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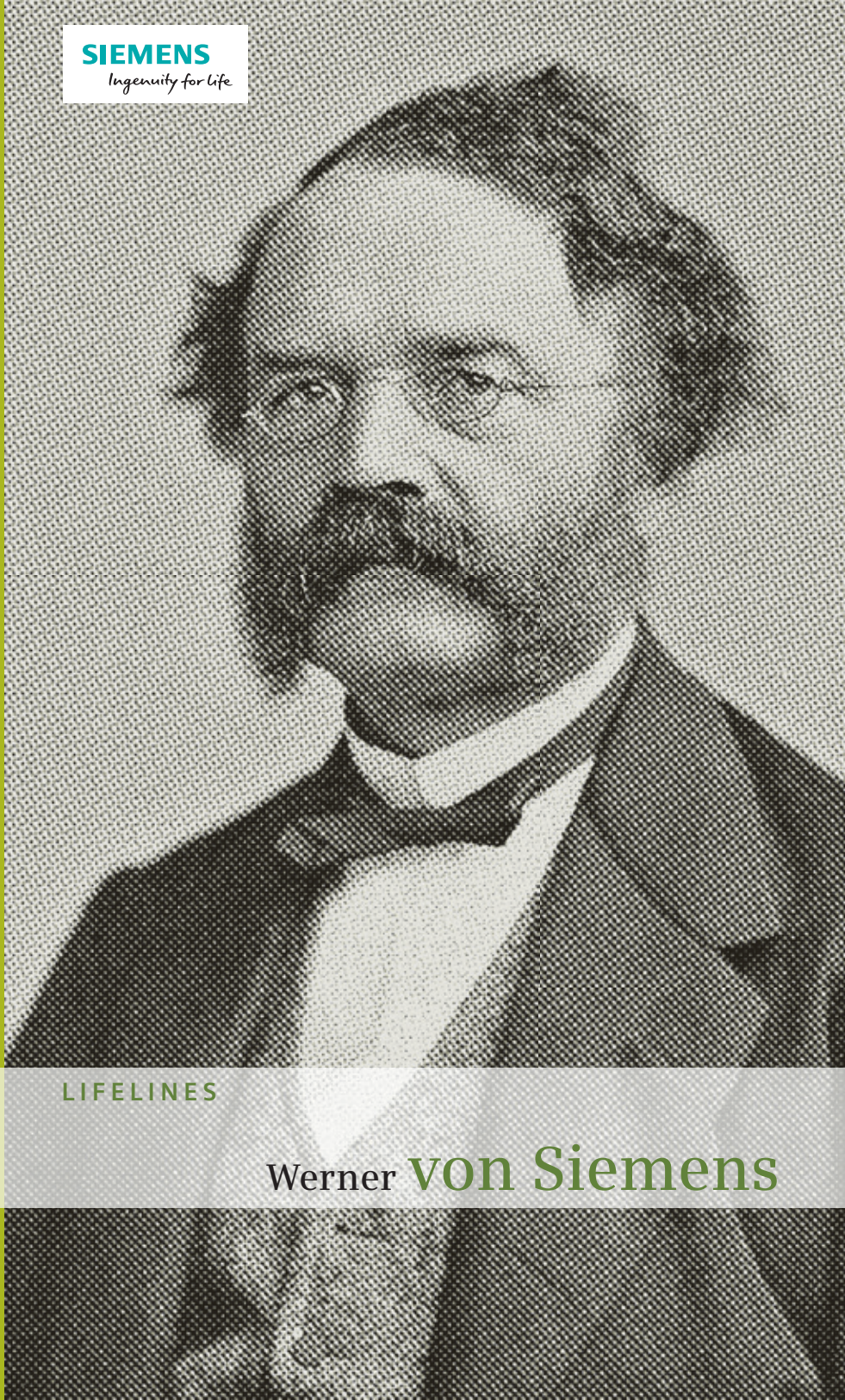


LIFELINES

# Werner von Siemens

**Werner von Siemens** was born in 1816 in the village of Lenthe near Hannover, Germany. December 13, 2016 marks the 200th anniversary of his birth. To commemorate this occasion, the Siemens Historical Institute commissioned a biographical portrait of this entrepreneur and inventor who started life as the son of a tenant farmer and rose to become one of the outstanding figures of the 19th century.

The brochure is the fifth volume in the LIFELINES series, which is dedicated to introducing the men and women who have done the most to shape the history and development of Siemens. This group includes businessmen who led the company, members of the Managing Board, engineers, inventors and creative thinkers. A conscious effort has been made to include the lives and contributions of those individuals who are not always counted among the company's most prominent figures.

Werner von Siemens

Werner von

# Siemens

13. 12. 1816 – 6. 12. 1892

LIFELINES

Werner von Siemens, ca. 1864

## Introduction

Few business personalities have remained as well-known over the years as Werner von Siemens, the “Father of Electrical Engineering”. Yet even two centuries after his birth, much still remains to be discovered about the man’s biography. Even more, there is a genuine need to develop a picture of Werner von Siemens appropriate for our times. For research of that nature, the correspondence between Werner von Siemens and his siblings – comprising some 6,500 letters preserved at the Siemens Historical Institute – offers a virtually inexhaustible resource.

Werner von Siemens was born in 1816 on a farm estate in what is now Lower Saxony. He grew up in a period when incipient industrialization was changing the world as never before. While still a schoolboy, he discovered an interest in mathematics and technology. As university study was beyond his financial reach, he served for many years in the military to acquire a background in technology and science. Then came the discovery of his life’s mission: the application of electricity. In October 1847, Werner von Siemens joined forces with precision mechanic Johann Georg Halske and his own cousin Johann Georg Siemens to found a telegraph construction company – the forerunner of today’s Siemens AG.

Business and family were always inseparable for Werner von Siemens; several of his brothers were working for the company. The close relationship among three Siemens brothers – Werner, William and Carl, working respectively in Berlin, London and St. Petersburg – gave rise to a multinational family-run company that well understood what to do with the opportunities offered by the age’s first wave of globalization. Werner von Siemens’ invention of the dynamo machine in 1866 made him one of the pioneers of a new era in the history of electrical engineering. The dynamo made it possible to put electricity to work generating energy, lighting streets and homes, and driving machines and vehicles.

Posterity came to associate the name “Werner von Siemens” primarily with inventions. Within just a few years after his death, he had already been idealized as a hero of German technology. Schools and streets were named not for the businessman, but for the inventor. That perspective began to dim in later decades – and with it, our image of Werner von Siemens. Over the past 70 years, the only noteworthy biographies to appear have been produced by directors of the Siemens Archive or SiemensForum.[1]

Yet researching Werner von Siemens is certainly still worthwhile today, especially when one looks at the man as a whole, free from idealization. It becomes clear what a wide range of talents it took to be both a highly successful businessman, a gifted technician, and an important inventor. Above and beyond those qualities, Werner von Siemens also stood out as the father-figure who held a large family together. And he was notable as one of the first industrialists to recognize the connection between scientific research and economic development. Most of all, what made Werner von Siemens so special was his versatility.

The present biography shows us a man of firm principles, who always pursued his goals with the greatest persistence and stamina, overcoming both calamities and dry spells in the process. He was able to do all this because he focused not on short-term gain, but on creating something that would last. The ultimate currency that counted for him was “receiving recognition of the rightness of my actions and the usefulness of my work”.[2]



## Origins and education

### Childhood in the country

Werner von Siemens was not a businessman straight out of the cradle. His father was a middle-class tenant farmer managing the Obergut farm estate in Lenthe, a village around ten kilometers west of Hanover. This is where Werner von Siemens was born on December 13, 1816, the fourth child of the family. He was baptized Ernst Werner Siemens; the “von” indicating nobility was conferred on him only late in life. His parents, Christian Ferdinand Siemens and Eleonore, née Deichmann, were not wealthy, but educated. They raised their children lovingly and taught the bourgeois values of their era. Both came from families with a long history in the middle class; for generations, his fathers’ ancestors had been respected craftsmen, merchants and city councilors in the city of Goslar.

Growing up among a large number of children left a lifelong impression on the young Werner. His two surviving elder siblings, Ludwig and Mathilde, were subsequently joined by three younger brothers: Hans, Ferdinand and Wilhelm (who changed his name to William in 1844). Two other children died in infancy. Werner soon had to take responsibility for his younger brothers. The world in which the Siemens children grew up consisted at first of family members, the farmstead, and the village. The Siemenses had an extensive network of relatives, with whom they communicated largely by letter. There were no railroads yet; industrialization, which

2016 The house in Lenthe where Werner von Siemens was born is still standing today, a protected historical monument. A permanent exhibition about the electrical pioneer’s life opened there to commemorate his 200th birthday.


North Germany ca. 1850

had already begun in England, had not arrived in the Kingdom of Hanover.

It was a bad time for tenant farmers like Christian Ferdinand Siemens. Agriculture was suffering from falling prices all over Europe. The elder Siemens was constantly in arrears on the rent. When the Obergut lease expired in 1823, the owner made no offer to renew. The eight-member Siemens family was compelled to move to Menzendorf, a village about 25 kilometers east of Lübeck, where the father took over the lease on a state-owned farm. There in Menzendorf, which at the time was in the Archduchy of Mecklenburg-Strelitz, the family continued to lead a modest existence. The setting was an idyllic one for the growing Werner. But his father had little success managing this farm as well; the administrators repeatedly threatened to foreclose because he was behind in paying debts. Meanwhile, new children kept coming. Werner von Siemens now had four more brothers: Friedrich, Carl, Franz and Walter. The older boys were educated at first by their grandmother. Then, at age eleven, Werner entered a secondary school in Schönberg. For a year he traveled the nearly six kilometers to school on foot or riding a pony. Then his father decided to engage a private tutor, the theology student Christoph Sponholz. Sponholz made a deep impression on Werner by constantly encouraging his pupils' ambition and achievement, and rewarding them with exciting stories.[3]

Despite the family's strained financial situation, the parents set a high priority on educating their sons well. So at age 15, Werner and his younger brother Hans were sent to a well-known humanist *Gymnasium* – a secondary school – the Katharineum in Lübeck. It soon became evident that his interests and talents inclined to mathematics. He could rouse no enthusiasm for ancient languages. In his second year, he added private tutoring in mathe-

**Starting 1819** Persistent overproduction of agricultural products causes a farming crisis in Europe, with prices dropping sharply.

matics and drawing. But at Easter 1834 he left the school without a diploma.

