

Walter Reichel

Walter Reichel's lifework is closely linked with the development of the rail and generator businesses of Siemens. He is as intimately associated with the legendary high-speed train with three-phase locomotives as he is with the design of generators and large motors. He was quickly entrusted with tasks of great responsibility, both at home and abroad, and he interrupted his Siemens career for two years in 1904 to accept a position as a regular professor of electrical engineering in Berlin. Unfazed by the political upheaval of his time, Reichel was passionate about railway electrification and the further development of electrical engineering as a separate field of study at Germany universities.

The brochure is the seventh volume in the **LIFELINES** series, which presents portraits of individuals who have shaped the history and development of Siemens in a wide variety of ways. This includes entrepreneurs who have led the company and members of the Managing Board as well as engineers, inventors, and creative thinkers. Walter Reichel



Walter **Reichel** January 27, 1867 – May 23, 1937



The Siemens engineer – Walter Reichel, 1907

Walter Reichel – An engineer with courage and vision Introduction

Walter Reichel was the hero of many a wild tale, some of which were still circulating at Siemens in the 1950s. One was especially popular: During one of the company's test runs for the Research Association for High-Speed Electric Railways, Reichel, a Siemens engineer and later a university professor, had himself lashed not just on top of the high-speed car, but underneath it as well, so he could observe how the current collector and the wheel bearings performed while the car was in motion. During the 1950s, Wolf-Dietrich von Witzleben, a member of the Supervisory Board, wanted to know more about this story. The head of the Siemens Archives, Friedrich Heintzenberg, was able to oblige; he had once asked Reichel personally, while they were traveling together from Munich to Garmisch, if the story was true. Heintzenberg confirmed that the first part was correct, but that the tale that Reichel had had himself strapped to the underside of the car definitely belonged in the category of myths.

The Berlin trial runs with fast self-propelled electric rail cars established Reichel's reputation as a daring, inventive mind. In 1903 he and his colleagues set a speed record of more than 200 kilometers per hour on Berlin's Marienfelde–Zossen trial track. Turn-of-the-century Germany, with its enthusiasm for progress and technology, received the news with exuberance – nearly every newspaper reported the event. The liberal *Frankfurter Zeitung* even wrote that the trial runs had "virtually provoked a nervous excitation in every cultured land on earth." At the time, the press

1949 The headquarters of Siemens' central administration was moved from Berlin to Munich. Wolf-Dietrich von Witzleben, who had been part of the company's top management since 1939, was largely responsible for this decision. was still emphasizing the competition among nations for technological and economic dominance; few could have imagined the possibility that little more than a decade later, a world war would cost millions their lives and bring the Wilhelmine era to a catastrophic end.

When the Republic was proclaimed in Berlin in November 1918, Walter Reichel was 51 years old, head of the Dynamowerk, a member of the Managing Board of Siemens-Schuckertwerke, and a professor of electrical engineering in Berlin-Charlottenburg. He was a sought-after author and expert, Chairman of the Association of German Engineers (VDI), and head of a family. He was also a citizen of the City of Berlin, whose political controversies he engaged in with the same vigor that he devoted to the further development of electrical engineering as an academic discipline or the debate about the "electrification" of the railroads. He retired in September 1932, but he maintained his professional contacts. He remained much in demand internationally as an expert, and up to his sudden death in May 1937 was still promoting, in trade journals and general interest magazines, the electrification of train lines in Germany – an ambitious project that the Deutsche Reichsbahn (the German National Railway) was pursuing only haltingly. After promising beginnings, the concept was shelved as the National Socialist regime began preparing for war.

Walter Reichel's career is so closely associated with the development of railway technology and electrical engineering that it's easy to overlook how much it owes to the era when it began. Reichel was a member of a new social group: German engineers. Their rise in society went hand in hand with the unfolding of the commercial and industrial revolution, and reached its climax even before World War I. Yet what special traits made Reichel so exceptional as an engineer? Was it his daring, in tandem with

1856 Berlin engineers came together at Alexisbad, a spa town in the Harz mountains, and founded the Association of German Engineers to promote the international exchange of the latest technological developments. science? What role did Siemens play in his life, as a company and an employer, and what challenges did he face, especially in the politically and economically troubled years of World War I and the Weimar Republic? This volume of "Lifelines" will try to answer questions like these. Yet just as in any biography of an historical personality, he must be understood as both a producer of and a product of historical developments, which must also be presented – sticking as closely to the sources as possible.

Walter Reichel left no personal notes, but the collection of the Siemens Historical Institute does include the *Erinnerungen an einen großen Ingenieur* ("Recollections of a Great Engineer") written in 1951 by Franz Paufler, Reichel's former university assistant and later employee. This memoir, Reichel's correspondence with supervisors and colleagues, along with his numerous professional articles, provide the sources from which his biography can be reconstructed.

1905 Franz Paufler wrote his thesis on the electrification of the Berlin municipal railway. Once he had passed his exams, he worked as an assistant under Reichel's professorship. His career at Siemens began in 1910 at the Dynamowerk in Berlin.

"Work is balm to the blood" – School and university during the Empire

Walter Reichel had barely turned 12 when Werner von Siemens presented the first electrically powered railway at the Berlin Industrial Exposition on May 31, 1879. Born in Laurahütte (now Semianowice Śląskie) in Upper Silesia in 1867 and living in Dresden at the time of the exposition, the boy probably knew nothing of the "mighty fun" that prompted thousands of Berlin residents to pay two silver groschen for a short ride on the electric train around the exhibition grounds near the Lehrter Railroad Station. For Werner von Siemens, the train at the exposition was a superb piece of advertising. He reported to his brothers that many had taken an interest in the narrow train, including the director of the Tivoli amusement park in Copenhagen.¹ He felt this was an important point to emphasize, because enthusiasm for the latest development from Berlin was modest in both London and Petersburg, where his brothers William and Carl had been living for some time.

Yet it would be hard to imagine a more vivid way than this little train to show the public that a dynamo-electric machine was also capable of heavy work. It was now clear that "electricity" would offer the possibility for more technical innovations than its prior use for transmitting news and generating light would have led one to suspect. Forward-looking projects like the locomotive, presented with great fanfare at national and international trade shows, were yet another reason why more and more young men were interested in a technical course of study and fields with new

1879 The Berlin Industrial Exposition opened in May.It attracted national attention and was also a commercial success.By October, it had been visited by more than two million people.

content like electrical engineering. Walter Reichel would choose this path, too, although originally he planned to study medicine. That at least is what his 1885 secondary-school diploma from Dresden's Kreuzschule tells us.

We have no information about what changed his mind. It may have been the example of his father, though the 18-year-old knew him only from the family's stories. Walter was only three years old when Adolf, his father, died. As machine director at Count Hugo Henckel von Donnersmarck's Laurahütte iron and rolling mill, Adolf would have been well aware of both the blessings and the hazards of the nascent heavy industry sector. In the year of Walter's birth, the plant put out more than 13,000 metric tons of pig iron and 25,000 metric tons of finished products like railroad rails. It was entirely on a par with the Ruhr industrialists' comparable plants in western Prussia.

After Adolf's untimely death, the family moved to Dresden in 1870 to live with relatives. In later years, Reichel himself spoke little of his time in Dresden. Yet his mother clearly set a high priority on her son's education; in 1881 he was admitted to the Untersekunda class – roughly, the tenth grade – at the city's famed Kreuzschule. It can't have been easy for his mother to have raised the money for tuition. In his last year at school Walter received a scholarship from the school's foundation. This historic humanist Dresden secondary school, still famed today for its boys' choir, had introduced the natural sciences into its curriculum after the Revolution of 1848, and – very much in the spirit of the times – had also added gymnastics and singing lessons alongside the standard range of subjects. Apart from its musical tradition, the Kreuzschule differed little from other neo-humanist secondary schools for the middle class of the new German Empire. Lesson plans for the boys included reading Goethe and Herder, Cicero, Homer, and

1836 The village of Laurahütte and the ironworks of the same name were established. A growing number of laborers and mechanical engineers were being drawn to the Silesian industrial area by the surrounding hard coal mines and the expansion of the steelworks. Molière, as well as probability theory, optics, and magnetism. Such an educational program also included writing essays on topics like a quote from Herder: "Work is balm to the blood, work is the fount of virtue." We do not know whether Walter Reichel took this Protestant maxim to heart. But later he would be a particular fan of gymnastics, which he said had taught him endurance and team spirit. He passed his university qualifying exams during Easter 1885 with a grade of "good" – roughly equivalent to a U.S. or U.K. "B" – and to judge from the accompanying notes, his conduct was impeccable.

The same month that he received his diploma, he enrolled to study mechanical engineering at the Königlich Technische Hochschule (Royal Technical University) of Berlin, in Charlottenburg. Here, mathematician and mechanical engineer Adolf Slaby also taught something called "electromechanics." Slaby, whose research was supported by Werner von Siemens, had the mission of strengthening electrical engineering as a discipline at the Charlottenburg institution. Reichel attended his lectures, as well as his practical demonstrations in a specially equipped electrical engineering lab.

In those days, Berlin was not yet the mecca of the German electrical industry that it would become by the turn of the century. Electrical engineering was not even taught yet as a separate field. Even experts like Werner von Siemens were skeptical about specializing in one's studies too soon. Accordingly, in Berlin, electrical engineering remained a sub-discipline of the course of studies in mechanical engineering until 1897. It was only after that time that young engineers could decide to specialize in such fields as general mechanical engineering, railroad construction engineering, or electrical engineering. Reichel would personally play an important role in getting electrical engineering established as an

1876 In addition to his appointment as a teacher of mathematics and mechanical engineering in Potsdam, Adolf Slaby became a professor in Berlin. As a co-founder of the Electrotechnical Association, he also promoted academic training.



