *Essays* are published.
 1582-Pope Gregory XIII implements the Gregorian calendar.
 1583-William of Orange rules the Netherlands; he is assassinated on orders of Philip II of Spain (1584).
 1587-Mary, Queen of Scots, is executed for treason by order of Queen Elizabeth I.
 -Monteverdi composes the *First Book of Madrigals*.
 1588-The Spanish Armada is defeated by the English.
 -Henry, King of Navarre and Protestant leader, is recognized as Henry IV, first Bourbon king of France. He converts to Roman Catholicism in 1593 in attempt to end religious wars.
 1590-Henry IV enters Paris, wars on Spain (1595), marries Marie de Medici (1600), and is assassinated (1610).
 -Spenser writes *The Faerie Queen*.
 -El Greco paints *St. Jerome*.
 -Galileo experiments with falling objects.
 1598-Boris Godunov becomes the Russian czar.
 -Tycho Brahe describes his astronomical experiments.

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1588-Giambattista della Porta is the first to mention the use of the trompe bellows, invented in Italy.
 -Agostino Ramelli writes his book on machines, including milling devices, *Le diverse et artificiose machine*, in Paris.
 c1595-Verantius writes *Machinae novae* in Venice.

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17th century

1600-Giordano Bruno is burned as a heretic.
 -The English East India Company established.
 1603-Shakespeare writes *Hamlet*.
 1605-Cervantes writes *Don Quixote de la Mancha*, the first modern novel.
 1609-The *Relation*, the first newspaper, debuts in Germany.
 1610-Galileo sees the moons of Jupiter through his telescope.
 1611-Gustavus Adolphus is elected King of Sweden.
 -The King James Version of the Bible published in England.
 -Rubens paints his *Descent from the Cross*.
 1614-John Napier discovers logarithms.
 1618-The Thirty Years' War begins as Protestants revolt against Catholic oppression; Denmark, Sweden, and France will invade Germany in later phases of the war.
 -Kepler proposes the last of the three laws of planetary motion.

1633-The inquisition forces Galileo to recant his belief in Copernican theory.

1642-The English Civil War begins, pitting the Cavaliers, supporters of Charles I, against the Roundheads, parliamentary forces. Oliver Cromwell defeats the Royalists (1646). Parliament demands reforms. Charles I offers concessions, is brought to trial (1648) and beheaded (1649). Cromwell becomes Lord Protector (1653).
 -Rembrandt paints his *Night Watch*.
 1644-Descartes writes his *Principles of Philosophy*.
 1648-The Thirty Years' War ends with the German population about half of what it was in 1618 because of war and pestilence.

Early 17th century-Massive deforestation provides a pressing incentive to find a means of smelting iron with coal.
 1603-Sir Hugh Platt supplies a recipe to the brewing industry for making briquettes of raw coal, known as 'coke;' it would later be applied to metallurgical practices.
 1612-1613-Simon Sturtevant and John Rovenzon publish treatises, advocating the adoption of coal-burning blast furnaces.
 1617-Georg Engelhard Löhneiss writes on the organization of mining and its employees in the *Bericht von Bergwercken*.

1627-Mathurin Jousse describes the sequence of colors on tempering of steel. He also discusses the recognition of good iron or steel, on the basis of fracture.
 1636-Mersenne writes the first serious tests of tensile properties of gold, silver, copper and iron.

1640-In the *Arte de los Metales*, Alvaro Alonzo Barba discusses smelting operations as practiced in the gold and silver mines of the New World, but also contains information on European metallurgy.
 1648-Use of the chimney stack to enhance the draught spreads throughout Europe.
 1651-Biringuccio mentions a solar furnace, a German mirror capable of melting a gold ducat.

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1660-English Parliament calls for the restoration of the monarchy and invites Charles II to return from France.
 1661-Charles II is crowned King of England. Louis XIV begins his personal rule as absolute monarch and starts to build Versailles.
 1664-The English limit “Nonconformity” with the reestablished Anglican Church.
 -Isaac Newton experiments with gravity.
 1665-The Great Plague in London kills 75,000.
 1666-The Great Fire of London. Molière writes *Misanthrope*.
 1667-Milton writes *Paradise Lost*, widely considered the greatest epic poem in English.