### Training in the military

When he left school, Werner von Siemens decided to take up studies at the Bauakademie (academy of architecture) in Berlin. But his parents were in no position to finance that expensive education. Then what should he do? His tutor from Lübeck counseled the young man to apply to the engineering corps of the Prussian Army, as an officer candidate. That career included three years of attendance at the artillery and engineering school in Berlin, where Werner would get an education in technology and science at the state's expense. Taking that advice, the 17-year-old applied to join the Artillery, where he would have better chances than in the engineering corps, and in the fall of 1834 he was accepted as an officer candidate. First he had to serve for twelve months in Magdeburg. During that time, he became friends with a fellow member of the brigade, William Meyer, who was almost the same age. In the fall of the following year, the two friends were permitted to transfer to the artillery and engineering school. There they took courses in physics, chemistry and mathematics from scientists from the university and other institutions of higher education in Berlin. A new world opened up for Werner von Siemens. The courses aroused an enthusiasm for science that would set the course for the rest of his life. He completed his artillery-related studies as a necessary chore.

In the summer of 1837, Werner von Siemens passed the test for second lieutenant, the lowest rank as an officer. The next year he completed his training in Berlin. He had to return to his unit in Magdeburg, but was firmly determined to apply the scientific knowledge he had acquired. He had no aspiration to a career in the military – on the contrary, he considered military service solely as a way of gaining the training he wanted and ensuring a livelihood until he could find work that fit his talents.

Werner von Siemens as a second lieutenant, ca. 1842/43

1799 The Bauakademie is founded in Berlin. It offers future builders and surveyors a thorough training in science and other disciplines.

1834–1849 Werner von Siemens serves in the Third Artillery Brigade. He will be promoted to first lieutenant only upon his resignation from the military in June 1849.

### A responsible brother

The next few years were overshadowed by personal misfortunes for the young officer. Both parents, sick and despondent, died within half a year of each other: his mother at age 47 in July 1839, his father at age 52 the following January. Christian Ferdinand and Eleonore Siemens had had two more children, daughter Sophie and son Otto, while Werner was training in the military. The parents' death left ten orphans who were not yet of age and for whom guardians had to be appointed. Werner von Siemens felt responsible for his younger siblings. He could not apply to be their guardian, for under the laws of the era, he still counted as a minor himself. But he assumed the role of head of the family, because his elder brother Ludwig had been disinherited by their father. Werner had already brought his brother William to join him in Magdeburg in 1838. But he could do nothing for the other younger children. All the same, henceforth he would feel it was his duty to ensure that the family could still keep together.

1. January 1876 Legal adulthood is set at age 21 throughout the German Empire. Until now, in many regions people still counted as legal minors until age 25.



## An officer and inventor

Unlike most of his Magdeburg comrades, Artillery Lieutenant Werner von Siemens did not spend his free time in card games or amorous dalliances. His passion was for chemical and physical experiments – which, lacking a laboratory, he performed in his own apartment. In 1840 he was transferred to Wittenberg. Now his experiments turned toward developing a galvanic method for gilding. He was able to gild a nickel silver teaspoon, followed by his pocket watch. At last his process matured to the point that it brought him his first patent, on March 29, 1842.[4]

But the young artillery lieutenant was not spending all his free time on scientific experiments. While still at the artillery and engineering school, he had dueled often – a pastime that was part of a young officer's code of honor. Duelists and their seconds risked severe punishment if they were reported. But that seldom happened. And even when a duel was reported, as a rule the officers were quickly pardoned. After one such duel in Wittenberg, in which Werner von Siemens acted as a second, he was reported by a wounded officer. A court martial then sentenced him to five years of imprisonment, which he began serving in April 1842 at the officers' penitentiary of the notorious Magdeburg Citadel. Only three weeks later, he was pardoned. In his Recollections, he embellishes the description of his imprisonment, writing that he set up "a small laboratory" in his "barred but roomy cell", and was "quite content" with his situation. During the first month of his term, he claimed to have conducted "experiments" in his cell that

1840s About 50 to 70 patents a year are granted in Prussia; they always have a term of five years.

were his first successes in gilding a teaspoon.[5] But in fact, as we have already seen, he had been granted the patent for his gilding technique even before his imprisonment. So the description in his autobiography is myth. But it carries a message for the reader: once Werner von Siemens had set himself a goal, even fortress walls could not keep him from achieving it.

As of October 1, 1842, Second Lieutenant Siemens was reassigned to the artillery workshop in Berlin. His superiors had realized that he could be more useful to the army there than in a fort's artillery unit. Their assessment was that "with his preferred inclination to scientific study, he has little military talent".[6] Being a duty officer at the Berlin artillery workshop was ideal for Werner. Here he could work on additional inventions, while at the same time drawing inspiration from the royal capital's scientific community. He was a member of the Physical Society of Berlin from its founding in January 1845, held lectures there, and came to know major scientists like the physiologist Emil du Bois-Reymond.

## A band of brothers

As an officer, it was difficult for Werner von Siemens to market his first patent. In his search for highly solvent potential buyers, he had to rely on the support of his brother William, barely 20 years old, thus adding a business aspect to the brothers' already close relationship. Early in 1843, William sailed for England, where after tough negotiations he was able to sell the rights to the gilding method to silver manufacturer George Richards Elkington for a substantial sum. Following that success, both Werner and William now dedicated themselves to "invention speculation" of the most diverse kinds. In 1844, William moved permanently to England, where he settled as an engineer.

1845 The Physical Society in Berlin is founded. Today, under the name "Deutsche Physikalische Gesellschaft", it is the world's largest professional organization of its kind, with more than 62,000 members.



The later founders of the Physical Society of Berlin, 1842. Emil du Bois-Reymond is seated in the middle

In Berlin, Werner von Siemens gradually took in his younger brothers Carl, Friedrich and Walter to live with him. In November 1845 he was finally authorized to act as their legal guardian. He realized that as a consequence he would be almost constantly short of funds – his modest salary as a second lieutenant was not

1843 Elkington, Mason & Co., a firm in Birmingham, England, is the leader in electroplating and gilding far beyond British borders.

really enough to support them. Hopes for income from new inventions failed to bear out. It was typical of him not to be discouraged. He firmly believed in a better future. He later wrote:

*"I have always lived more in the future than in the present; as long as the future smiles on me, I can readily bear the rough sides of the present, which is seldom entirely attractive!"*[7]

## "A solid career in telegraphy"[8]

At a business partner's suggestion, in July 1846 Werner von Siemens began working with electrical telegraphy. This new technology, developed in England, was now to be introduced in Prussia. Within a few weeks, he developed a new design model for a pointer telegraph, a mechanism invented nine years earlier by Englishmen Charles Wheatstone and William Fothergill Cooke. Werner's device synchronized the operation of two corresponding telegraphs electrically, so that the Siemens pointer telegraph was more reliable than the Wheatstone version. If the operator of the transmitting telegraph pressed a letter key, this interrupted the current, and the pointer on the receiving device stopped on the same letter.

### Founding a company

Around his 30th birthday, Werner von Siemens recognized that he was not getting ahead working with a wide range of different inventions. With remarkable resolve, he therefore decided to start over again. He now concentrated entirely on "magnetical telegraphy". This strategy represented a considerable risk, because at that time not a single example of his improved pointer telegraph had ever been built. What would happen if his design proved inadequate? Werner could not build the telegraph himself – he had to find a skilled mechanic who could. As 1846 turned to 1847, Emil du Bois-Reymond, whom he knew from the Physical Society, put

Around 1850 England, the motherland of industrialization, is at the height of its economic dominance. Many inventors seek their fortunes here.

1830s In England, Charles Wheatstone and William Fothergill Cooke develop an electrical telegraph apparatus. In the USA, Samuel F. B. Morse introduces the first electrical "writing telegraph".

him in touch with the precision mechanic Johann Georg Halske. That connection would prove to be a major stroke of luck.[9]

At the time, the military had a monopoly on telegraphy in Prussia. The director of telegraphy and the telegraphy commission were subordinate to the General Staff of the Army. Once Halske had built the first Siemens telegraph, Werner von Siemens was in a position to convince the Telegraphy Commission of his invention's advantages. The director of telegraphy then arranged for him to be reassigned to serve the Telegraphy Commission. That put Werner von Siemens under the agency that decided on building telegraph lines and awarding the associated contracts.

Meantime Werner made the necessary preparations to found a telegraph construction company jointly with Johann Georg Halske. Since neither of them had the necessary capital, Johann Georg Siemens, an eminent lawyer and a cousin of Werner's, stepped in with a rather large loan as an additional partner. The company was founded when the articles of incorporation were signed on October 1, 1847. A few days later, Werner von Siemens got a Prussian patent for the pointer telegraph. Now production could begin.[10] Siemens and Halske had rented a building on a rear courtyard at Schöneberger Straße 19, in the immediate vicinity of the Anhalt railroad station. The two company founders would live in the same building. Because of Siemens' status as an officer in service with the Telegraphy Commission, the company appeared at first only under Halske's name, as "Werkstatt Halske" – "The Halske Workshop".

At the time, the Telegraphy Commission was planning to lay a number of underground telegraph lines in Prussia. They had set a competition for builders from Germany and other countries for March 15, 1848, in Berlin; the results would decide who would get the contracts. Werner von Siemens felt his success was assured,

Siemens pointer telegraph (replica), 1847

but the competition suddenly had to be called off because on that very day, the revolutionary rioting that had been spreading among other European cities also broke out in Berlin. That night, Werner von Siemens experienced the Berlin "Barrikadenaufstand" (barricade revolt) first-hand. His own sympathies lay with the revolutionaries, who were demanding fundamental citizens' rights and a German national state.

A few weeks later, filled with nationalistic enthusiasm, he volunteered to join the German-Danish war over the status of the duchies of Schleswig and Holstein. His sister Mathilde now lived in Kiel, where her husband, the chemist Carl Himly, had been appointed to a professorship. Werner von Siemens and his brother-in-law secured Kiel harbor against attack by the Danish fleet. The two of them built the first marine mine blockade there, made of sacks of gunpowder that could be ignited electrically. Werner then

**1846** The first electrical telegraph line in Prussia goes into operation: an experimental line between Berlin – the capital – and Potsdam.

**March 18, 1848** Berlin residents gather at the Schlossplatz. As the military begins to clear the plaza, chaos sets in and two shots are fired. The "Barrikadenaufstand" (barricade revolt) breaks out, leaving several hundred dead.

took over the command of the Friedrichsort fortress, located in front of Kiel. He was later assigned to defend Eckernförde Bay. He saw no combat, but stayed in the war for three months even though his young company was at a crucial phase of its life.

### Telegraph construction for the Prussian state

After his return, the Telegraphy Commission assigned Werner von Siemens to set up a telecommunications connection between Berlin and Frankfurt am Main, where the German National Assembly had been meeting since May 1848. A second line was to be laid from Berlin to Aachen. The commission had already decided in advance that the Frankfurt line should be equipped with pointer telegraphs and cables insulated with gutta-percha, using a process Siemens had developed. Werner's London-based brother William had tipped him off about the special characteristics of gutta-percha – a rubber-like material from Southeast Asia. With gutta-percha, he was able to develop a process for covering copper telegraph wires with a seamless coating. For the times, his method proved to be the best technique for insulating underground communications cables. It gave Siemens a technical lead over his competitors; after all, both planned lines were to be laid largely underground. Werner von Siemens actually played three roles in installing the telegraph lines. As an officer working for the Telegraphy Commission, he was in charge of construction. At the same time, he was a partner in the company that made the telegraph devices. And he was a contract partner for the cable supplier.