The new building of the Technical University in Berlin-Charlottenburg was still a stop on the horse-drawn tram line when Walter Reichel began his studies

independent course of study at universities. But he himself was still a member of the generation of graduates who earned a degree in general mechanical engineering and then acquired the requisite specialized knowledge in practice afterwards.

Reichel spent his student years in ways typical of the Wilhelmine era. Already an enthusiast for gymnastics during his school days in Dresden, he sought out fellow athletes. By the winter semester of 1885 he had already been accepted in the Akademischer Turnverein zu Berlin (ATV), an academic athletics association founded in 1860. While graduates in various technical university majors still had to struggle for recognition as full-fledged academics, the Turnverein made no distinctions between technicians who had

1860 The Akademischer Turnverein zu Berlin was founded with the goal of spreading gymnastics to all German universities. Its motto was: *Mens sana in corpore sano* (a sound mind in a healthy body).

graduated from a technical institute and academicians from a traditional university. The Berlin group still operated in the tradition of progressive gymnastic associations; members wore the patriotic black, red, and gold of the post-Napoleonic German unification movement and maintained contacts with other associations. For a young student with few financial resources, the association also offered an opportunity for social and academic networking. An enthusiastic gymnast like Walter Reichel had little trouble making lasting friendships with other athletes. As a student, he was a "Vorturner" who gave demonstrations of moves, and even as a senior member, an "Old Man," he seldom missed an opportunity to work out. Gymnastics would remain his passion; he remained faithful all his life to the association, whose members were mostly of a national-liberal political persuasion during this era.

1886 Gymnastics retained very little political significance. Only the black, red, and gold colors recalled the times when athletes alarmed German princes with their German-nationalist and republican demands.

Electrified by the "electric" – First designs and inventions

"It is in fact not possible for me to make a living on an abstemious wage of 4 marks, as I must entirely support myself and can neither obtain nor expect financial assistance of any kind from my family."² So wrote Walter Reichel to Siemens & Halske in Berlin shortly before his probation period ended in May 1890. He had completed his university studies in 1889, after nine semesters, with the examination for a government construction manager. On November 15, 1889, he began work in his first job as a designer of vehicles and overhead line systems at Siemens & Halske on Markgrafenstrasse.

The starting salary of a Siemens engineer was indeed modest – especially for someone like Reichel, who was thinking of marrying and starting a family. The average wage for a beginner in a profession at Siemens was 4.40 marks a day, or 1,609 marks a year. A laborer at the Charlottenburg plant earned only slightly less.³

At the insistence of Heinrich Schwieger, head of the Electric Railways Department, the Personnel Department quickly complied with Reichel's request for a higher daily rate. After all, the 23-yearold engineer was a promising employee with obvious talent. While still in his probationary period, he developed a patentable invention for electric trams. And that was thanks most of all to the environment he found at Siemens & Halske.

Werner von Siemens himself had recruited Schwieger, an experienced rail expert, from the Prussian State Railway to advance the development of electrically powered rail vehicles for urban

18905 Siemens produced telegraphs, telephones, fire alarms, signaling systems, and measuring equipment at its Markgrafenstraße location. The factory in Berlin's city center also housed the Railway and Electrochemical Departments. transportation. Under Schwieger's supervision, Reichel was assigned to resolve issues with the electric power feed. A strategic advantage here was that Siemens & Halske had, at its own expense, already built the world's first electric tram in 1881, in the Berlin garden suburb of Gross-Lichterfelde. The line ran barely two and a half kilometers, from the Lichterfelde station of the Anhalt Railway to the Prussian Main Cadet Corps School, and was considered further evidence that the future belonged to electrically powered rail.

But operation in practice was still less than satisfactory. Similarly to the solution at the Berlin Industrial Exposition of 1879, the rails themselves were used to transmit the 180-volt power supply. One rail served as the source and the other as the return. But this solution was poorly suited for street-level operation – short circuits were common. And the designers had not taken into account that draft animals pulling wagons could suffer painful shocks when crossing the rails. Curious two-legged users of the system, on the other hand, were inclined to find the experience more entertaining than frightening – as the *Berliner Tageblatt* reported, getting "electrified" by putting a moistened finger on the electric rail became a kind of folk pastime shortly after the line opened.⁴

All the same, providing popular amusement was obviously not Siemens' main interest in the project. The idea instead was to convince the influential Berlin rail experts at the Prussian Ministry of Public Works and the Prussian Rail Administration that an electric drive had a future in rail vehicles. Accordingly, the Lichterfelde tram line was primarily an experimental setup within the realworld environment of a growing metropolis.

Yet the first "Electrics" produced no direct follow-up orders. Even with above-ground catenary lines or slotted-tube lines, which Siemens presented at the International Electrical Exposition in

1885 Heinrich Schwieger began his employment at Siemens. Among other things, the civil engineer was responsible for building the municipal railway and subway in Budapest, the elevated railway and subway in Berlin, and the electric tram in Vienna.



A promotional tour of European capitals – visitors to the Paris Exposition also marveled at the latest "Electric" from Siemens & Halske

Paris, an electric power feed was too complicated and too expensive. The design office at Siemens&Halske thus continued to ponder alternatives. The range of options was broad, but almost none of the developed solutions panned out in practice. Heinrich Schwieger, Reichel's supervisor and an experienced rail man, preferred electric rails laid to the side or underground for the

1881 The First International Electrical Exposition took place in Paris from August 15 to November 15, 1881. Companies from the U.S., Germany, Italy, the Netherlands, and France exhibited their innovations.



planning of railway projects in Berlin, Vienna, and Budapest. But for the tram in Lichterfelde, Reichel developed a better idea. In 1889, he experimented by setting up a stable framework on the tram car roof, with two wire loops attached to it that were able to rotate around a horizontal axis. A collector plate pressed the loops against the overhead line from below. The experiments with this design went well, and the current collector was registered that same year with the Imperial Patent Office in Berlin,

1894–1896 Siemens built the first subway on the European continent in Budapest. A few years later, the German capital followed suit. Germany's first elevated railway and subway began operation in 1902. under number 53783. No wonder Schwieger supported Reichel's 1890 request for a raise and quickly assigned him new tasks with a high level of responsibility.

At almost the same time, in the United States, a former Marine officer and inventor named Frank J. Sprague developed a poletype current collector with a contact wheel. Like Reichel's development, this design also proved to work well in practice. But it required more complex, expensive overhead line systems. Other competitors in the growing market for electric railways, like AEG, Union-Elektrizitätsgesellschaft, and Elektrizitäts-Aktiengesellsch aft vorm. Schuckert & Co. in Nuremberg, did not pursue their own developments, but acquired licenses for patents held by Sprague or companies like General Electric Company, and then adapted them to European requirements. Yet having the best technical solution wasn't the only factor involved. Companies had a competitive advantage with the investing municipal governments if they could act as general contractors in electrifying the city's horse-drawn tram lines, offering not only a power supply, but operations management and financing for the system as well. The Siemens brothers had great success with these "venture" businesses deals, especially outside Germany. Within the German Empire, on the other hand, governments moved far more cautiously, and funding for such projects ran up against the limits of the feasible, which quickly proved a disadvantage in competing for concessions. In Berlin, Siemens, AEG, and the Nuremberg-based Continentale Gesellschaft für elektrische Unternehmungen competed for business in electric trams.

As an engineer, Reichel was not yet concerned with such business issues. He was focused on solving technical problems. The potential of electric power transmission fascinated him. Similarly to Sprague in America, after finding a somewhat satisfactory

1887 Frank J. Sprague designed the world's first electric tram network for the city of Richmond, Virginia. The mathematician, engineer, and company founder is considered the father of electric traction in the U.S. solution to the power-feed question, he turned to drive technology. Where the first electric tram car in Lichterfelde had still managed with one motor, Reichel now tried out distributed drives. Two-axle underframes would need two motors. Reichel decided on motors with a cast-iron dipole magnet frame and a helical wheel transmission.

The engineer as businessman – a learning experience in Genoa and Berlin

The chance to test a tram with this kind of drive in continuous operation came when the company received an order from Genoa, Italy. Siemens was to deliver a tram car for a Swiss company, Bucher & Durrer, and its subsidiary Società di Ferrovie Elettriche e Funicolari (SFEF). In the summer of 1892, Reichel traveled to the Italian port city to see the tram commissioned. There he was introduced to the city's business world by Carlo Moleschott, Siemens & Halske's local agent; he remained in Italy for almost a year until the first segment of the line opened between Piazza Manin and Piazza Corvetto. This was Reichel's first assignment abroad for Siemens, and he discovered that he would not be able to concentrate his work solely on solving technical problems – as a representative of Siemens & Halske, he would have to take business policy factors into account as well. After all, the company was up against stiff competition from AEG in the Italian market. With vigorous support from Deutsche Bank, AEG won the contract in 1894 to supply the entire Italian port city with electric light and power, and also acquired the companies that had landed the concessions to build tram lines. When Reichel remarked offhandedly a year later that a bow collector would work better to run the trams than AEG's trolley system, a note of protest was immediately sent

1891 The first German International Electrotechnical Exhibition took place in Frankfurt am Main. Thanks to the initiative of Oskar von Miller, it was the first time power was transmitted practically loss-free over a distance of 175 kilometers.



to management at Siemens & Halske, with a terse demand: The company would please see that Mr. Reichel did not interfere with AEG's execution of construction, just as AEG was not interfering with Siemens' work.⁵ Reichel quickly learned that the highly competitive market for electrical equipment called for not just technical knowledge but diplomatic dexterity.