1683-The war of European powers against the Turks (to 1699) begins. Vienna withstands a three-month Turkish siege at the high point of Turkish advance in Europe.
 1684-Gottfried Wilhelm Leibniz's calculus is published.
 1687-James II calls for freedom of conscience. Protestants fear the restoration of Catholicism and demand a “Glorious Revolution.” William of Orange is invited to England and James II escapes to France (1688). William III and his wife, Mary, are crowned.
 -In France, the Edict of Nantes of 1598, granting freedom of worship to Huguenots, is revoked by Louis XIV, forcing thousands of Protestants to flee.
 1689-Peter the Great becomes Czar of Russia and attempts to westernize the nation and build Russia as a military power. He defeats Charles XII of Sweden at Poltava (1709).
 1690-William III of England defeats the former king James II and Irish rebels at the Battle of the Boyne in Ireland.
 -John Locke writes *Human Understanding*.

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1665-Robert Hooke develops a theory of the hardening of steel based on the colors it turns during tempering and relates it to the hardening of other materials by cold working.
 Late 17th century-Blast furnaces double in size.
 -The invention of reverberatory furnace makes it possible to substitute raw coal for charcoal in the process of smelting.

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18th century

<p>1701-The War of the Spanish Succession begins, the last of Louis XIV's wars for domination of the continent. The Peace of Utrecht (1714) will end the conflict and mark the rise of the British Empire. Called Queen Anne's War in the colonies, it ends with the British taking New Foundland, Acadia, and the Hudson's Bay Territory from France, and Gibraltar and Minorca from Spain.</p> <p>1704-Bach writes his first cantata.</p> <p>1707-The United Kingdom of Great Britain is formed, as England, Wales, and Scotland are joined by the parliamentary Act of Union.</p>	<p>Early 18th century-New methods of producing iron and steel are introduced.</p> <p>-Swedish scientists, Emanuel Swedenborg and Christopher Polhem, improve Swedish metallurgical and mining methods, almost doubling their country's iron production.</p> <p>1700-The volume of the Stückerofen triples in size from that of 1500.</p> <p>1702-Mathurin Jousse writes the first publication, actually one on carpentry, that included viable instructions for the construction of a windmill.</p> <p>1709-The first recorded successful experiment in using coke for smelting iron ore, at Bosley, in Shropshire.</p>
<p>1729-Bach writes the <i>St. Matthew Passion</i>.</p> <p>-Isaac Newton's <i>Principia</i> is translated from Latin into English.</p>	<p>1722-The first reliable treatise on iron metallurgy, Réaumur's essay on the art of converting iron into steel, is written.</p>
	<p>1732-By this time, there are six blast-furnaces and nineteen hammer-forges, besides numerous bloomeries, in the British colonies of North America.</p> <p>Mid 18th century-The first known round-house post-mills are constructed.</p> <p>-By employing a continuous process of feeding ore and fuel into the furnace as the pig iron is tapped, furnaces are producing twice the amount of pig iron per day as the first blast furnaces of 1500, while consuming less fuel.</p> <p>-Cast iron is applied to uses where stone, wood and other metals had formerly served.</p> <p>-Cast iron gears are used in the mill, allowing for improvements in turning.</p> <p>1738-Schlüter's metallurgical handbook is written.</p>
<p>1740-Captain Vitus Bering, a Dane employed by Russia, discovers Alaska.</p> <p>-Frederick II "the Great" is crowned king of Prussia.</p> <p>1746-The British defeat the Scots under the Stuart Pretender, Prince Charles, at Culloden Moor, the last battle fought on British soil.</p>	<p>1745-Edmund Lee patents the automatic fantail, keeping a windmill facing directly into the eye of the wind.</p>