In February 1849, the Frankfurt am Main line went into operation. Mere weeks later, it became evident why the telegraph would be of outstanding political importance. On March 28, 1849, the National Assembly, meeting in the Paulskirche in Frankfurt,

May 1848–May 1849 The German National Assembly meets in the Paulskirche in Frankfurt on the Main. The members of this first parliament representing all of Germany adopt a Reich Constitution in March 1849, but the largest German states refuse to recognize it.

Looking through to the first workshop at Schöneberger Straße 19, undated photo

elected Prussian King Friedrich Wilhelm IV as the German Kaiser. Thanks to new communications technology, the election – which the king declined, because adhering firmly to the idea of devine rights of kings he regarded the offering of the crown to him by the National Assembly as an arrogant insult – was known in Berlin within an hour. Werner had entrusted the construction of the Aachen line to his friend and fellow brigade-member William Meyer. With the completion of this, the longest telegraph line in Europe at the time, the future of the telegraph workshop on Schöneberger Straße seemed secure. Werner von Siemens now resigned from the military, with the intention of dedicating himself to the company full-time. As was customary on such occasions, he was simultaneously promoted to first lieutenant. On June 12, 1849, after more than 14 years in the Prussian Artillery, he returned to being a civilian.

In the meantime, control of the Prussian telegraph system had passed from the General Staff of the Army to the Ministry of Commerce. Now messages could also be telegraphed by companies, news agencies and private individuals. The Siemens and Halske workshop continued to land large contracts for the Prussian state telegraph system – the company had become the system's monopoly supplier. But in spring 1851, malfunctions began accumulating on the state's lines, which were laid almost entirely underground. In many cases, the gutta-percha insulation on the cables had become damaged. The technical director of the Prussian telegraph administration, Friedrich Nottebohm, blamed Werner von Siemens for the problems. When Siemens published a position paper denying that he was at fault, Nottebohm canceled all the state contracts[11] – and the young company faced its first crisis. Werner von Siemens was compelled to look for more orders from outside Germany – an effort at which he had not been successful

Contemporary depiction of the two founders, 1855

so far. Looking ahead to the expansion he hoped for, he bought a house on a large lot at Markgrafenstraße 94 and emphasized that the company should now call itself "Telegraphen-Bauanstalt von Siemens & Halske" – the "Telegraph Construction Company of Siemens & Halske".[12]

1849 Electrical telegraphy makes it possible to establish the first German news agency, in Berlin. Two years later the Reuters agency is founded in London.

1852 With the relocation from Schöneberger Straße to Markgrafenstraße, the workshop of Siemens & Halske becomes a factory. Today, both locations are in the Friedrichshain-Kreuzberg district of the city.

## Werner von Siemens, private person

Since 1843, Werner von Siemens had gradually been bringing his brothers Carl, Friedrich and Walter, to come and live with him. Only a few years after their parents' death, strong bonds had been reestablished among the children. As the eldest in the family, Werner was the pivot point of this group, which was also the focus of his private life. Once the Telegraph Construction Company had been founded, it seemed an obvious step for 21-year-old Friedrich and 18-year-old Carl to join the firm. Friedrich soon moved to London, where he worked with his elder brother William to win orders for Siemens pointer telegraphs. In 1850, in the British metropolis, William took charge of Siemens & Halske's first international agency. That same year, Carl too moved to London to represent the electrical engineering company at the Great Exhibition, the first world's fair. Above and beyond these initial steps toward expansion, the rest of Siemens & Halske's international business also continued to be run by individual Siemens brothers. The close ties between family and business proved an advantage for all involved. Werner von Siemens could rely on his brothers' loyalty. That was especially the case for Carl, who acted for Siemens & Halske first in Berlin, and then in London, Paris and St. Petersburg. It is unlikely that an employee who was not a family member would have been willing to stand the stress.[13]

Even at age 35, Werner von Siemens' personal life was still dominated by his ties with his younger brothers. All the young men, including Werner, were unmarried. A "deep-rooted fraternal room-communism", as Werner von Siemens once called this close connection, was consistent with the company founder's lifestyle – in the rear-courtyard building at Schöneberger Straße 19, he lived under the workshop.[14] Other than his immediate family, his closest companions during that period included only his long-standing friend William Meyer – Siemens & Halske's first office head, starting in 1855 – and Johann Georg Halske, who likewise lived at Schöneberger Straße 19 with his family.

Werner von Siemens with his younger sister and brothers, 1851: left to right, Otto, William, Friedrich, Hans, Sophie and Walter

Werner von Siemens was not an ascetic. He was often highly sociable. He enjoyed celebrating with his close friends and his siblings and was a passionate devotee of smoking cigars. His elder

1851 The first world's fair – the Great Exhibition – is held in London.
As one of the world's leading electrical companies, Siemens has been a regular presence at all the major technical and industrial shows ever since.

1855 William Meyer begins working as chief engineer and executive representative at the Berlin headquarters of Siemens & Halske.
He establishes a certain degree of bureaucratic structure within the company for the first time.

sister Mathilde Himly went so far as to liken his brother's home to a tavern.[15] But Werner von Siemens had no hobbies, no interest in music, art, literature or religion. In that sense he was a technician through and through. The only topic that could draw him away from current business and questions of science and technology was politics.

### Achieving love through reason

For many years, Werner von Siemens' life had no room for a wife. Before he founded his company, all his time was taken by serving as an officer, caring for his younger brothers, and hunting for inventions. In September 1845 he informed a Magdeburg widow who suggested matching him with a partner that he had "no time to fall in love and get married".[16] Once he had opened the workshop, building telegraph lines absorbed all his attention. Not until late in 1851, after he had bought the house on Markgrafenstraße, did Werner begin to think of starting a family. Five of his seven younger brothers had at last been set up on their own, and none of them lived any longer in Berlin.

It was amid this situation that he decided to marry 27-year-old Mathilde Drumann, a distant relative from Königsberg. She had fallen in love with him in the summer of 1845 when she and her mother had stopped off in Berlin on their way elsewhere. When her mother died unexpectedly, Werner had provided some consolation to Mathilde, who was his niece in the second degree. Though he did not reciprocate her feelings, he had known for years that she was waiting for him. Now the time had come – and Mathilde was a good choice: he could rely on her, she knew his family and understood the close ties among the Siemens brothers. The Siemens family had previously made marriages with relatives

1838 Mathilde Siemens marries Göttingen chemist Carl Himly, later appointed a professor at the University of Kiel. The couple will have six children.

Mathilde Drumann and Werner von Siemens, 1852

rather often, and for similar reasons. And such marriages were also rather commonplace among the 19th century bourgeoisie in general.[17] In a letter to William, Werner was frank about his reasons for getting engaged to Mathilde Drumann:

*"My bride is no particular beauty, but that is a secondary question. I am certain that I will live contentedly and happily with her, and that is enough."*[18]

Even if his choice of a wife was a decision of the head, not the heart, Werner von Siemens had no intention of living in a marriage of convenience. After their engagement, he heaped his fiancée with displays of affection. Mathilde was wary at first, but at last realized he was serious. The wedding was held in Königsberg on October 1, 1852, with only a small group in attendance. A few days later, along with the families of Johann Georg Halske and Johann Georg Siemens, the newlyweds moved into Markgrafenstraße 94.

1852 Mathilde Drumann is Werner von Siemens' niece in the second degree. There have already been three marriages between her mother's family and the Siemenses.



## Rise to a multinational family entrepreneur

Shortly after his engagement in January 1852, Werner had left for Russia to land contracts there. Russia lagged far behind in electrical telegraphy, so there was no domestic competition for Siemens & Halske. The Russian telegraph system was under the state's General Roads Administration, whose Director General, Count Piotr Andreievitch Kleinmichel, gave Werner von Siemens a sympathetic ear. A few months later, the German company received a major contract from the tsar's empire. In June 1853, Werner assigned the management of the Russian business to his brother Carl, who now moved to St. Petersburg and demonstrated his ability with the technically challenging construction of a submarine line between St. Petersburg and the island suburb of Kronstadt. Over the next two years, Siemens & Halske's revenues from Russia leaped ahead. To fight the Crimean War against the Ottoman Empire, the British Empire and France, the Russians urgently needed electrical telegraph connections. In a short time Carl von Siemens managed to build telegraph lines between Moscow and the Crimean peninsula and between St. Petersburg and the Baltic region. Siemens & Halske was now the monopoly supplier to the Russian state, and was able to push through lucrative maintenance agreements. For a time, nearly 90 percent of the company's total revenues came from the Russian telegraph business. In recognition of these successes, in 1855 Carl von Siemens replaced his cousin Johann Georg as a partner in Siemens & Halske.

1853 The Crimean War between Russia and the Ottoman Empire begins. It ends in a Russian defeat after England and France enter the war on the Ottoman side.

By the time the company began getting government contracts again in Prussia in 1857, it was far and away the leading maker in the German telegraph market. That was due not least of all to the partners' technical and design skills: the Siemens pointer telegraph had now been rendered obsolete by the Morse telegraph, and Siemens & Halske had responded by producing improved Morse devices. Additionally, by designing a two-way telegraph (1854) and the so-called double-T armature (1856), Werner von Siemens made important contributions toward the improvement of long-distance telecommunications. An agreement with British cable maker R. S. Newall & Co. gave Siemens & Halske an entrée

Employees of the Russian maintenaince service of Siemens & Halske, undated photo

First construction office in St. Petersburg, 1853

into the new field of submarine cable telegraphy. In the summer of 1857, on a first cable expedition with his British business partners in the Mediterranean, Werner von Siemens developed his own cable-laying theory, which made a significant contribution to the project's success. He had now decided to establish a subsidiary in London so as to tap the world market for submarine cables from there. Once again the brothers' fraternal bonds made a key contribution to the company's international expansion. At the beginning of October 1858, they founded "Siemens, Halske & Co." in London, under the management of William Siemens, with the partners of Siemens & Halske as joint investors with William.

### Risks and opportunities in the submarine cable business

The submarine cable business involved substantial risks because the technology was not mature and required a large financial outlay. Werner von Siemens got some sense of the nature and scope

1855–1867 Siemens & Halske takes charge of maintenance and operation for the Russian state telegraph network. These Remonte contracts ensure a reliable income for the company.

1851 The first permanent submarine telegraph cable begins operation between Dover and Calais.

of these risks in 1859, when he participated in a cable expedition to the Red Sea, where R. S. Newall & Co., acting for the Red Sea and India Telegraph Company, made the first attempt to lay an undersea cable to India. On the way back, Werner was shipwrecked and stranded for days on a coral island. The telegraph connection to India failed, because the cable suffered irreparable damage. The clients lost around one million pound sterling on the project.