Even after the Genoa business fell through, Reichel remained in contact with his Italian colleagues. He enjoyed the chance to

1893 For the first time in company history, Siemens & Halske issued a bond. The family-owned company did not have sufficient capital compared to its publicly listed competition.



In the driver's cab at the crank – Walter Reichel himself oversees commissioning the electric tram line Görlitzer Bahnhof–Treptow in Berlin in 1896

discuss technical matters, and he wanted to stay informed on how the situation evolved. The gift of inspiring trust, together with his strong technical expertise, seems to have been one reason why, immediately after his return, Reichel was entrusted with setting up and running the electric tram system in Dresden. He was then assigned to build the Berlin tram lines from Gesundbrunnen to Pankow and from the government district to Treptow and

January 1, 1899 Siemens established a regional company in Milan, Italy – the Società Italiana Siemens per Impianti Elettrici Anonima.

would later pursue retrofitting the Lichterfelde line to operate at 500 volts.

All this effort left its mark on Walter Reichel. His health was compromised. In January 1895 he was diagnosed with typhus, and for more than two months he was unable to work. By that point he was married to Elisabeth Lange and was the father of a young son, four months old. The days were long gone when the little family had to scrape by on a daily wage of 4.40 marks. Reichel was now drawing a tidy salary, as well as the bonuses that Siemens customarily paid for exceptional achievement. The family could afford a vacation home in Zinnwald, on the border between Bohemia and Saxony, where Reichel retreated after his diagnosis. By March 1895 he had recovered and resumed his work in Berlin at full strength.⁶

1879 The typhus pathogen was discovered. Typhus was a bacterial infection that was sometimes referred to as "spotted fever." Its cause was and continues to be a lack of hygienic conditions.

From 20 kph to 200 – High speed for electric railways

Walter Reichel was a success, and was getting ahead quickly. By 1897 he had already been appointed senior engineer and supervisor of the tram car construction office. Meanwhile, Siemens& Halske had become a family-owned stock corporation. Wilhelm von Siemens, the company founder's second son, took a special interest in the high-voltage business, and – like his father – was deeply interested in electrifying the railways. The necessary experimental facilities became established due in large part to his involvement. Reichel welcomed Wilhelm von Siemens' business ideas and plans, and he had enough expertise and imagination to pursue the associated technical developments. Speeds higher than the 20 kph permitted for systems like the electric trams in Berlin had long been possible. While heading his tram projects and operations in Genoa, Dresden, and Berlin, Reichel had grown familiar with all issues of the wheel-and-rail system that was to be electrified. He was just as interested in mechanical questions of car design and current collectors as he was in the evolution of motors and other electrical equipment for railway operation. It was probably thanks to Wilhelm von Siemens and Reichel's patron Heinrich Schwieger that Reichel and his colleague Emmerich Frischmuth were sent to New York in 1899 to study the electric train system there.

Though Europe had made advances in electrifying urban local public transportation, as well as in developing power plant and line technology – not least of all thanks to patents from the USA –

1897 Wilhelm von Siemens, along with his brother Arnold and uncle Carl, was appointed to the Supervisory Board of Siemens & Halske AG. For decades, he shaped the commercial development of the expanding company.

the metropolises of North America still served as role models for the German electrical industry. It was not by chance that the trip to New York in November 1899 happened during a phase when the new Siemens-owned experimental line in Lichterfelde was testing the use of three-phase current at 2,000 volts and 50 hertz for everyday rail operations. Reichel – as well as Frischmuth, whose improved arrangement for suspending overhead lines was patented in the USA in 1899 – played a major role in this development and also in planning Germany's first electric elevated and underground rail line, which was inaugurated in Berlin in 1902.

Further new assignments awaited both men: Not much more than a month before they left for New York, after more than a year of preparation, the Studiengesellschaft für elektrische Schnellbahnen (Research Association for High-Speed Electric Railways) was founded, also in Berlin. This collaboration between industry,



Siemens experimental railway in Lichterfelde – Walter Reichel (second from left) joins Emmerich Frischmuth (fourth from left) and colleagues to test three-phase-current technology, a bow current collector, and overhead lines



Reason to celebrate in Berlin – Germany's first electric elevated and underground rail line is ready for operation

the financial sector, and the state was a first in the economic history of the German Empire. The shareholders on the financial end were Deutsche Bank, Delbrück, Leo & Co., the Nationalbank für Deutschland, and Jacob S. H. Stern; the electrical industry was represented by the two competitors AEG and Siemens & Halske; and car and superstructure construction was the province of four companies – A. Borsig, Philipp Holzmann & Co., Fried. Krupp, and Van der Zypen & Charlier. The aim of the research consortium was to explore the potential for the electrical operation of full-scale railways capable of intercity travel, to gather experience with

1845 Van der Zypen & Charlier was founded in Cologne-Deutz. The logistics and coach building company became specialists in building railway cars. electric drives, and to investigate whether overhead lines could provide a suitable power feed at high speeds. The Studiengesellschaft would also look into such matters as car design, the general stresses on the superstructure, the limits of technical feasibility, and not least of all, questions of cost-effectiveness. The Prussian state participated by having the Royal Prussian Military Railway lend a portion of its route from Berlin-Schöneberg to Jüterbog for the planned trial runs. These runs would go between Marienfelde and Zossen – a distance of 23 kilometers.

"Traveling without a ticket" – don't fool with the military's railroad

The conditions for the trial runs were defined by a technical committee that included engineers from both the participating companies and the state railway. Engineers from Siemens and AEG worked together on almost all mechanical matters related to the fast, self-propelled cars. Two mechanically similar cars resulted. Yet at the same time, the two companies were competing for the best electrical engineering solution in "their" car. The challenge was to determine whose vehicle would be the first to achieve a speed of 200 kph - a dare that a sportsman like Reichel was only too delighted to accept. But his eagerness did not sit especially well with the bureaucracy of the Prussian railway. After all, the military and test section of the line had to follow the railway's rules. In 1901, when Reichel rode to his workplace "without a ticket" in the baggage car of a freight train, and simply jumped off after traveling a kilometer when the train wouldn't stop, he was immediately reported. The silently disapproving message in a letter to the Studiengesellschaft stated: "The use of the travel opportunity of the military railway for functionaries of the Studiengesellschaft

1875 The first 45 kilometers of the military railway were put into operation. It was financed with French reparations and was initially operated exclusively by Prussia's Military Railway Brigade.

located on the route must proceed solely in accordance with the generally applicable regulations."⁷

It's no surprise that Reichel had no time to lose. He was involved not only in designing the electric drives for cars on the Berlin Hochbahngesellschaft's elevated and underground railway, but also with time-consuming debates about the company's future timetables and management. Even after the first segment of what today is Berlin's U1 subway opened in February 1902, the line still demanded his attention – he would manage and oversee operations until that autumn. That same year, Reichel was appointed deputy manager of the Electric Railways Department at Siemens & Halske, and was granted a company power of attorney. And on April 1, 1903, when Siemens merged with Elektrizitäts-Aktiengesellschaft vorm. Schuckert&Co. to form Siemens-Schuckertwerke, Reichel became the new company's deputy director.

Nothing is impossible – spectacular world record runs

Despite all his responsibilities, Reichel repeatedly found time to concentrate on the high-speed experiments. And on October 6, 1903, the red-letter day occurred: On a trial run with Reichel in the driver's cab, the Siemens car was the first to achieve a speed of 201 kilometers per hour on the test track. The magic barrier of 200 kph had been broken, and after a few improvements, further records were set at 210 kph. The successful run was the climax of three years of calculations and trials. Building on a suggestion from Wilhelm von Siemens, the train ran on three-phase current at not less than 10,000 volts. The electricity was supplied by the Oberspree power plant, built by AEG in 1897. Siemens & Halske built the overhead line system.

1873 Sigmund Schuckert started up a workshop for dynamometers and measuring equipment in Nuremberg. In 1893, the master mechanic withdrew from the company, which became "Elektrizitäts-Aktiengesellschaft vormals Schuckert & Co."



Breaking the 200 kph barrier – the record high-speed car on the test track of the Marienfelde–Zossen military railway

The cars' electrical equipment appeared to meet expectations. On top of that, Reichel had insisted that the front end of the car should be in a "parabolic" design – what would later be called "streamlined." Yet neither the tracks nor the railbed could withstand the initial trial runs at speeds above 100 kph. The Prussian Ministry of Public Works, under Minister Hermann Budde, then provided an entirely new track. Alongside the rails proper, each of them 12 meters long, guide rails were now laid to cushion any swerving movements of the three-axle rail truck. These were mounted on thick wood planks that were firmly anchored in a

1902 Hermann Budde was appointed Minister. The former officer recognized the importance of railways for modern warfare and was largely responsible for the expansion of the Prussian railway troops. ballast bed of basalt stone. The three-phase overhead line ran along and above the rails and had to be exactly parallel to the track.

The current collectors on the two three-axle self-propelled cars look audacious from today's vantage point. Reichel had decided on a pole design that he considered especially "supple." The actual current collectors oscillated in horizontal planes on a main frame with a collector head and an axis of rotation. But the design wasn't terribly reliable. In the first trial runs at speeds above 100 kph, the current collector turned out to lose contact with the overhead line far too often.