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<p>1751-Publication of the <i>Encyclopédie</i>, the “bible” of the Enlightenment, begins in France.</p> <p>1755-Samuel Johnson's <i>Dictionary</i> is first published.</p> <p>-A great earthquake in Lisbon, Portugal kills over 60,000.</p> <p>1757-The British Empire in India begins, as Robert Clive, British commander, defeats Nawab of Bengal at Plassey.</p> <p>1759-Voltaire writes <i>Candide</i>.</p> <p>-Haydn composes <i>Symphony No. 1</i>.</p>	<p>c1750-Good sheet iron is produced by rolling- and slitting-mills.</p> <p>1759-John Smeaton presents to the Royal Society the first scientific study of windmill sails.</p>
<p>1762-Catherine II (“the Great”) becomes the czarina of Russia.</p> <p>-Jean Jacques Rousseau writes his <i>Social Contract</i>.</p> <p>-Mozart tours Europe as a six-year-old prodigy.</p> <p>1765-James Watt invents the steam engine.</p> <p>1769-Sir William Arkwright patents a spinning machine, an early step in the Industrial Revolution.</p>	<p>Late 18th century-The role of carbon is finally recognized as the essential difference between wrought and cast iron and steel.</p>
<p>1772-Joseph Priestley and Daniel Rutherford independently discover nitrogen.</p> <p>-The Austria, Prussia and Russia divide the land and people of Poland in 1772, 1793, and 1795, ending its independence.</p> <p>1775-Priestley discovers hydrochloric and sulfuric acids.</p> <p>1776-Adam Smith writes <i>Wealth of Nations</i>.</p> <p>-Edward Gibbon writes <i>The Decline and Fall of the Roman Empire</i>.</p> <p>-Fragonard paints <i>Washerwoman</i>.</p> <p>-Mozart composes the <i>Haffner Serenade</i>.</p> <p>1778-Franz Mesmer uses hypnotism.</p>	<p>1772-In England, Andrew Meikle invents the spring-sail for windmills, solving the problem of setting and shortening the sail-cloths in poor weather.</p>

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1781-Immanuel Kant writes *Critique of Pure Reason*. Herschel discovers Uranus.

1783-William Blake writes his poetry.

-Beethoven's works are first printed.

1784-Crimea is annexed by Russia.

-John Wesley writes *Deed of Declaration*, the basic work of Methodism.

1785-Russians settle the Aleutian Islands.

1787-Lavoisier completes his work on chemical nomenclature.

-Mozart composes *Don Giovanni*.

1788-The French *Parlement* presents grievances to Louis XVI, who agrees to the convening of the Estates-General in 1789, not called since 1613.

-Goethe writes *Egmont*.

-Laplace writes *Laws of the Planetary System*.

1789-1799-The French Revolution begins with the storming of the Bastille.

1790-The H.M.S. *Bounty* mutineers settle on Pitcairn Island.

-Aloisio Galvani experiments on electrical stimulation of the muscles.

-Lavoisier formulates *Table of 31 chemical elements*.

1791-Boswell writes *Life of Johnson*.

1792-Mary Wollstonecraft writes *Vindication of the Rights of Woman*.

1793-Louis XVI and Marie Antoinette are executed. The Reign of Terror begins in France.

1794-Kosciusko's uprising in Poland is quelled by the Russians.

-The Reign of Terror ends with the execution of Robespierre.

1796-Napoléon Bonaparte, a French general, defeats the Austrians.

-Edward Jenner introduces the smallpox vaccination.

1798- Napoléon extends French conquests to Rome and Egypt.

1799-The Rosetta Stone is discovered in Egypt.

-Napoléon leads a coup that overthrows the Directory, establishes the Consulate, and becomes the First Consul, one of three who rule France together.

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c1784-Henry Cort invents the puddling process, in which the evolved heat of coal fuel was transmitted by reverberation to make pig iron into bar iron, ensuring the triumph of coal in iron metallurgy.

1789-Stephen Hooper invents the roller-reefing sail, allowing all blinds in the windmill sails to be opened and closed simultaneously without stopping the mill.

1795-American, Oliver Evans, designs the first automatic mill for the mass-production of flour, using power-driven roller-mills and cylindrical bolters.