But that did not deter Werner and William from carrying out comparable projects, including out of their own pockets. So that the company would no longer be tied to a third-party cable maker, Siemens, Halske & Co. built its own cable factory in the London suburb of Woolwich. The two brothers planned to use cables from this plant in January 1864 to lay a new telegraph line across the Mediterranean, from Cartagena in Spain to Oran in what is now Algeria, under a contract from the French government. They set out in a ship that was unfit for the high seas, with inadequate equipment, were then caught up in the outskirts of a hurricane, and barely escaped with their lives.[19] This cable project too ended with a severe financial loss; the British branch of Siemens lost half its capital.

Johann Georg Halske had severe doubts about this business policy. He was no longer willing to share such serious risks, and decided to take leave of his fellow partners as of January 1, 1867. He had withdrawn from the British company even earlier. That branch was now wholly owned by the Siemens brothers, and would be known as "Siemens Brothers" from then on. Halske was a cautious man, who balked at taking potentially unforeseeable risks. In contrast, Werner von Siemens was able to take such risks in stride, as long as they carried him closer to a goal that he absolutely wanted to achieve. He summarized the contrast a few years later in a letter to his brother Carl: "Meyer and Halske judged too much on the basis of results, not of the future."[20] Werner had realized that the future of telegraphy lay in global networking by way of submarine cables, and he wanted a share of that future. He owed the eventual success of this vision to a considerable dose of luck – with just a little less good fortune, he would have lost his life on one of the cable expeditions.

The Siemens Brothers cable factory in Woolwich, 1866

1847–1867 Precision mechanic Johann Georg Halske has been a joint owner of Siemens & Halske for nearly 20 years. After leaving the firm, he becomes involved as a local politician and a patron of the applied arts in Berlin.

1851 The first permanent submarine cable is laid between England and France. Submarine cable telegraphy will soon become a pacemaker for globalization.

### "An enterprise of world standing comparable to the Rothschilds'"

Halske was the last partner who was not a member of the Siemens family. After he had announced his withdrawal, Werner von Siemens suggested to brothers Carl and William that they should bring the businesses in Berlin, London and St. Petersburg together in a multinational family-run company, named "Gebr. Siemens". In November 1863 he wrote to Carl:

*"My guiding idea behind these suggestions was to found a permanent company which might later, under our boys' management, become an enterprise of world standing comparable to the Rothschilds' and others, and earn our name respect in the world."*[21]

It was entirely characteristic of Werner von Siemens, who always pursued ambitious goals, to develop visions. This was something alien to his brothers; they were unable to rouse much enthusiasm for dynastic considerations or a future Rothschild-style "enterprise of world standing". Consequently the new articles of incorporation signed on August 24, 1867, agreed only to establish an overall business in the form of a fixed profit-sharing arrangement among the brothers. Henceforth Werner would receive 40 percent of all profits of Siemens & Halske and Siemens Brothers, William would get 35 percent, and Carl would get 25 percent.[22]

**19th century** The five sons of bank founder Mayer Amschel Rothschild rise to become Europe's leading financiers. The bank maintains branches in Frankfurt, Vienna, London, Paris and Naples.



## A shadow cast over family life

A little more than one year after Werner and Mathilde's wedding, on November 13, 1853, their first child was born: a son named Arnold Wilhelm. A second son came on July 30, 1855, baptized Georg Wilhelm but generally known just as Wilhelm. Now Werner von Siemens no longer had to worry about an heir to take over the firm. He loved his children, and family life was very important to him, even if he could spare little time for his brood during these years as he built up the international business. Mathilde Siemens had suffered since Wilhelm's birth from a cough that developed into a "serious chest ailment".[23] No doubt this was tuberculosis,

The Siemens couple with their children Wilhelm, Anna and Arnold (from the left), ca. 1860

one of the most common causes of death in those days. In the coming years, Mathilde Siemens would repeatedly have to spend extended periods in sanatoriums. Her little sons stayed with her, initially in Bad Reichenhall, later in Merano, Bad Rehberge and other places where people took the "cure". There was no possibility that Mathilde would return permanently to the home on Markgrafenstraße, in the center of Berlin next to the plant site. Despite her illness, the couple had two more children, daughters Anna (born December 18, 1858) and Käthe (born September 23, 1861).

Before Käthe's birth, Werner von Siemens had bought a country house for his ailing wife in Charlottenburg, at the time a rather rural suburb of Berlin. This house at Berliner Straße 36, immediately past the square known as "Am Knie" (now Ernst-Reuter-Platz), was where the family moved in the spring of 1862, after an extended remodeling. But here too, it was not possible for all to live together permanently. Werner von Siemens kept his main residence on Markgrafenstraße, and his boys attended grammar school at the Friedrich-Gymnasium in the central district of Berlin, because there was no secondary school yet in Charlottenburg. The parents hired a nursemaid to tend their daughters: Sophie Wolff, a distant relative. In 1864, Werner hired a tutor for his sons, educator Gustav Willert. The nursemaid and tutor became important figures in the Siemens children's lives, because their ailing mother was hardly able to take care of them, and their father was often away on business.[24] Despite the idyllic setting of the country house in Charlottenburg, the associated hopes for Mathilde's recovery did not bear out. She suffered a relapse early in 1865, and by April it was clear that the doctors could do no more. Aged barely 51, she died on July 1, 1865, surrounded by her husband and children.

After 1850 The spread of tuberculosis peaks in Europe. One out of every two deaths among Germans between the ages of 15 and 40 is attributed to tuberculosis. The causes of this "people's plague" are not discovered until 1882.



## Representative and lobbyist

In spite of his wife's illness and the time he was spending on the expansion of the submarine cable business, early in the 1860s Werner von Siemens began becoming politically active. He became caught up in the era's revival of the forces of liberalism and the German national movement. His father before him had been devoted to the idea of a unified Germany with a constitution protecting freedoms, and he himself had entered the war against Denmark to fight for these principles in 1848. As an entrepreneur operating on an international scale as well, he was an enthusiastic adherent of the German nationalist movement. In 1860 he joined the Deutsche Nationalverein (German National Union); a year later he was one of the founders of the Deutsche Fortschrittspartei (German Progressive Party), which had a liberal, nationalist orientation. Even though Werner really had no time for political work, his friends in the party persuaded him to run for a seat in the Prussian House of Representatives. In May 1862 he was elected to the Prussian legislature as a representative for the Solingen electoral district.

The Fortschrittspartei now had a majority in the House of Representatives, and was determined to prevent a planned reform of the army by exercising Parliament's rights over the budget. The new Prime Minister, Otto von Bismarck, ignored the Parliament, violating the Constitution. As an officer of many years' standing, Werner von Siemens sympathized with the army reform, but adhered to party discipline.[25] When Bismarck took the lead of the

1859 The German National Assembly is constituted in Frankfurt on the Main. Its aims are to elect a national parliament and found a unified German state under Prussian leadership.

German national movement during the four-year constitutional conflict, Werner abandoned all reservations about the Prime Minister. National unity meant more to him than any constitutional question. It roused him to enthusiasm that Bismarck worked toward a German national state under Prussian domination, with wars against Denmark (1864) and against Austria and the German Confederation (1866). Werner von Siemens was one of the liberal representatives who voted in September 1866 to grant the Prime Minister immunity from prosecution for his offenses against the Constitution, and thus ended what was known as the Prussian Constitutional Conflict. Werner then resigned from office, so he could again devote more time and energy to the company and his own experiments. His goal of achieving a German national state under Prussian leadership had come within reach.

After the German Empire was founded in 1871, Werner von Siemens took a public role in another way. Now he strove to achieve politically, but from outside of Parliament, certain innovations he considered necessary. He especially worked toward a reform of the patent laws. These laws still dated from the preindustrial age, and set a priority on inventors' interests. Moreover, patents were only rarely issued in Prussia by that time. In that era of liberal economic policies, they were considered an outdated monopoly. As early as 1863, Werner von Siemens had written a highly regarded position paper for the Berliner Kaufmannschaft (Berlin commercial community). Here he argued for patent protection that would focus on "aspects of the national economy" and thus on the interests of rapidly growing industry.[26]

On March 28, 1874, Werner von Siemens joined businessmen, professors and engineers with similar attitudes to found the Deutsche Patentschutz-Verein (German Patent Protection Association). With Werner as chair, the association developed proposals for a

Werner von Siemens in the Prussian House of Representatives (center of the fifth row of seats), 1865

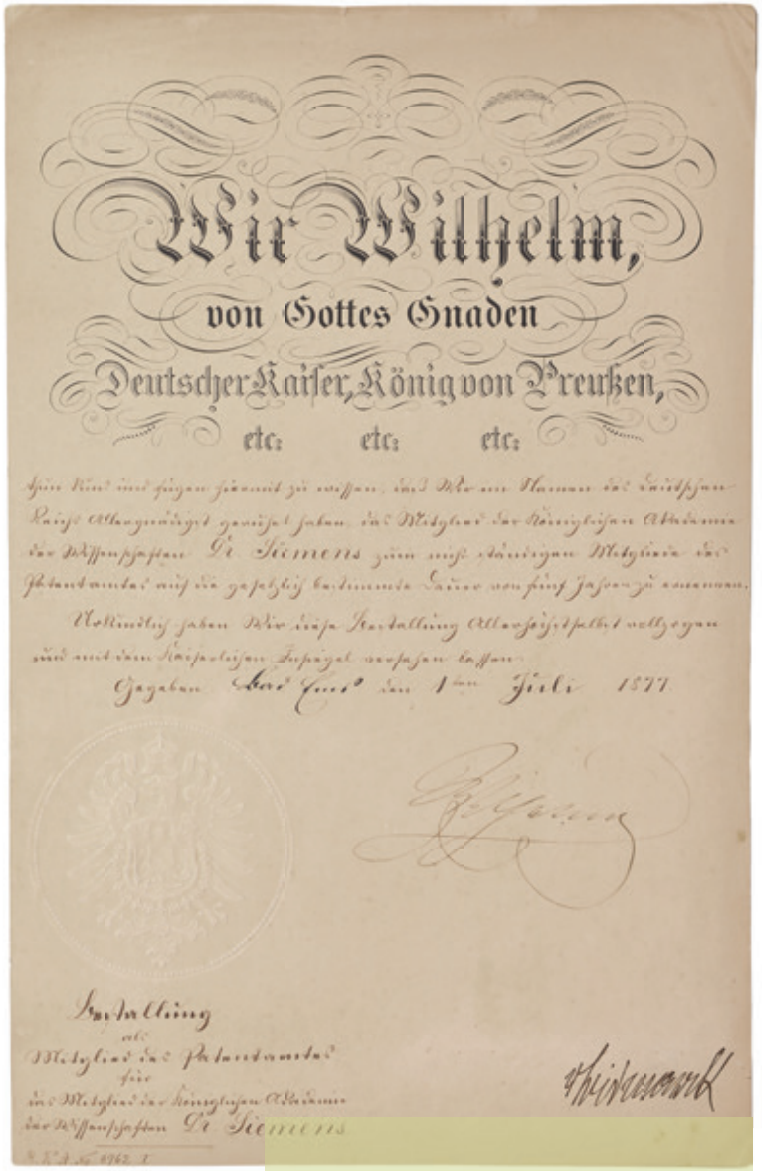
new patent act. It was a favorable moment: a persistent economic crisis had turned the government away from liberal economic policies. Amid that situation, Werner von Siemens once again made good use of his talent for writing position papers, and in April 1876 sent Bismarck a concise memorandum.[27] Within a few months a bill had been introduced that largely matched the Deutsche Patentschutz-Verein's proposals. On May 25, 1877, the Reich-

1864 The German-Danish War is the first of what will become known as the German Wars of Unification. Upon the successful conclusion of these wars, the German states are unified to form the German Empire.