"A remedy was possible only with the most careful observation," Reichel later reported in the anniversary issue of the gymnastic association's *Alt-Herrenzeitung* (old men's newspaper). He had been asked to contribute an article on the significance of gymnastics for an engineer. What better subject than a report on the spectacular world record runs:

"I had the strongest steam locomotive tow the high-speed car at 40 meters per second, and standing on the car roof, protected from the cold wind only by a thin coat, and from the locomotive's fumes and soot only by driving spectacles, I observed the mechanical action of the current collectors. After the run, I clambered back down from the roof, transfigured into a chimney sweep."⁸

On the basis of his observations, Reichel designed a new current collector. He worked for three days and three nights with a skilled Siemens technician on the new design, which would now work flawlessly at a speed of up to around 215 kph. Word of such escapades spread, of course, and cemented Walter Reichel's reputation as a daredevil.

The trial runs were a technical and promotional success. The participating engineers gathered priceless experience in every

1903 The actual high-speed experiments were conducted from mid-September to the end of November. On October 6, 1903, the Siemens car was the first to achieve a speed of 201 kilometers per hour on the test track. field of rail technology, and the German electrical industry once again demonstrated its ability to perform. Reichel himself made an important contribution toward preserving the memory of just how important those runs were. For example, he reported on the beginnings of the Studiengesellschaft in the illustrated periodical *Die Woche*: "Messrs. Rathenau und Schwieger, [...] met by chance in a sleeping car on a journey from Berlin to Milan and [... exchanged] their thoughts," leading to the idea of "building an experimental electric railway that would travel at not less than 200 kilometers per hour." The sheer daring of this project, even in



Vehicle and designer well staged – the "parabolic" front of the high speed railcar also attracts attention

the Wilhelmine era, with its faith in progress, is illustrated by the fact that in those days, the German railway network used only steam locomotives with a maximum speed of 100 kph. To Walter Reichel, for whom no challenge seemed too great, the agreement between Rathenau and Schwieger was "indeed a magnificent goal for German rail technology."⁹ Yet the plan could hardly have been carried out without the financial sector's interest in the high-speed experiments – especially the interest of Deutsche Bank.

Magnificent goals and economic benefits – what do we get from high speed?

Despite all the euphoria, it remained an open question whether high-speed travel could be an economic success as well. Reichel himself wrote, "Moreover, the power consumption of 1,600 horsepower for the vehicle on the flat is so great that in terms of costeffectiveness, it may not be advisable to run railways at 200 kilometers per hour."¹⁰ Such cautious, but most of all diplomatic, assessments, which Reichel authored in view of the competing interests within the Prussian railway, received next to no attention from the advocates of high-speed electric transportation and operation with full-capability trains. Marketing can outpace business politics: The publication of a "Memorandum on a High-Speed Berlin-Hamburg Railway" won Siemens & Halske and AEG no friends at the Ministry of Public Works.¹¹ The signals from the ministry made it abundantly clear that advocates of electrifying the existing network, much less building a new one, were in the minority. Immediately after the Studiengesellschaft's trial runs ended, the state railway began testing older and newer steam locomotives, coupled to modern corridor coaches with compartments, to determine their potential for high speed.¹² The Prussian

1838 Emil Rathenau was born in Berlin. The mechanical engineer and founder of AEG was always open to new technological ideas. Cooperation with Siemens was common practice despite all competition. railway administration and its technicians felt the potential of steam power was far from exhausted. Reichel, for his part, learned that overly loud propaganda for technical innovations did not necessarily meet with a warm reception from the state railway.

As far as the Studiengesellschaft was concerned, it had proved what it set out to prove. Electric drives permitted speeds in excess of 200 kph. That did not necessarily lead to a follow-up contract for the consortium that had been founded for this specific purpose. The Studiengesellschaft was liquidated in 1906. But the trial runs had begun a new chapter in Walter Reichel's life.

1938 The U.K.'s Mallard broke the record for steam locomotives with a speed of 201 kilometers per hour. New types of steam locomotive were being developed up until 1959. Regular steam locomotive operation in Germany ended in 1977.

Why not both – Academia and Siemens?

When Reichel was appointed deputy director of Siemens & Halske's Electric Railways Department in 1902, he confirmed receipt of his new employment agreement and at the same time expressed a wish to add a new clause to the contract: "It has repeatedly occurred that officers of the firm receive a call to teach at one of Germany's technical universities. In the event that I should ever receive such a call in the next few years, and that I have the desire to accept it, I would like to keep open the option of making a transition and terminating the contract on half a year's prior notice."¹³ The letter was apparently not especially welcome to management. Only two days later, Reichel drafted a far humbler letter to his supervisor and patron Schwieger:

"Knowing oneself is the first path to improvement! I do not know whether by nature I am inclined to sit perpetually on the powder keg of fighting for a defining influence and would therefore like to keep open the option of a career in teaching. [...] I hope that you will support me in this, as you have done before, with your kind advice and assistance."¹⁴

He did not have to wait long for an answer to this second letter. Schwieger reported on his conference with Wilhelm von Siemens about Reichel's request: "Mr. von Siemens is of the opinion that you [..] should not insist [...] on the special clause. I can only join in that view, while pointing out to you that if such a case should really arise – which in the company's interest I would not care to

1894 Siemens & Halske established a separate department for electric railway business. In 1903, this area of responsibility was transferred to the newly founded Siemens-Schuckertwerke. desire – a satisfactory solution will be found for you in any case." And he added: "Moreover, I am of the opinion that without doubting your talent as a writer and teacher, you should primarily still seek your vocation in designing and inventing."¹⁵

In parallel with his activity for the Studiengesellschaft, Walter Reichel had begun publishing. His first publication, titled "Experiments with the use of high-voltage three-phase current for the operation of electric railways," had appeared in the Elektrotechnische Zeitschrift in 1900. Not long afterward, Reichel earned a doctorate on this topic. With Alois Riedler presiding and Adolf Slaby assisting, he completed the requirements with honors, and in February 1903 received the "degree of doctor in engineering" from the Royal Technical University. The institution had changed since Reichel was a student there. In 1899, on the occasion of its 100th anniversary, it had been granted the right to confer doctorates, and thus had attained the same status as a traditional university. Consequently it was able to attract renowned professors like Alois Riedler, who would reform the study of mechanical engineering. Along with Slaby, he was one of the influential university teachers who maintained good contacts in industry and the cultural bureaucracy. It was certainly thanks to him as well that the Ministry of Culture asked Reichel to teach as a regular professor of "constructive electrical engineering." The ministry hoped that the 37-year-old Reichel would lend the field of electrical engineering a sharper profile. And indeed, Reichel made no secret of the fact that he was planning extensive reforms.¹⁶

Walter Reichel had decided to accept the invitation, and in January 1904 he asked the Managing Board and Supervisory Board of Siemens-Schuckertwerke for permission to accept the appointment, which would be "an honor" for all involved. The company was not keen to let a man like Reichel go. After all, he was working on

1888 Austrian Alois Riedler was appointed to the Technical University in Berlin. The professor of mechanical engineering advocated practically-based academic training and established the first German mechanical engineering laboratory in Berlin. a number of forward-looking projects, like building the first ACpowered rail line, from Murnau to Oberammergau, and on top of that he was a member of the Supervisory Board of the Rotterdam-Scheveningen railway and held a responsible position in negotiations on electrification matters with Gustav Wittfeld of the Royal Railway Directorate in Berlin. Reichel was well aware of his position and responsibilities. In a six-page letter to Schwieger, he listed all the unresolved matters, made staffing and organizational suggestions, and asked for a leave that would enable him to attend all the important meetings, but keep him free enough that he could "throw" himself "full-force" into preparing his lectures.¹⁷

Practice-oriented research and theory – Professor Walter Reichel

Reichel took up his position as a university professor in October 1904 and at once began working to separate electrical engineering organizationally from the other fields of the Mechanical Engineering Department. He thus aroused the bitter enmity of his former professor Slaby and the German experimental physicists, who warned against "breeding" specialized technicians with an "extremely limited perspective." On the surface, what was at issue was the academic credibility of the field; underneath, the problem was professional vanity and lecturers' fees. Reichel could not get his reforms adopted. By contrast, his idea of setting up an "electrotechnical experimental field" was a complete success even though he significantly overstrained the school's resources with his request for 215,000 marks. Nevertheless, the institution financed construction of a hall on its campus, and with generous donations in kind from Siemens-Schuckertwerke, Reichel finally had his experimental field. Electrical machines and control

1904 Siemens electrified the Lokalbahn between Murnau and Oberammergau. Germany's first train to run on single-phase alternating current went into operation in 1905 and is the basis for the rail electricity system still used in Central Europe today.


Rönigliche Technische Lochschule zu Charlottenburg:

Practice-oriented academic training – Walter Reichel convinces the administration of the Royal Technical University in Charlottenburg to support construction of suitable premises panels to monitor operations, instruments for precision observations, and a tram car and electric elevator were accommodated in the hall, where lectures, practical exercises, and research all began in 1907.¹⁸

If Reichel had ever assumed that the university was a place where one does not have to fight for influence, he was wrong. Squabbles among colleagues, a shortage of funding, and not least of all the lower salary, which he was unable to supplement with lucrative sidelines as he had hoped, led him to resign from his professorship in 1908. As he had done at Siemens four years earlier, he ensured that arrangements were made for a successor, and set the course for a further professionalization of the field. He suggested subdividing the discipline into three sub-fields theoretical electrical engineering, electrical mechanical engineering, and system design - a proposal that was adopted. He would continue to lecture on system design and on electric railways, and would thus maintain his connection with the school. Walter Reichel was not the first Siemens engineer to switch over to a university setting. But he was one of the first to return to the company afterward.