1873 Europe enters a decades-long period of deflation as prices collapse on the stock markets.

stag adopted the Patent Law, which took effect on July 1. It provided for establishing a Patent Office and introduced the requirement of publication, compulsory implementation, and an entitlement to be granted a patent. From now on, patents would have a term of 15 years and were no longer granted to the inventor, but to the applicant.[28] Thus industry and industrial associations had won out – the great age of individual inventors was past. The sharp increase in patent applications over the next few years shows that the new law encouraged Germany's economic development. On July 1, 1877, the President of the new Kaiserliche Patentamt (Imperial Patent Office) appointed Werner von Siemens a non-permanent member of the authority. The position was associated with an appointment as "Geheimrat" (Privy Councilor).

**July 1, 1877** Today's German Patent and Trade Mark Office begins its existence as the Kaiserliche Patentamt. Founded in Berlin, the authority has been located in Munich since 1949.


Wir Wilhelm,
von Gottes Gnaden
Deutscher Kaiser, König von Preußen,
etc. etc. etc.

Certificate appointing Werner von Siemens a member of the Kaiserliche Patentamt, July 1, 1877

## Telegraph lines to India and America

As early as 1856, Werner von Siemens had formed the intention to extend the Russian telegraph lines across the Caucasus to India.[29] It would take years before the project took actual shape. In the meantime, the Siemens brothers did indeed turn their attention to the Caucasus, where the company got contracts to build local telegraph lines. Werner and Carl established a branch office in the Georgian capital of Tbilisi, and in 1860 placed it under the management of their 27-year-old brother Walter. Four years later, on his recommendation, the brothers invested a rather large amount of capital in the Caucasus by acquiring a copper mine in Kedabeg as a "private business". But expectations that the mine would prove a profitable investment were long in reaching fulfillment. Yet even though Kedabeg caused substantial losses, Werner saw it as another family company that he wanted to keep firmly in hand as "an indestructible item of family property".[30] A few years later, Walter was followed to Tbilisi by the youngest brother, Otto. Otto established a rather large oil business in the Caucasus for the firm's branch there.

### The Indo-European telegraph line

In 1865 the Siemens brothers found the opportunity had arrived to attack the project of a line to India. It would run from London, across the North Sea to Emden in Germany, then across Prussia, Poland, Southern Russia and the Caucasus to Tehran.[31] From there, it could connect with an existing line of Britain's India Telegraph Department, which led on to Karachi and further to Calcutta. The necessary concessions from the governments in London, Berlin, St. Petersburg and Tehran were gradually obtained, in negotiations that were sometimes protracted. Here it proved to be an advantage that the Siemens brothers and their companies were established multinationally. William conducted negotiations in London, Werner in Berlin, Carl in St. Petersburg and Walter in Tehran. To raise the necessary capital, William and Carl urged their brother Werner to found a stock corporation in London. Werner was uncomfortable with the idea. He had a distinct aversion to stock companies. But his brothers won out. In the negotiations to found the Indo-European Telegraph Co. Ltd. in London, the young lawyer Georg von Siemens – only son of Werner's cousin and former investor, Johann Georg Siemens – proved his mettle.[32]

In the spring of 1868, Siemens & Halske began building the line under a contract for the Indo-European Telegraph Co. Work was carried out in three segments from the Prussian-Russian border to Tehran. Existing lines could be used between London and the border between Prussia and Russia. Shortly after work began, Walter Siemens died in a tragic accident in Tbilisi, and Werner appointed youngest brother Otto as the new head of the branch. Since the Persian concession had to be renegotiated, he sent Georg von Siemens, now general counsel for Siemens & Halske, to Tehran. The negotiations took nine months. During that period, engineer Ernst Höltzer pursued further work on the Persian segment.[33]

Even before the Indo-European telegraph line had been completed, Werner learned that a well-financed company headed by Scottish businessman John Pender was laying a submarine cable

1864 Once the Kedabeg copper mine has been acquired, it takes considerable effort to make the business profitable. The copper business does not begin showing a profit until the late 1870s.

1870 Georg von Siemens leaves Siemens & Halske to become one of the founding directors of Deutsche Bank. He heads the bank for 30 years, and is raised to the nobility in 1899.


Route of the Indo-European telegraph line, 1870

through the Red Sea to India. In the competitive bidding, Pender's British Indian Submarine Telegraph Company won by a hair. When the Indo-European telegraph line opened on April 12, 1870, it was able to send a telegram from London to Calcutta, some 11,000 kilometers away, in only 28 minutes. That set a new standard for telegraphic traffic to India. Pender, for his part, began operations in June 1870 on a continuous submarine cable from London to India. The Siemens brothers realized that submarine cable technology had now reached maturity and would dominate the future. The Indo-European telegraph line had earned them a *succès d'estime*, but only a major submarine cable project would put them among the global players in the sector.

1869 John Pender founds the British Indian Submarine Telegraph Company – one of a total of 32 telegraph companies included in the "Cable King's" empire.



## Adventure in the Atlantic

Of all the Siemens brothers, it was Carl most of all who urged laying an intercontinental submarine cable. He had taken over the management of Siemens Brothers in London in 1869. After a good deal of vacillation, the brothers decided to initiate a transatlantic project of their own, with the aim of breaking John Pender's monopoly – the "Cable King" controlled the three existing transatlantic lines. Because he charged high prices, there was great interest in Europe and the USA in establishing new connections that would be independent from him. In March 1873, the Siemens brothers founded a special company in London for their new major project: Direct United States Cable Co. Ltd. The stock of the new company was placed with the support of Deutsche Bank, where Georg von Siemens, Werner's former general counsel, now sat on the board of directors. Since Siemens Brothers had learned from its past mistakes, William Siemens commissioned a shipyard to build a professionally equipped cable ship, which was christened the *Faraday* in February 1874.[34]

Werner von Siemens stayed in the background during the wearisome, risky execution of the transatlantic project. The cable-laying was supervised by his brother Carl and the engineer Ludwig Löffler. On May 16, 1874, the *Faraday* sailed off toward the North American coast to begin laying the cable from there. On July 2, the Reuters news agency reported that the ship had sunk off Halifax, Nova Scotia. Fortunately, this soon turned out to be a deliberately planted false report. The Siemens brothers now knew that in this project they would have to contend not just with the Atlantic, but with powerful antagonists.

The project repeatedly faced potential disaster because the cable broke or was lost. It took three tries before the line could finally

1866 American entrepreneur Cyrus W. Field lays the first permanent transatlantic cable, between Newfoundland and Ireland, for John Pender's Anglo-American Telegraph Company.

open for operation in September 1875. Over the following months, the cable was broken three times by competitors' sabotage. The attacks ceased only when the results of an independent investigation were released, confirming the existence of sabotage, and the *Faraday* was permanently stationed in Halifax to make repairs at any time. Nevertheless, Pender was still able to shut out his new competitor by making a tender offer to the shareholders of Direct United States Cable Co. Ltd.; in 1877 he absorbed the line into his own ring of cables. Yet Siemens Brothers remained in the business. The company got contracts from France and the USA to lay additional transatlantic cables, and by 1884, Pender's monopoly was finally broken.

### Keeping employees for the long term

The international cable projects sharply raised both revenues and profits at Siemens & Halske. These years made Werner von Siemens a wealthy man. In today's terms, his annual income from the Berlin business alone came to about EUR 880,000.[35] Upper management also benefited from the rising profits – they received smaller percentages. In the early 1870s, Germany enjoyed an economic boom, and wages rose accordingly. At the same time, staff turnover rose with the size of the company's workforce. In its early years, Siemens & Halske's workers came mainly from the crafts environment, and developed a strong loyalty to the company. As the number of orders rose in the early 1870s, it now became important to hire large numbers of employees, many of them even untrained; as a rule they developed no long-term ties with a company and changed employers often. Amid this situation, and under the influence of the social-reform debates of the day, Werner von Siemens began for the first time to consider providing social insurance benefits through the company. Until then, he had given little thought to such issues. In a spirit of "liberal patriarchalism", he expected both good performance and obedience from his employees.[36] Despite his benevolent intentions, he seldom became involved in his employees' affairs.

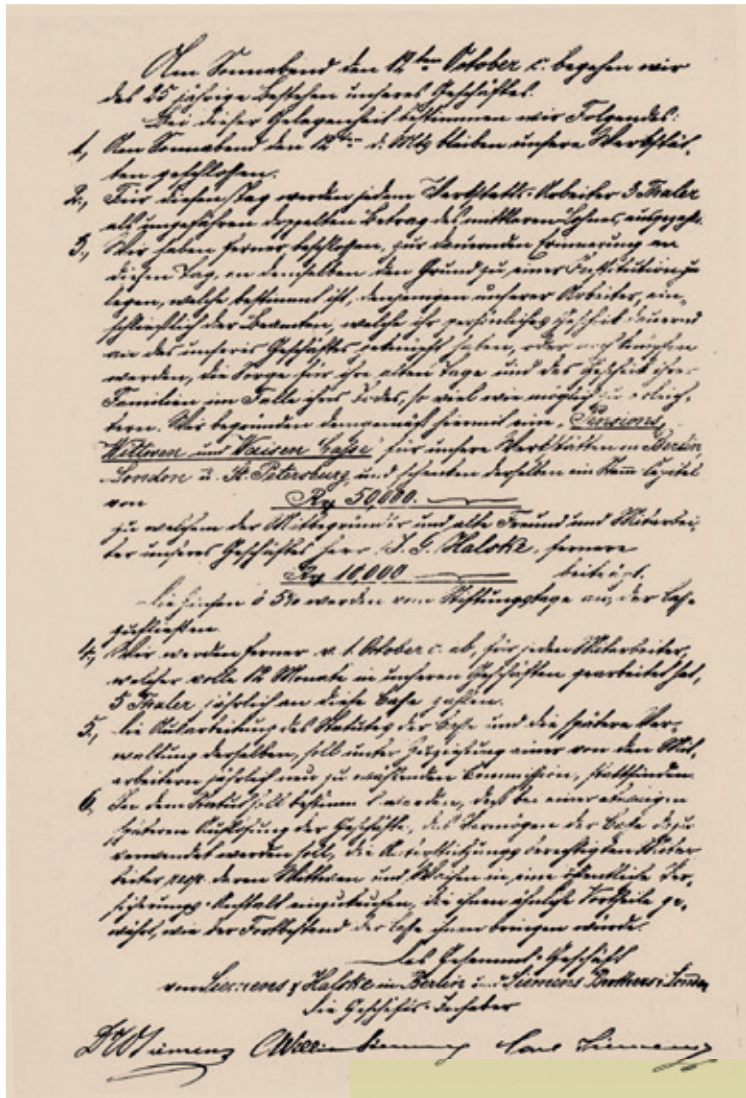
Now he realized that social-insurance benefits for the staff would also benefit the company. On the occasion of the company's


A view from the bridge of the Faraday across the deck, undated photo

1876 British scientists Sir William Thomson and Sir Frederick Joseph Bramwell issue a public report confirming that competitors had sabotaged the transatlantic cable laid by Siemens Brothers.