1902 Siemens engineer Emil Veesenmeyer became a professor of electrical engineering and studies in design drawing in Stuttgart. He developed the first three-phase mining locomotive for his former employer.

Signs of nerves – Work life and private life

Though Siemens reluctantly let Walter Reichel go in 1904, the contact remained open on both ends. Reichel accepted research assignments from Siemens for tasks like developing a DC motor for 3,000-volt operation, and conversely, he could count on support for his electrotechnical experimental field. As late as 1902 he still seemed uncertain whether he was really suited for a career at Siemens. When Wilhelm von Siemens and Heinrich Schwieger declined his request to include an escape clause for a possible academic career in his employment agreement, he wrote yet another letter to Schwieger asking for an extended leave, with a frank explanation: "I feel very fatigued, and am now contending somewhat with insomnia and the like (signs of nerves) as well as digestive indispositions. My family physician has advised me to stay away from work for three months, but that will presumably not be feasible. [...] Please take into account that the last five years have in fact demanded quite considerable efforts, and the coming winter will also not offer much relief in that regard."19

The candor with which Reichel discusses his physical complaints does not fit all that well with the image of a dynamic engineer who does not shrink from any challenge. Later, when he was also head of the Dynamowerk, he would make sure to take regular breaks by adding an extra Monday here and there to his hunting weekends at a game reserve near Cottbus. That at least is the tale relayed by Franz Paufler, his long-standing assistant and confidant. But in the years shortly after the turn of the century,

As of 1907 Siemens-Schuckertwerke's plant for large machine construction was moved from the center of Berlin to the site of the future Siemensstadt. In 1908, Walter Reichel took over management of the Dynamowerk, which was then under construction. Reichel could not yet allow himself such liberties. Yet even when he seemed totally absorbed in work, he still had his family life. Reichel liked taking off to spend time visiting his mother in Zinnwald or just staying home, or maybe traveling to Tyrol and Lake Como for 14 days. The latter, as he wrote to Schwieger, also enabled him to inspect the Lecco–Colico train route – a line that was situated in an exquisite landscape, and was also the first in the world to be electrified with three-phase AC current.

Paufler characterized Reichel as a strongman, boisterous and impulsive. His wife, on the other hand, was said to be just the opposite: "petite, reflective, and quiet." There is no way to tell whether this is anything more than a cliché of the era. In any event, Elisabeth Reichel, née Lange, had her first child, Walter, in 1894; Martin followed in 1896, then Erika in 1900, and the youngest daughter, Hildegard, in 1902. The family lived in a rented apartment on Bahnstrasse in the Berlin suburb of Lankwitz. Reichel did not have a long commute to work. After their fourth child was born, the couple rented a house with a yard on Lindenstrasse. This popular suburban area in the southern part of Berlin was also the home of Swedish architect Alfred Grenander, who designed the first stations for the overhead rail company. Walter Reichel then had his university colleague Walter Franz, an architect and specialist in industrial buildings, design a house for him. Franz had also been invited, with Alois Riedler's support, to take up a brand-new professorship in industrial construction and building design as part of the Mechanical Engineering Department. In 1906 the Reichel family moved into their new home in Berlin-Lankwitz at Beethovenstrasse 14. It goes without saying that the house very soon had a telephone line.

Reichel was a member of the relevant professional societies by virtue of his profession and position. But apart from his long-

1889 Eight years after the first telephone connection in Berlin,

10,000 telephone stations were set up. Private households could now afford a telephone. For the first time, women were employed as operators.



Private life remains private – Elisabeth and Walter Reichel, probably in the mid-1920s

standing connection with the Akademischer Turnverein, he had little interest in belonging to social organizations. On the other hand, he was especially concerned that the Turnverein should prosper. He was a member of its building committee for a new clubhouse, supported the youth, and took part in the ball games of the "old men," though Paufler tells us he was "lamed" by an old sports injury. He enjoyed being sociable most of all among colleagues and friends from sports and hunting. Berlin's social life, on the other hand, for all its diversity, did not seem to appeal to him much.

1930 Walter Reichel was a member of technical associations as well as the Verein für Deutschtum im Ausland (Association for German Culture Abroad), the Gesellschaft für Deutsche Kunst im Auslande (Society for German Art Abroad), and the Kaiser Wilhelm Society.

Learning from the competition – Reichel goes exploring in North America

In October 1908, after four years of work at the university, Walter Reichel signed a new employment agreement with Siemens-Schuckertwerke GmbH. When he had resigned in 1904, Siemens had more than 31,000 employees; by 1908 the workforce had grown to 42,000. The high-voltage current business was handled entirely by Siemens-Schuckertwerke, while the parent company, Siemens & Halske, dealt with the low-voltage current business. The two companies' sales revenues had more than doubled in just four years. With the original location of the former Elektrizitäts-



Machine construction relocates – Walter Reichel (seated, second from left) and his colleagues at the Dynamowerk on Nonnendammallee

Aktiengesellschaft vorm. Schuckert&Co. in Nuremberg and the plants in Berlin, the high-voltage current business had two significant production sites.

Berlin was still the real powerhouse in German electrical engineering. This was where things got invented, calculated, and built. Some parts of electrical machine construction were still going on at what was known as the Charlottenburger Werk, while others had already relocated to the area of the Dynamowerk, now under construction on Nonnendammallee, northwest of Berlin. Reichel would now be in charge of all design tasks at this plant, as well as its equipment and expansion. He was also to keep an eye on worldwide developments among the competition and ensure that Siemens products remained competitive in the world market. His own real specialty, electric railroads, would remain under the charge of Emmerich Frischmuth. Reichel would assist developments in the Railroad Department in an advisory capacity.

This division of work proved to be very astute. The two engineers remained in close contact and engaged in professional dialog with one another. As had been the case back in 1899, it was a trip to North America that laid the foundations for their work together. In the late summer of 1907, Reichel was still teaching at the Technical University when the two men were commissioned by the Ministry of Culture to travel more than 6,000 miles to study electrotechnical installations and rail vehicles on site in the USA. The tour was headed by Gustav Wittfeld, the guiding spirit behind electrification at the Prussian-Hessian State Railway in Berlin. Philipp Pforr from AEG and Friedrich Jordan from Felten & Guilleaume-Lahmeyerwerke were also part of the group. Their joint mandate was to examine the large power plants and the latest electrical installations of the American railways. There could hardly have been a better preparation for returning to the hands-

1907 More than 50 percent of the people employed by the German electrical industry were working in the greater Berlin area. The nearly 48,000 employees were distributed among 226 companies of various sizes.



The first choice for railroad engineers – the Hotel Belmont in New York shortly after its completion on life in an industrial operation. It may even have been this trip that led Walter Reichel to return to "designing and inventing" for a company.

The five men were very well acquainted. While the two major electrical engineering companies, AEG and Siemens, contended for state contracts in rail transportation, Wittfeld was their most important contact. At the same time, he showed sound professional understanding when it came to the technical and operational aspects of electric drives, power feeds, or power supplies. They all knew each other from working together and from a variety of professional conferences.

Wittfeld, Frischmuth, Pforr, and Jordan embarked for New York from Genoa. Reichel himself traveled from Bremerhaven, thus combining business with pleasure. That was because Siemens, together with AEG, had landed an order from the Prussian Railway Directorate to deliver electrical equipment for the suburban Blankenese–Ohlsdorf route in Hamburg. That route was soon to undergo a trial run, and Reichel, who had helped get the deal, held a quick inspection of the electrified railway installations before boarding the fast steamer *Wilhelm II* on August 20, 1907.

Seven days later, the party gathered at the Hotel Belmont in New York. The choice of accommodations itself is highly indicative, and very much in the spirit of the trip. Just opened in 1906, the Belmont was not only one of the most up-to-date and splendid hotels in town, it was a "railroad hotel." Its namesake and coowner, banker, and entrepreneur August Belmont Jr., was the president of the Interborough Rapid Transit Company, which operated the subway that had opened in 1904. The 28-story hotel rose above the subway tunnel shaft on the company's land at the corner of 42nd Street and Park Avenue. The architects were Warren & Wetmore, who were building the new Grand Central Station at the

1905 Siemens won the contract to supply all the contact line and power distribution equipment for Germany's first electric commuter rail line. Starting in 1907, it ran between the Hamburg suburbs of Blankenese and Ohlsdorf.



colleagues – the delegation from Germany

same time. Of course the hotel had its own access to the subway and Grand Central. Could the German tour group have known about Belmont's personal extravagance – a man who had his own underground rail siding built where he could park his private subway car that he used for inspection tours? Reichel's report to the Ministry does not tell us.

The group had decided on a rigorous schedule: From New York they headed to Boston and then Schenectady, headquarters

1892 The Edison General Electric Company merged with its largest competitor, the Thomson-Houston Electric Company, to form the General Electric Company. The headquarters of the new company was in Schenectady, New York. of their mightiest competitor, General Electric, and onward to Niagara Falls to tour the power plants on both the American and the Canadian side of the falls. They then traveled down along Lake Erie to Buffalo, and on a "common steam train" to Westinghouse in Pittsburgh, then onward to Chicago and Salt Lake City. While Wittfeld and the rest now progressed toward Mexico, Reichel's itinerary took him to Colorado Springs, Los Angeles, San Francisco, Portland, and Spokane. There was hardly an electric railway, power plant, or transformer station that he did not view. This strenuous schedule undoubtedly gave him a superb overview of the state of the art in the USA and the practicality of the various applications involved. What surprised Reichel was the routine use of three-phase-current turbines at the big power plants in the state of New York. He admired the Westinghouse motors that could be used for both AC and DC operation, criticized the extreme variety of overhead line suspensions, and was amazed at the weak insulation on overland lines. His report, completed in 1908, describes almost every installation and cites the associated professional literature. One of Reichel's strong points was that he could look beyond the narrow confines of his own assignment and thus discover other things worth reproducing. For example, he remarked with approval that the workshops at General Electric offered "great professional pleasure for the mechanical and electrical engineer," and he noted the "lunch house" specially set up for the workers there.