1874 The Faraday is the first ship built specifically to lay cable. It is named in honor of the discover of electromagnetic induction, Michael Faraday.

25th anniversary in October 1872, he announced that he had founded a Pension, Widows' and Orphans' fund for all employees in Berlin, London and St. Petersburg.[37] The three shareholders donated 50,000 talers for the purpose; Halske added another 10,000 talers. The employees were now entitled to a pension – a benefit that few companies offered at the time. Since the amount of the pension entitlement depended on how long the person had been with the company, employees now had a strong incentive to stay at Siemens & Halske. Moreover, the company's benefits were intended to make it easier to enforce piecework and to counteract the influence of the rising socialist workers' movement on the staff.



Legal document establishing the Pension, Widows' and Orphans' fund, 1872

**1880s** Chancellor Otto von Bismarck introduces health insurance (1883) and accident insurance (1884). In 1889, the Reichstag approves a retirement and disability insurance program.

## New family happiness, a change of lifestyle

After his wife Mathilde's death, Werner von Siemens had firmly decided never to marry again. He had no wish to place a stepmother over his four children; instead they would grow up with their familiar caretakers. But when he met Antonie Siemens, a 28-year-old distant relative from Hohenheim near Stuttgart, he changed his mind. Her father Karl von Siemens, who taught as Professor of Agricultural Technology at the Land- und Forstwirtschaftliche Hochschule Hohenheim (Hohenheim Technical University for Agriculture and Forestry), was a cousin of Werner's in the third degree. The two men thought highly of one another, but had little contact. At the invitation of her uncle Adolf, her father's younger brother, who was lieutenant colonel in the Prussian Artillery, Antonie came to Berlin in March 1869, stayed in the city for some time, and was hosted more and more often at Werner's house. He found the tall, young Swabian maiden likeable, and initially considered her as a suitable wife for his youngest brother Otto – until he himself fell deeply in love with her. Antonie moved into his house, and in May the wedding announcements were sent out. Werner wrote at the time to the wife of his cousin Johann Georg: "I must tell you that I've been taken in by a clever Swabian trick. Our tall Swabian lady has turned me aside from my intent not to marry."[38] The wedding was held in Hohenheim on July 13, 1869. It was the businessman's second marriage to a relative, and in this case as well, family trust and the congruity of many personal values may have played a role in his decision.

1838 Karl von Siemens is appointed instructor in agricultural technology and head of the chemical technical workshop at the Land- und Forstwirtschaftliche Hochschule Hohenheim.

Werner von Siemens and his second wife, Antonie, with their children Hertha and Carl Friedrich, ca. 1878

In the next years, Werner von Siemens became a father to two more children. Daughter Hertha came into the world on July 30, 1870, and son Carl Friedrich arrived on September 5, 1872. Werner now came to know a familial happiness that had not been his during his first marriage, in part because of Mathilde's illness. Also in contrast to that period, he was now a wealthy man, head of a company with some 600 employees. It was easier for him to delegate tasks, and he had correspondingly more time for his family. There was also now a shared focus for their lives. After the wedding, the family moved to the country house in Charlottenburg. There was a good school in Charlottenburg by this time, and Arnold and Wilhelm transferred there. In 1872 to 1874, Werner had the country house remodeled into a handsome industrialist's villa, with a large ballroom. The Siemens villa now hosted festive dinners and balls for several hundred guests. Yet Werner von Siemens was not living aloof. He also held rustic garden parties for his neighbors, with grilled sausages. In spite of their 24-year age difference, Antonie and Werner had a happy marriage. One contributing factor here may have been that he accepted her ties to her Swabian homeland and her relatives there. Since Antonie and the children often spent extended parts of the summer in Swabia, he bought her a country house in a suburb of Stuttgart called Degerloch.

Ballroom of the Siemens villa in Charlottenburg, after 1874

## A "scholar" among scientists

Werner von Siemens' new lifestyle was also in part connected with the fact that he was now among Berlin's eminences. He had already received significant honors. The Berlin university had conferred an honorary doctorate, and the Berliner Kaufmannschaft had elected him to their board of elders. He now consorted with well-known people as his friends – not businessmen, but scientists. He was friends with some of the most significant physicists of his era: Emil du Bois-Reymond, Hermann von Helmholtz and Gustav Robert Kirchhoff. The connection with these scientists was highly typical of Werner; after all, as he wrote in his *Recollections*, he considered himself as "more a savant and engineer than

After 1870 Charlottenburg develops within a few decades from a rural small town of 20,000 souls to one of the biggest, richest cities in Prussia.

1860 Werner von Siemens is awarded an honorary doctorate by the Philosophical Faculty of Berlin University, founded in 1809 (now the Humboldt University of Berlin).

a merchant".[39] From today's vantage point it may seem strange that a businessman of his standing would want to be seen as a scholar. Of course he was not an academic. But he was indeed one of Germany's first industrialists to build on scholarly knowledge. He had contributed a great deal to the creation of a branch of industry founded on new discoveries in physics, and even as a wealthy businessman he still disappeared often into his "lab room". His friends Hermann von Helmholtz and Emil du Bois-Reymond considered him one of their own. Such an innovative technician, as they saw it, could only be an outstanding physicist.

These scientists were all members of the Prussian Academy of Sciences. At their nomination in November 1873, Werner von Siemens was the first technician to be elected a member of this learned society. He was probably the only member of the Academy who had never attended university. He himself experienced the honor as one of the highlights of his life. In his response to Werner's inaugural speech to the Academy, Bois-Reymond explained that his friend had been admitted because "at such a level, as a prince of technology, [...] you remained inwardly a German scholar in the most noble sense of the word".[40]

1700 The Royal Prussian Academy of Sciences is founded in Berlin as the "Society of Sciences of the Electorate of Brandenburg". Having undergone several name changes since, the academy still exists today.



## The dynamo machine and heavy-current technology

Even before the Indo-European telegraph line was built, in the fall of 1866 Werner von Siemens came up with his most significant invention: the discovery of the dynamo-electric principle and the design of a dynamo machine based on that principle. Today we know that the Hungarian inventor Anianus Jedlick and the Danish engineer Søren Hjorth had already discovered the dynamo-electric principle back in the 1850s. But they were unable to put their discovery to any use. Werner von Siemens was the first to publish the principle and to place a dynamo on the market.

His invention was founded on the inductor with a double-T armature, which he had developed ten years previously. But this design was capable only of low output, because the permanent magnets it employed generated only a relatively weak magnetic field. Werner noticed that the residual magnetism remaining in the soft iron core of the electromagnets was enough to generate what was at first a low voltage, which could be used, with the aid of suitable circuitry, to power the electromagnets. The resulting amplified magnetic field increased the generated voltage until the soft iron core was magnetically saturated. This dynamo-electric principle, the "self-excitation of electricity", made it possible to eliminate permanent magnets and batteries. Such a generator was able in principle to convert unlimited amounts of mechanical energy ("work") into electrical energy. On that basis, it became possible to build electric lighting systems, electric motors and power plants.[41]

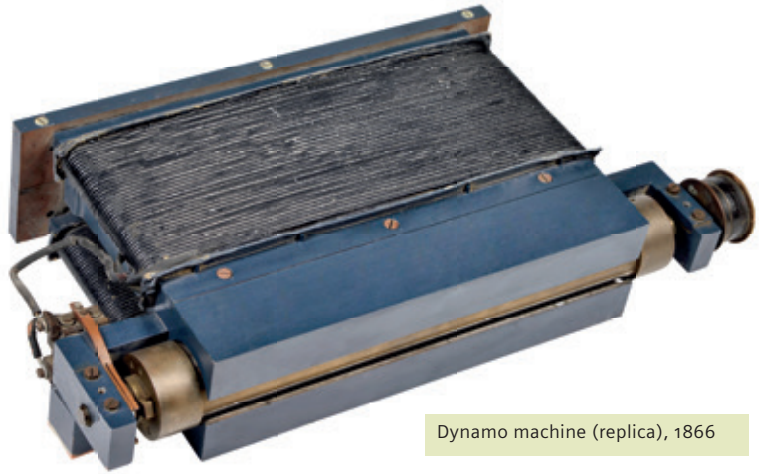
1866 After discovering the dynamo-electric principle, Werner von Siemens writes to his brother William: "The whole thing has great potential for development and can pave the way for a new era of electromagnetism!"

Werner von Siemens immediately realized the importance of his invention. Before the year was out, in December 1866, he invited Berlin's leading physicists to attend a demonstration at the Markgrafenstraße plant. Gustav Magnus, one of Germany's most famous physicists, announced the invention to the Prussian Academy of Sciences on January 17, 1867. He read out a description authored by Werner von Siemens, which ended with a far-sighted recognition:

*"By means of the method employed, electric currents can be produced in a cheap and simple manner, wherever mechanical agency is available. This circumstance will be of considerable importance in many departments of the arts."*[42]

A short time later, British inventors Charles Wheatstone and Samuel Alfred Varley also announced that they had succeeded in building a dynamo machine, but only Werner von Siemens was able to develop the device to maturity for production. The busy entrepreneur assigned the necessary work for the development to the chief designer at Siemens & Halske, Friedrich von Hefner-Alteneck. By the end of 1875, the moment had come. This was the beginning of a new era in the history of electrical engineering, which had hitherto been dedicated primarily to telegraphy and cable technology. Werner von Siemens himself coined the term "electrical engineering" at the time, in a memorandum for the founding of the Elektrotechnischer Verein (Electrical Engineering Association).[43]

The dynamo machine could power only individual lights at first. Further developments were needed before entire lighting systems could be built. Only after Russian engineer Pavel Yablochkov invented electrical candles in 1876, and Friedrich von Hefner-Alteneck invented the differential arc lamp two years later,



Dynamo machine (replica), 1866

did it become possible to light whole buildings and streets. On March 1, 1879, the Siemens villa in Charlottenburg became the first private residence in Germany to be lighted with electricity. Werner von Siemens invited some 250 guests to a great ball to celebrate the occasion. Two days later, he reported to his brother William: "The electric lighting proved itself superbly. [...] But the most important thing was that the temperature remained pleasant to the very end (2:30 a.m.), while with gaslight we used to have to ventilate the room every half hour."[44] Because of its high cost, however, electric light was no alternative to gaslight yet.

A few weeks later, Siemens & Halske aroused a great deal of public attention with the first electric railway, at the Berliner Gewerbeausstellung (Berlin Commercial Exposition). Werner von Siemens was now pursuing the goal of building an elevated railway along Friedrichstraße in the center of Berlin. Like many experts, he considered it impossible to build an underground rail-

1884 The first German electrical power plant is built in Berlin. In those days, power plants were called centrals.

1882 In Berlin, Siemens & Halske installs the first street lighting to use electric arc lamps.

The first electric streetcar in Lichterfelde, 1881

way because of the capital city's high water table. But after protests from those living along the route, Kaiser Wilhelm I squelched the elevated railway project. Instead, Siemens & Halske now built a ground-level railway in the residential suburb of Lichterfelde – the world's first electric streetcar system. It was festively opened on May 12, 1881. Werner's elevated railway projects in other cities also failed to materialize. For the time being, the electrification of transportation remained limited to electric streetcars and regional railroads.

1890 The world's first electrical subway (underground) is running in London. The first subway built by Siemens & Halske will go into operation in Budapest in 1896.



## The patriarch and his principles

When American inventor Thomas Alva Edison revolutionized electrical engineering by introducing the carbon-fiber incandescent lamp (1879) and building the first electric power grid (1882), Werner von Siemens was unimpressed at first. To him, Edison seemed a mere "American 'go-ahead' inventor", looking for quick money.[45] He later changed his mind, and a personal friendship evolved between the two inventors. Nonetheless, Edison's business model of building and operating power plants with stock companies was incompatible with Werner von Siemens' business principles. "We are not lighting entrepreneurs, but manufacturers!" he wrote to his brother Carl as early as 1878.[46] All the same, Werner had to come to terms with Edison's European holding company in order not to abandon incandescent lamp manufacturing and the power plant business to the competition. In 1883, Siemens & Halske invested in Berlin engineer Emil Rathenau's founding of the Deutsche Edison-Gesellschaft, and four years later it invested in that company's successor, Allgemeine Elektricitäts-Gesellschaft (AEG). AEG quickly became a mighty competitor of Siemens & Halske. As a stock company, with the support of Georg von Siemens and Deutsche Bank, it was able to raise the large capital investments needed to build power plants and grids. Before the century was out, AEG's revenues were outpacing those of Siemens & Halske.[47]

Werner von Siemens could have prevented the sharp rise of AEG if he had not held firm to outmoded principles.[48] His brother Carl urged him to convert Siemens & Halske into a stock corpora-

1880s Siemens has been the unchallenged market leader in electrical engineering in Germany for decades. But now new companies are thronging into the market. AEG arises as a strong competitor against Siemens.

tion.[49] But Werner had a deep aversion to the capital market, banks and the stock exchange. Siemens & Halske, he felt, should remain a family-run business, not subject to the influence of any banker, not even his relative Georg von Siemens. AEG's strategy of relying on new financing concepts and making do without inventions of its own was alien to Werner von Siemens. To his way of thinking, an industrialist was a maker – not a merchant. That was the only way he could achieve the goal that he had set himself as an entrepreneur: to create things that were useful and lasting. He professed his loyalty to that principle for action especially impressively in a letter to Carl dated December 25, 1887 – the most significant of his many letters:

*"I see the business only secondarily as a financial asset. For me, what I've found is more an empire and something I'd like to leave undiminished to my descendants so that they can continue to work within it."*[50]

1887 79 of the 100 largest German industrial companies are stock corporations. The growing need for capitalization causes the number of partnerships to shrink.



## A patron of research

Werner von Siemens was not one of those entrepreneurs who donate large amounts on charitable causes. But once he possessed wealth and influence, he was a consistent advocate of scientific research. He was certain that the "Age of Natural Science" had dawned, with his era's rapid advances in physics, chemistry and medicine.[51] He was one of the first to recognize that the natural sciences had become a key resource for industrial development. In an opinion paper of April 1883, he noted that a country's industry could "never achieve a leading international position" if the country was not "simultaneously in the lead of scientific progress."[52]

At that time he conceived the idea of establishing a non-academic research institute for physics and technology. Such suggestions had already been in the air for ten years, always with his participation. But by then the institute had never been realized because of diverging ideas about its scientific orientation. Now, working with his friend Hermann von Helmholtz, he began pushing the project ahead consistently with his own ideas.

In July 1883, Werner von Siemens made an offer to the Prussian Minister of Culture to donate a plot of land worth about 200,000 marks for the founding of a "state institute for experimental physics".[53] Half a year later, he increased the offer by 300,000 marks for the construction of an institute building on the property, which was in the immediate vicinity of his villa in Charlottenburg. Since the Prussian government vacillated, he directed the offer

1879 Charlottenburg Technical University is formed by merging the Berlin Bauakademie and the Königliche Gewerbeakademie (Royal Trade Academy). The new buildings, dedicated in 1884, are located near the Siemens villa.

to the Minister of the Interior of the German Empire. In a memorandum, he gave assurance that with the donation, he had

*"in mind only the purpose of doing a service for my native land and demonstrating my love for science, to which alone I owe my rise in life."*[54]

Werner von Siemens and Hermann von Helmholtz still had to overcome numerous obstacles before March 1887, when the Reichstag adopted the first budget for the Physikalisch-Technische Reichsanstalt (Imperial Physical and Technical Institute, today the Federal Physical Technical Institute).[55] Helmholtz now assumed the directorship of this, the world's first major research institution, which became a role model for later research institutes.

It was most probably this achievement that led Kaiser Friedrich III to raise Werner von Siemens to the hereditary nobility on May 5, 1888. Werner was by no means delighted at the honor, especially because nobody had asked him in advance – and he only learned of his elevation to the nobility from the newspaper.[56] But as the title had already been conferred, it would have been difficult to refuse. That would have essentially represented an insult to the Kaiser, who was fatally ill at the time.

Buildings of the Physikalisch-Technische Reichsanstalt, ca. 1894

1887–1914 The Imperial Physical and Technical Institute is already recording outstanding scientific achievements in its first decades in existence. Its Board of Trustees includes luminaries like physicists Max Planck and Albert Einstein.

1946 The building of the Imperial Physical and Technical Institute is severely damaged in the Second World War. After the war ends, the institute's headquarters are moved to Braunschweig.

## Successors and memoirs

Werner von Siemens' concept of a "Gebr. Siemens" family-run company that the next generation would transform into an "enterprise of world standing comparable to the Rothschilds'" already fell apart during his lifetime. In London, his brother William died in 1883, without children. Carl, who was again running the business in St. Petersburg, had only one son left, who had no talent for business. The other brothers had gone their own ways, or had died young. Friedrich was a successful businessman in Dresden, where he owned a company building industrial furnaces and a glass factory. Hans, who had built up the glass factory in Dresden, had died back in 1867. Ferdinand lived on an estate in East Prussia. Otto, the youngest brother, had taken over the management of the Tbilisi branch after Walter's death in 1868, and had himself died young there three years later.

At any rate, the future of Siemens & Halske as a family-run business was secure. But Werner von Siemens found it difficult to hand over the management to his elder sons Arnold and Wilhelm, who had already been working for the company for a considerable time. After Werner's 65th birthday, Arnold at last became a partner, in 1882, followed two years later by Wilhelm. Of course, their father still held the reins. Since both sons repeatedly suffered from lung illnesses, and sometimes were under medical treatment for months, he also had few other alternatives. Meantime, the boom in heavy-current technology caused Siemens & Halske to grow as never before. New plants were built in Charlottenburg to

1884 Arnold von Siemens marries Ellen von Helmholtz, daughter of the era's most famous German physicist, who is a close friend of Werner von Siemens.

The Siemens brothers Friedrich, Werner, Ferdinand and Carl (left to right), ca. 1889

Werner and Antonie von Siemens on the terrace of the country house in Bad Harzburg, with friends and their children Carl Friedrich and Hertha (lower right), ca. 1892

produce dynamos and cables. Within a decade, the workforce grew from 876 employees (1880) to 3,950 (1890).

Only at the beginning of 1890, at age 74, did Werner von Siemens step aside as a partner. The company was converted from a commercial partnership into a limited partnership. The head of the family continued to reject the idea of forming a stock corporation. Werner von Siemens would now have three years to enjoy his retirement. He traveled to the Caucasus with Antonie, Carl and his youngest daughter Hertha, went bear hunting there, spent a winter on Corfu and a spring in Italy. His four children from his first marriage had married between 1882 and 1887, and a total of eleven grandchildren were born during Werner's lifetime.

He now began working hard on his memoirs. For that purpose, he repeatedly retired for extended periods to the country house in Bad Harzburg that he had bought back in 1882. The autobiography became an outstandingly well-written work in which Werner von Siemens presented his principles and made his points between colorful descriptions of cable expeditions and journeys to the Caucasus. His comments ended with the finding:

> *"For my life was beautiful, because it essentially consisted of successful labor and useful work, and if I finally give expression to the regret that it is approaching its end, I am only urged thereto by the pain that I must be parted from my dear ones, and that it is not permitted me to continue to labor for the full development of the Age of Natural Science."*[57]

Werner von Siemens was spared a lengthy illness. After the Julius Springer publishing house had issued the first copies of his Recollections on November 29, 1892, his strength suddenly abandoned him. He fell ill, and pneumonia set in. On December 6, 1892, a few days before his 76th birthday, Werner von Siemens died peacefully at his home in Charlottenburg, surrounded by his family.

**Starting 1883** Step by step, the development and production of dynamos, arc lamp fabrication, and the production of all other heavy-current products are relocated to the Charlottenburger Werk (charlottenburg plant).

**2008** The 19th edition of Werner von Siemens' *Recollections* is released. The autobiography has been translated into many different languages. There has also been an iPad app on the electrical pioneer's life since 2011.

## Notes

1 Sigfrid von Weiher, *Werner von Siemens*, Göttingen 1975; Wilfried Feldenkirchen, *Werner von Siemens*, Columbus, Ohio 1994.