1886 George Westinghouse founded the Westinghouse Electric Company. The subsidiary Westinghouse Electric & Manufacturing in Pittsburgh, Pennsylvania, produced electrical components, generators, and electric vehicles.

"The yield is significant" – Return to Siemens

The journey took more than a month and a half, and even though Reichel regretted that there was too little time for intensive study, he was certain that "the yield is nevertheless a very significant one [...] and will certainly benefit German implementations."²⁰ When he decided to resign from his teaching position and return to industry, Reichel was soon able to join Frischmuth in applying at Siemens the findings and observations they had made in the USA.

Reichel first of all gave his full attention to the plant for large machine construction, which had been rising on Nonnendammallee since 1906. With his collaboration, this is where the halls of the "Dynamowerk" arose by 1910/11; including the extension



The locomotive hall at the Dynamowerk – a plant for building prototypes and test vehicles

building for installing electrical equipment in locomotives, this facility had usable floor space of some 70,000 square meters. In 1912, the electric motor plant went into operation, with an additional 62,000 square meters of space.²¹ Walter Reichel was in charge of a production range that included turbo generators, motors for reversible rolling mills and conveyors, including the associated control units, and drives and transformers for electric railways.

The factory buildings on the site that would eventually become Siemensstadt were massive. They complied with Reichel's ideas, because all the important electrical engineering production and test facilities were combined at a single site. He preferred direct communication with his staff and short decision-making paths. The fact that the Railway Department also moved into Siemens-Schuckertwerke's newly constructed headquarters building on Nonnendammallee at the end of 1913 was practical from a personal standpoint as well. Frischmuth and Reichel could now share a chauffeured car from the southern part of the city to Siemensstadt. If they had argued, Franz Paufler reports, one of them would sit in the back seat, and the other in front next to the driver. Obviously these disagreements did no damage to their work together.

1897 To ensure the expansion of the traditional Berlin site, Siemens & Halske purchased a largely undeveloped tract of land northwest of Berlin. By 1914, a completely new district was created known as "Siemensstadt."

DC or AC – Generators and motors for the world

Until World War I broke out, business at Siemens-Schuckertwerke was proceeding splendidly. The order books were full, and the rail sector had tasks that were not just lucrative but technically demanding and interesting. Following the electrification of local public transportation, the German Empire was now trying out its first long-distance electric routes. The various rail companies were experimenting with different kinds of current for rail operations. At times, the trade journals were relentlessly filled with disputes about the best type of current. In these debates, Walter Reichel argued that DC was unsuitable for operating long-distance trains or heavy freight traffic.

In the years just after 1910, the German railway network still looked like a patchwork quilt. Each of the state railway administrations in the Empire had its own regulations, and of course its own locomotives, in the most diverse configurations. On the question of electrification, they increasingly labored toward a common denominator. At the initiative of Bavaria, which was just about to order electrical equipment for the Walchensee power plant and the voltage converters for the Saalach power plant in Bad Reichenhall, the Bavarian, Baden, and Prussian State Railway administrations entered into negotiations with a unified approach. Ultimately, in November 1912, they agreed on a uniform AC system at 16 2/3 hertz and 15,000 volts. Independently from the Germans, the railroad administrations in Austria, Switzerland, and Sweden adopted this standard as well. The decision largely

1907–1911 Siemens electrified the route between St. Pölten, the capital of Lower Austria, and the pilgrimage site of Mariazell. The world's first mountain railway to run on single-phase alternating current is still a tourist magnet today.



Any kind of electricity can be managed – and generators can now be produced cost-effectively

followed the arguments advanced by Reichel and his cohorts. Yet ultimately, as Reichel noted in the *Siemens-Zeitschrift* in 1924, any kind of electricity is manageable and therefore usable to drive electric trains. In the end, he pointed out, the system one decides on is a matter of cost-effectiveness, and – not to forget – also of "emotional inclination."²² He had no taste for ideological debate – he was too much a pragmatist for that. In Germany, the agreement

1921 The first issue of the *Siemens-Zeitschrift* appeared in January. Among other things, the monthly journal provided employees, customers, and the company's business partners with information on innovations and important projects. The journal was discontinued in 1996. benefited both the electrical industry and the state railways, because a uniform rail electricity system made it simpler to implement innovations. And it also made it more cost-effective to produce generators and transformers.

In Europe, it was water-rich Sweden that was quickest to advance in electrifying its railways. In May 1910, the Swedish parliament decided to electrify the North Swedish ore railway and approved the requisite funding. Together with Allmänna Svenska Elektriska Aktiebolaget (ASEA), Siemens-Schuckertwerke first received the order to electrify a 129-kilometer subsegment from Kiruna to Riksgränsen. That made Sweden the first country to convert a railroad line entirely from expensive steam to cheaper electric traction.

Reichel, who had happened to cross paths with Swedish Rail Director Granholm during his 1907 voyage to the USA, was especially devoted to this project. The German engineer, who regularly spent his free time hiking in the mountains, found his trips to the North both challenging and refreshing. Work with his Swedish colleagues went smoothly. Siemens got the order to deliver 11 electric double locomotives for ore trains. In 1913 it started production on these engines, designed for a maximum speed of 60 kilometers per hour. The loaded trains had to haul some 1,850 metric tons of ore across slopes of 1.9 percent, and because of the weather conditions on Europe's northernmost rail line, they were equipped with electric heating. Since the Swedish rail system's hydroelectric plant at Porjusfall was also nearly complete, Reichel initially assumed that the first segment of the Riksgränsen railway would be able to open in 1914. But it took an extra year. The big moment finally came early in September 1915, and regular operations began on the electrified route.23

1900 The small settlement near a railway station and not far from the Kiirunavaara ore mountain was given the name of Kiruna. Until iron ore was industrially extracted by open-pit mining, the Sami people were practically the only inhabitants of the region.



Electrifying Europe's northernmost rail line – year after year, the double locomotives on the Swedish Riksgränsen railway transported many millions of tons of iron ore

1915 The ore trains between Kiruna and Riksgränsen traveled at an average of nearly 40 kilometers per hour. Operating schedules were constantly interrupted by snowstorms and avalanches.

Keeping the plant running – World War I and the Revolution

Reichel had hoped to return to Sweden for the railway's opening, but World War I and its aftermath put a temporary end to such plans. Since Sweden was neutral, the order for the ore train could still be completed. But all other electrification projects had to be shelved, including the promising trial run on the Dessau-Bitterfeld route. During the war, Siemens, like so many others, switched its plants over to producing armaments, and operations were severely hampered. Many laborers and office workers among the largely male staff had been conscripted. There was also a shortage of raw materials. The military administration had first priority for the copper wire that was so essential to the electrical industry.

Revenue from producing armaments could not make up for the losses that the war caused by curtailing international business. It became exceedingly clear what the war meant to an exportoriented company like Siemens, with its many international offices. Reichel, as director of the Dynamowerk, was still responsible for production in the conventional energy business. He had to keep the plant running. Under difficult conditions, the plant built and developed generators, such as the 12,500 kilovolt-ampere (kVA) three-phase turbo generator of 1916 for the Silesian electricity plant in Breslau. But it was involved more and more in building airplanes, propeller drives, munitions, and submarine equipment. That was not the plant's core business, and Walter Reichel became increasingly testy. He felt his achievements were not

1914–1918 In addition to electrical engineering military equipment such as spotlights and equipment for warships and telephone and telegraph materials – the company manufactured goods normally produced by other industries. properly respected. He was thus all the more delighted when the King of Sweden made him a Knight First Class of the Order of Vasa in 1916. It was the first official state honor Reichel received. A year later, in October 1917, he was granted the title "Geheimer Regierungsrat" (Privy Councilor) in Germany. But that December, when management notified him that he would be receiving Germany's Cross of the Order of Merit – which he had already declined once before – he gave vent to his bitter feelings. He explained his displeasure in a letter to Carl Friedrich von Siemens: "I have done no more than was my duty, yet to the best of my knowledge and ability, I have put in at least as much effort as the many people who have had the Cross for years now. I must therefore experience it as a rejection when the Cross is now tossed in my direction so tardily [...]."²⁴

The episode clearly shows how deeply interested Reichel was in the civil conventions of the German Empire. He reacted with extreme sensitivity to any form of rejection or perceived slight. Adding to the problem was his growing workload and a war-weary staff who more or less openly threatened to strike. As 1917 turned to 1918, tensions also arose between Reichel and Carl Friedrich von Siemens, who had been head of Siemens-Schuckertwerke since 1912. The main issue was aircraft construction - today a nearly forgotten line of business at the plant from those days. Carl Friedrich von Siemens demanded a new cost-effectiveness calculation for the Type G airplane, which Reichel did not comply with immediately. The Head of the House of Siemens, ten years younger than he, subjected him to a clear reprimand. Reichel resolved the misunderstanding, but gave full voice to his irritation: "It cannot exactly increase one's pleasure in one's work when one is aware of having done one's best, and gets harsh words in return." Reichel felt a powerful pressure to justify himself: "As a

As of 1909 Siemens was also active in the aircraft market and designed its own biplanes. After 1914, the company expanded airplane and engine development and created the air-cooled radial engine, an ultra high-performance power unit.