2 Siemens Corporate Archives [hereinafter: SAA] W7236, Werner to Carl, Charlottenburg, December 25, 1887.

3 Werner von Siemens, *Recollections*, ed. Wilfried Feldenkirchen, Munich 2005, 33.

4 Prussian patent for a process for dissolving gold by means of the galvanic current for gilding by the wet method (1884), in: Siemens, Werner von: *Scientific and Technical Papers*, vol. 2: *Technical Papers*, London 1895, 1.

5 Siemens, *Recollections*, 48–49.

6 SAA 2.Ls 903, Bemerkung des Brigadiers über Werner Siemens 1846, extracts from the "Conduitenliste von den Offizieren der 3. Artillerie-Brigade" of December 1, 1836–December 1, 1847.

7 SAA F1276, Werner to Mathilde, Berlin, November 26, 1856.

8 SAA W1594, Werner to William, n. p., December 14, 1846.

9 For Halske's biography, see Ewald Blocher, *Johann Georg Halske*, Munich 2014.

10 SAA 21.Li 53, Gesellschaftsvertrag zwischen 1. dem Mechanikus Herrn Halske 2. dem Artillerieleutnant Werner Siemens 3. dem Justizrath Georg Siemens, October 1, 1847.

11 Cf. Werner Siemens, *Kurze Darstellung der an den preussischen Telegraphen-Linien mit unterirdischen Leitungen bis jetzt gemachten Erfahrungen*, Berlin 1851.

12 SAA W17, Werner to William, Berlin, October 11, 1851.

13 On this point, see Martin Lutz, *Carl von Siemens* 1829–1906, Munich 2013, 59–97.

14 SAA F1156, Werner von Siemens to Mathilde Drumann, Berlin, June 22, 1852.

15 SAA 3.Li 509, Mathilde to Wilhelm, Berlin, March 1875.

16 Cf SAA W8539, Werner to William, Berlin, September 25, 1845.

17 On this point, see David Warren Sabean, "German International Families in the Nineteenth Century. The Siemens Family as a Thought Experiment," in *Transregional and Transnational Families in Europe and Beyond. Experiences Since the Middle Ages*, ed. Christopher H. Johnson et al. New York / Oxford 2011, 229–252.

18 SAA W1343, Werner to William, St. Petersburg, April 1, 1852.

19 Siemens, *Recollections*, 169–178.

20 SAA W5502, Werner to Carl, Charlottenburg, December 7, 1869.

21 SAA W4208, Werner to Carl, n. p., November 4, 1863.

22 SAA 21.Li 53, Gesellschaftsvertrag of August 24, 1867.

23 SAA W2253, Werner to Carl, London, November 10, 1856.

24 This is also confirmed by the memoirs of his daughter Käthe Pietschker, *Aus meinem Leben*, Hamburg n. d.

25 At the time, Werner von Siemens anonymously published a proposal for a compromise on the army reform: *Zur Militairfrage. Ein Vorschlag*, Berlin 1862.

26 Werner Siemens, ed., *Positive Vorschläge zu einem Patent-Gesetz. Denkschrift der Aeltesten der Kaufmannschaft zu Berlin an den Königlichen Staats- und Minister für Handel, Gewerbe und öffentliche Arbeiten, Herrn Grafen von Itzenplitz* (Berlin 1869).

27 Memoir on the necessity of a patent law for the German Empire (1876), in: id.: *Scientific and Technical Papers*, vol. 2, 576-582.

28 On the prior history and the terms of the Patent Act of 1877 see Ludwig Fischer, *Werner von Siemens und der Schutz der Erfindungen*, Berlin 1922; Alfred Heggen, *Erfindungsschutz und Industrialisierung in Preußen* 1793–1877, Göttingen 1975; Margrit Seckelmann, *Industrialisierung, Institutionalisierung und Patentrecht im Deutschen Reich, 1871–1914*, Frankfurt am Main 2006.

29 SAA W2315, Werner to William, Berlin, April 29, 1856.

30 SAA F84, Werner to Arnold, Degerloch, October 5, 1891. Concerning the Kedabeg copper mine and the oil business in the Caucasus, see Lutz, *Carl von Siemens*, 153–157 and 161–166.

31 Concerning the Indo-European telegraph line, see, e. g., Jorma Ahvenainen, *The History of the Near Eastern Telegraphs before the First World War*, Helsinki 2011, 107–149; Richard Ehrenberg, *Die Unternehmungen der Brüder Siemens*, vol. 1: *Bis zum Jahre 1870*, Jena 1906, 174–268; Museum für Kommunikation, ed., *In 28 Minuten von London nach Kalkutta. Aufsätze zur Telegrafiegeschichte aus der Sammlung Dr. Hans Pieper im Museum für Kommunikation*, Bern, Zürich 2000.

32 For the biography of Georg von Siemens see Karl Helfferich, *Georg von Siemens*, 2 volumes, Berlin 1921.

33 Ibid., vol. 1, 98–161; Dirk Schaal, *Ernst Höltzer*, Munich 2015.

34 Concerning the Direct United States Cable Co. Ltd. and laying the transatlantic cable in 1874/75, see Lutz, *Carl von Siemens*, 181–188; SAA 38/8/2, Richard Ehrenberg, Seekabel-Unternehmungen, manuscript, n. d.

35 SAA 14.Lh 622, Gewinne der Berliner Firma 1850–1896; converted at the rate of 1 taler to 3 marks and according to buying-power equivalent in: Deutsche Bundesbank, *Kaufkraftvergleiche historischer Geldbeträge/ Kaufkraftäquivalente historischer Beträge in deutschen Währungen*, version of January 15, 2015. URL: http://www.bundesbank.de/Redaktion/DE/Standardartikel/Statistiken/kaufkraftvergleiche_historischer_geldbetraege.htm [consulted March 14, 2016].

36 Jürgen Kocka, *Unternehmensverwaltung und Angestelltenschaft am Beispiel Siemens 1847–1914*, Stuttgart 1969, 233.

37 See Christoph Conrad, *Erfolgsbeteiligung und Vermögensbildung der Arbeitnehmer bei Siemens (1847–1945)*, Stuttgart 1986, 98 et seq.; Karl Burhenne, *Werner Siemens als Sozialpolitiker*, Munich 1932, 71–86; Jacob Kastl / Lyndon Moore, "Wily welfare capitalist: Werner von Siemens and the pension plan," In *Cliometrica 4* (2010), 321–348.

38 SAA F2120, Werner to Marie, Berlin, May 23, 1869.

39 Siemens, *Recollections*, 271.

40 Bois-Reymond, Emil du: *Erwiderung auf die Antrittsrede von Werner von Siemens*, URL: http://leibnizsozietaet.de/wp-content/uploads/2012/11/08_du_bois_reymond.pdf [consulted May 6, 2016].

41 Concerning the dynamo machine, see Siemens, *Lebenserinnerungen*, 250 et seq.; Otto Mahr, *Die Entstehung der Dynamomaschine*, Berlin 1941; Georg Siemens, *History of the House of Siemens*, vol. 1: *The era of free enterprise 1847–1910*, Freiburg im Breisgau 1957; http://www.deutsches-museum.de/sammlungen/meisterwerke/meisterwerke-iii/dynamomaschine [consulted May 19, 2016].

42 Siemens, Werner von: On the conversion of mechianical energy into electric current without the use of permanent magnets (1867), in: id.: *Scientific and Technical Papers*, vol. 2, 255–258, quotation on 258.

43 Werner von Siemens to Heinrich Stephan, February 5, 1879, cf Helmut Lindner, *Strom*, Reinbek 1985, 168.

44 SAA W6466, Werner to William, Paris, March 4, 1879.

45 "Dr. Werner Siemens über die neue Edison'sche Lampe," *Zeitschrift für Angewandte Elektricitätslehre*, 2 (1880), sub-vol. 2, 83.

46 SAA W6361, Werner to Carl, Berlin, December 28, 1878.

47 See Manfred Pohl, *Emil Rathenau und die AEG*, Berlin/Frankfurt am Main 1988.
48 Jürgen Kocka, "Siemens und der aufhaltsame Aufstieg der AEG," *Tradition* 17, 3/4 (1972), 125–142.
49 SAA W7368, Carl to Werner, St. Petersburg, January 20, 1889. On this point, see Lutz: *Carl von Siemens*, 270.
50 SAA W7236, Werner to Carl, Berlin, December 25, 1887.
51 Werner von Siemens, *Das naturwissenschaftliche Zeitalter. Vortrag, gehalten in der 59. Versammlung Deutscher Naturforscher und Aerzte am 18. September 1886*, Berlin 1886.
52 Siemens, Werner von: Offer concerning the foundation of an institute for the experimental promotion of the exact sciences and of higher engineering (1883), in: id.: *Scientific and Technical Papers*, vol. 2, 582–588.
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54 SAA 61.Lc 973, Denkschrift betreffend die Errichtung einer „physikalisch-technischen Reichsanstalt" für die experimentelle Förderung der exakten Naturforschung und der Präzisionstechnik, March 20, 1884.
55 On the founding of the Physikalisch-Technische Reichsanstalt, see David Cahan, *An Institute for an Empire*, Cambridge 1989; Dieter Hoffmann, "Werner Siemens und die Physikalisch-Technische Reichsanstalt," in *Werner von Siemens (1816–1892)*, ed. Dieter Hoffmann and Wolfgang Schreier, Braunschweig 1995, 35–47.
56 SAA W7343, Werner to Carl, Berlin, May 8, 1888.
57 Siemens, *Recollections*, 288.



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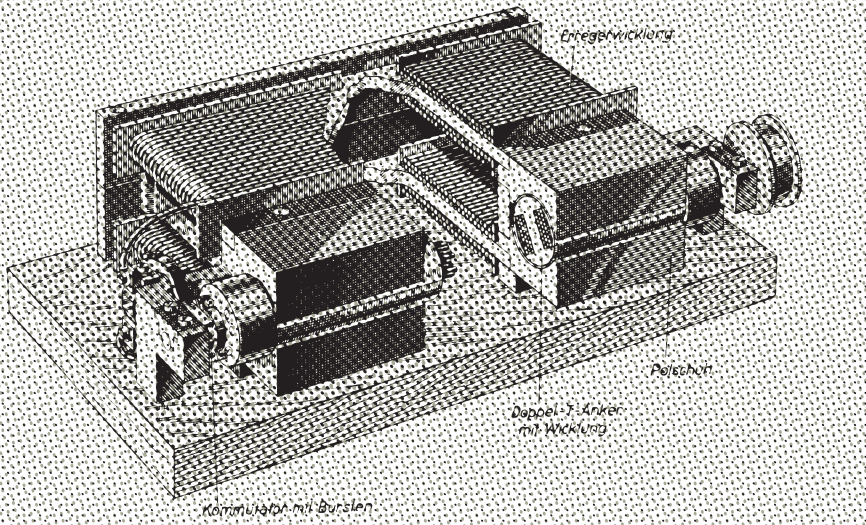
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