Siemens airplane production during World War I – Walter Reichel was in charge of this in Berlin

positive fact and achievement, I may point out that the plant put out a single-seater fighter of the new Type D.III series in just three weeks ... In the present times of coal shortages and work interruptions, this was an outstanding feat. [...] Following my overview, you can still influence and make all decisions about the D, G, and R aircraft entirely as you please, however you see fit at the moment for the business policy you desire."²⁵ Reichel was obviously not in agreement with the management on all points. The fighter planes with the new rotary engine were not yet technically mature. But Siemens was under pressure to deliver the new planes to the Imperial German Army Air Service. And Reichel could not

1917/18 The inspectorate of the Imperial German Army Air Service ordered a total of 200 Siemens D.III fighter planes. After improvements were made to the engine cooling system, the plane was considered the most advanced fighter plane in the German Air Force. know that in the spring of 1918, this entity was still ordering Type D.III aircraft from the Siemens-Schuckertwerke on a large scale.

It was a time of the greatest tensions, and hardly a trace remained of the great patriotic war enthusiasm of 1914. The first strikes of industrial workers in January and February 1918 were a clear sign that large segments of the population no longer had the patience or strength to continue a war that had cost millions of soldiers their lives. There was growing unrest among the Siemens workforce as well. Neither strikes nor the formation of workers' and soldiers' councils in the Revolution years of 1918/19 met with much sympathy from Walter Reichel. As much as he detested Wilhelm II, he was still a man of the German Empire and a staunch opponent of the Revolution. He joined in the call of the Citizens' Council of Greater Berlin of November 20, 1918. More than 2,000 representatives of business associations gathered under the cupola of the Circus Busch building to establish a counterbalance to the workers' and people's councils. Chaired by former AEG Director Waldemar Koch, the Citizens' Council called for such measures as "a prompt convocation of a constitutional national assembly based on a general, direct, secret vote by both men and women" and furthermore "so as to maintain law and order and establish constitutional conditions [...], an unconditional protection of property against lawless Bolshevik and other violent encroachment," as well as "the cessation of all measures of an economic, financial, and political nature to reorganize the foundations of a productive economy."26

The call was a belated attempt by the liberal-conservative bourgeoisie to counteract the highly organized Communist and Socialist parties. Like many representatives of the electrical engineering industry, AEG's Koch was also a member of the liberal German Democratic Party (DDP), and Carl Friedrich von Siemens

1920 The Greater Berlin Act was passed. It combined the cities and municipalities that had long been intermingled in greater Berlin under a single administration. At that time, 3.6 million people were living in the city. held one of that party's seats in the Weimar Republic's Reichstag from 1920 to 1924. Others who signed the proclamation would later shift further right, under the influence of the Treaty of Versailles and the global economic crisis of 1929, and become involved with the German National People's Party (DNVP). As far as Reichel was concerned, a political career or involvement with a political party was out of the question. He concentrated entirely on his work at Siemens-Schuckertwerke and continued to teach about electric railways and power plants at the Technical University.

1918 One week after the November Revolution in Berlin, the left-liberal German Democratic Party was founded. Its members were staunch proponents of parliamentary democracy.

New opportunities after war's end – Turbo generators and express-train locomotives

After 1919, Reichel was able to resume much of the research work that had begun before the war – such as the further technical development of rectifiers or increasing the performance of turbo generators. Successful work with Sweden, a country that had remained neutral during the war, also resumed in 1920. The double locomotives that had already been delivered had performed very well indeed, so that the Swedish engineers had started making calculations for single locomotives, which Reichel immediately picked up on. After a further call for bids, Siemens-Schuckertwerke got the contract to deliver the electrical equipment for 11 new locomotives to be produced by the Motala locomotive factory. In September 1922, at the invitation of Swedish Rail General Director Granholm, Reichel attended the first trial run of one of the new locomotives. The electric engine, equipped



Recovery from war and revolution – Walter Reichel is invited to Sweden for the inaugural run of the ore train

with gear motors, met every expectation, leading the Norwegians to also place an order for electric locomotives of the same kind to electrify their own segment of the route to Narvik. The substantial challenges posed by timetables and weather on the ore railway – now a total of 475 kilometers long – were an ideal opportunity to impressively demonstrate how cost-effective and powerful electric traction could be. Walter Reichel came home to Germany full of hope that projects to electrify rail traffic could soon be resumed there as well.

The chances were not bad. With the adoption of the Weimar Constitution, and after tough negotiations with the states that owned the railways, the new, democratically elected national government established the Deutsche Reichsbahn in 1920. Liberal politician and journalist Rudolf Oeser was appointed its general director. In an astonishingly short time, he was able to convert the various interests in the German states to the goal of a uniform rail system. Only the Bavarians insisted on their own "Group Administration," which meant that the officials of the former Bavarian State Railway would have relative autonomy in procurement decisions.

A certain measure of perplexity on the matter of electrification prevailed in the immediate postwar period. There was simply no cash to implement the prewar electrification plans. Until he retired in 1920, Gustav Wittfeld remained the contact man for all electrification matters at the Reichsbahn. He was succeeded by Wilhelm Wechmann, whom Reichel already knew from the Hamburg railway project. Wechmann was also a passionate fan of electric traction, and he was able to persuade Reichsbahn management to invest again in this modern technology. The Dessau– Bitterfeld experimental line and the electrification of the Leipzig– Magdeburg line now advanced. Electrification of the Berlin

1919 The Constitution of the German Empire took effect in August. Article 89 stated that the Empire was to take over all railroads serving as a means of general public transport and administer them as a unified system. municipal railway began in 1924, and people again began giving serious thought to an electrically powered express-train system in Germany.

Walter Reichel was now far more involved with administrative duties and with coordinating production operations at the Berlin and Nuremberg plants. But that did not impede him from keeping up with the latest developments in rail technology. He loathed the idea that Siemens might fall behind in the construction of an express-train engine. When the Bergmann company developed an express-train locomotive in 1924 that was significantly lighterweight than Siemens' version, he immediately began calculating how Siemens might counterattack. On the letterhead from the hotel where he was staying on vacation, the Schweizerhof in Nervi near Genoa, he outlined options for an improved drive technology to Siemens senior engineers Fritz Rampacher and Moritz Schenckel, and urged them to complete the calculations right away. One aspect here was preliminary considerations for a singleaxle drive with nose-suspended motors – a drive technology that would soon inaugurate a whole new era in the electric locomotive business. This type of motor would also be used in building what were known as the "flyers" - fast, self-propelled rail cars with a diesel electric drive. For the moment, though, the completed electric locomotives, with their coupling-rod drive, still strongly resembled steam locomotives.

Reichel's creative powers seemed inexhaustible. But even he needed the occasional break. A severe respiratory illness compelled him to spend the winter of 1924/25 in the Alps. The following summer he asked again for extra leave for a follow-up treatment in the mountains. But he was ready to resume his work in Berlin in good time for his university lectures to start in October.

1890s For use in his trams, Frank J. Sprague developed the axle-hung traction motor, which connected the motors to the axle via a bearing. The motor seemed unsuitable for the power requirements of locomotives.

Siemens generators for Bavaria's Walchensee power plant – railway power and electric locomotives for the Reichsbahn

By now, the Dynamowerk in Berlin had delivered two large railway electric generators to the Walchensee power plant; they were commissioned in October 1924 and at Eastertime 1925. Now the expansion of the electric power grid for the railways was advancing well not just in Silesia and central Germany, but in Bavaria as well, and the Bavarian Group Administration was placing additional orders. Negotiating with the former officials of the Bavarian State Railway was not always an easy affair for Walter Reichel; at one point, reacting to their specific extra demands, he sarcastically noted, "For Bavaria we'll have the equipment parts painted blue and white [the colors of the Bavarian flag] and we'll hang sausages over the catenaries."27 But he knew he had backing from the Reichsbahn. After all, he was on much better terms with Wechmann, the Reichsbahn director in Berlin. And custom-produced equipment was also not in the best interest of the Reichsbahn's central administration in Berlin. In a rationalization program that covered almost every sector, the Reichsbahn aimed to put an end to the multicolored menagerie of vehicles from the era of the multiple states' railroads. It was true that the variety of electric locomotives during the Weimar Republic was still reasonably manageable, but here as well, standardized models were to be introduced along the same lines as for the steam locomotives.

With their focus on improved productivity, market leaders like Siemens and AEG embraced standardization. But such ideas were also considered overly optimistic. In drive technology especially, the field was still advancing so rapidly that locomotives or selfpropelled cars that were delivered to exhibitions or celebrated as

1900 Bavaria's railway network covered 8,500 kilometers, making Bavaria the second-largest state railway in the German Empire after the Prussian State Railway, with its network of more than 34,000 kilometers.



Getting energy from water power – Siemens delivered two generators for the Walchensee power plant, each with 10,650 kilovolt-ampere capacity

innovations in the trade journals were already considered antiquated just a decade later. Settling rigidly on one type too soon would be a mistake.

Reichel also repeatedly ensured that innovative ideas were put to work at the company's Electric Railways Department. Even a low level of orders didn't discourage him. On the contrary – in 1928, entirely at Siemens' risk, he had an electric locomotive built without carrying axles, with its motors and trucks seated in a welded bridge frame. The model was ready for testing in 1930. The concept was so persuasive that the Reichsbahn realized the design had

1930 The Reichsbahn had 397 electric locomotives of various designs. The more than 900 self-propelled rail cars with power supplied through the rails were only a fraction of its total locomotive and self-propelled car inventory of more than 24,000 vehicles.



The idea of building an electric locomotive with no carrying axles paid off – the prototype went into series production and sold well

potential for an entirely new type of electric locomotive. Reichsbahn executive Wechmann was then able to persuade Bergmann Elektrizitätswerke, AEG, and Siemens-Schuckertwerke each to develop corresponding prototypes for an express-train locomotive. Thus the most significant suppliers were placed in a competition to find the best locomotive solution for use with full-service trains. The Siemens version, with mechanical parts provided by the Wismar coach factory, performed superbly.

Even if the railroads were not being electrified as fast as Wechmann and the electrical industry would have liked, these contracts awarded in the era of the 1929 global economic crisis represented a promise for the future. The single-frame truck locomotives with a single-axle drive were the most modern product that the rail industry of the day had to offer. In 1933 Siemens was awarded an order for 20 locomotives with the series name "E 44" for the electrified Munich–Augsburg–Stuttgart route.

As of 1933 The E 44 electric passenger and freight locomotive remained in use into the 1980s, primarily in southern and central Germany, and became the first electric locomotive in Germany to sell more than 100 units.

Keeping the ball rolling – The future of electric railways

In 1933, the year when the National Socialists took power, Walter Reichel turned 66 years old. We have no record of how he viewed this political development, which proved to have such lethal consequences. To outward appearances, everything went on as usual for him, especially because he was not among the group of people who had to fear for their lives because of their political convictions, their religious faith, or their ethnicity. Though he had been retired since September 1932, he was still much in demand as an expert to advise Siemens on all questions of designing current converters, as well as other matters. He played a significant role, for example, in developing the railroad current converters for an experimental power plant in Bad Reichenhall, the first effort in Germany to connect a railway power grid to the public power grid. He also still maintained close contacts with the Reichsbahn.

This state company put itself entirely at the service of the Nazi state when the National Socialists took power, and carried out all measures for enforced political conformity – *Gleichschaltung* – without reservation. That also meant that Bavaria's special entitlement, the Group Administration, was disbanded as early as 1933. The loss of Bavarian independence was compensated for by relocating one of the Reichsbahn's central offices from Berlin to Munich. Ever since 1930, these central offices had been responsible for such matters as purchasing, machine construction, and operating equipment. They were considered the railway's real innovation centers, and its engineers and purchasing agents were

1910 The purpose of the Saalach power plant in Bad Reichenhall was to generate power for trains as well as to supply electricity to the municipal power plant. After the war, Siemens built a mercury vapor converter to link the two networks.



to play an active role in the development of electrical engineering even after retirement

partners with the rail industry. That one of these offices was now relocated to Munich was a development that Walter Reichel was not alone in viewing as a "great shortcoming." After all, Siemens had concentrated its Research and Development Department at the Dynamowerk in the national capital, "where the traffic of all minds converges most vigorously."²⁸ For all his love of the mountains in the south, Reichel still felt that Berlin was the center of progress in electrical engineering. So he was less than delighted when Siemens' most important client in Germany began moving its center of competence for electric traction entirely to Munich in 1936.

Thus Walter Reichel remained very well informed of developments at Siemens, and especially at the Dynamowerk and at the

1923 A scientific department was set up at the Dynamowerk. Among other things, its research and development activities served to greatly increase the number of patent applications submitted by the plant.

Reichsbahn. He was still passionately interested in developments in the rail sector. With his good connections, he learned in 1934 from Wilhelm Wechmann – still in charge of electric rail operations at the Reichsbahn after 1933 – that a world record for steam locomotives was to be set.

Now Reichel worried that the return to concentrating on steam power would put rail electrification behind. As was typical of him, he immediately dispatched an incendiary letter to Karl Rissmüller, who was in charge of electric rail operations at Siemens, urging his former colleague to immediately start building a high-speed electric locomotive able to outrun a possible steam locomotive record. He also encouraged them to catch up at last to AEG, which had a lead in electric locomotive construction that seemed obvious from AEG's own locomotive production. The letter enclosed a four-page description of the technical equipment and design of the future locomotive. He recommended: "Take this draft and build the locomotive without the RZM!" (the Reichsbahn Central Engineering Office).²⁹ The letter shows a flash of the young Reichel's former daring. He probably sensed a challenge that felt similar to the first high-speed experiments more than 30 years earlier. And it was typical of him that he advised his former colleague not to wait for a contract from the Reichsbahn, but for the company to input the work on its own. That, he said, would still be "significantly cheaper" than the "ongoing cost of maintaining a locomotive factory, and especially nowadays when such expenditures would be viewed as voluntary donations toward a job creation program."30

So Reichel was quite critical of the National Socialists' economic policy. Yet he made no great effort to distance himself from those now in power. His nationalist mindset, as well as a proper dose of vanity, may have prompted him also to publish in National

1931 AEG and Borsig founded Lokomotivbau GmbH. In combination with the factory in Henningsdorf, this gave AEG a vertical integration that Siemens did not have.



Not steam, not electricity, but diesel electricity – the legendary "Hamburg Flyer" in Hamburg in 1933

Socialist hate sheets like *Der Angriff*. On the occasion of the presentation of the first express-train connection using the dieselelectric "Hamburg Flyer" in May 1933, he – like all the other propagandists of the National Socialist movement – joined in the general enthusiasm for large, power-politics projects that seemed to promise progress, such as an express line between Berlin and Rome: big projects that fed on the hubris of the fascist alliance

May 15, 1933 The Deutsche Reichsbahn inaugurated Germany's first scheduled express-train connection. The "Hamburg Flyer" required just 138 minutes to cover the nearly 290 kilometers between Berlin and Hamburg.

between Hitler and Mussolini. He was convinced that electrifying such a rail line could only have positive effects on industry and employment figures. Yet at the same time, he was still enough of a realist and an engineer to point out, even in the popular media, the technical tasks and challenges that would have to be dealt with in carrying out such projects.

Reichel tirelessly advocated for electrification projects like the long-distance connection between Berlin and Nuremberg, which was already well advanced. For that project, he said, there was a large supply of "well-trained rail electrical engineers"³¹ available. Thus, out of a kind of opportunism, as a way of promoting electrification, he picked up on National Socialist propaganda's popular theme of creating jobs – ultimately also to keep bread on the table for young engineers that he and his academic colleagues in the Electrical Engineering Department had trained. The anti-modern noises that also issued from the Janus-headed Nazi propaganda machine were of no interest to him. He was a man of technical progress, and that was the aspect he wanted to publicize.

1939 In May, before the start of the war, the Nuremberg–Saalfeld rail line was inaugurated, followed by the Saalfeld–Leipzig section in 1940. End-to-end electrification all the way to Berlin did not take place.

For business, research, and teaching – In the spirit of company founder Werner von Siemens

Reichel celebrated his 70th birthday on January 27, 1937. He was still much sought after as an advisor and the author of numerous articles in trade journals. He was also still a lively participant in the social life of the Akademischer Turnverein and was grandfather to five. Barely four months after his 70th birthday, Walter Reichel died, on May 23, 1937, after attending a sports celebration in Berlin-Grunewald.

Dismay at Reichel's sudden death was great. The obituary notice from the Supervisory Board and Managing Board of Siemens-Schuckertwerke, praising his lifetime of achievements, read in part: "His employees lose more in him than a revered supervisor." For those who worked with him most closely, those words came from the heart. After all, as a university professor and executive, Reichel had advanced many of them and repeatedly encouraged them to find unconventional solutions for technical challenges. For himself, and for the work at the Dynamowerk, he had always demanded the freedom that was necessary in order to advance innovation.

"There is no point in bossing around an R&D project from a headquarters office, for example. To do that, the headquarters would have to be able to achieve at least as much as the developed product itself."³²

This is what he once wrote about his work as director of the Dynamowerk. This self-confidence, which did not seek out conflict

1937 Shortly after Walter Reichel's 70th birthday, the Managing Board of Siemens-Schuckertwerke granted him the privilege of requesting a car from the company's own central garage as needed. but certainly also did not shy away from it, accounted for a large share of Reichel's success, both at Siemens and for electrical engineering in general.

Walter Reichel's work stands for a close, successful association among business, research, and theory, just as Werner von Siemens had advocated – an association that is not always free of conflict when it comes down to practice. A sound knowledge of what was technically feasible, combined with an urge to get things done without regard for hierarchies, along with a complete disregard for ideology, were the main characteristics of Walter Reichel's life's work. He belongs to the generation of well-trained young men who were hired by Siemens immediately after completing their first technical examinations, and who were quickly entrusted with considerable responsibilities. His technical developments and business activity were pioneering achievements, and they helped ensure that the company's reputation as a leader in electrical technology survived two world wars.

May 23, 1937 Walter Reichel's sudden death was a source of profound sadness. A quiet memorial service was held at the Wilmersdorf Cemetery crematorium. Carl Friedrich von Siemens delivered the eulogy.

Notes

- 1 Conrad Matschoss: Werner Siemens. Ein kurzgefaßtes Lebensbild nebst einer Auswahl seiner Briefe. Aus Anlaß der 100. Wiederkehr seines Geburtstages, vol. 2, Berlin 1916, p. 621.
- 2 Siemens Historical Institute (SAA = Siemens archive files), 13.Lt 742, Walter Reichel to Messrs. Siemens & Halske in Berlin, May 9, 1890.
- 3 Jürgen Kocka, Unternehmensverwaltung und Angestelltenschaft am Beispiel Siemens 1847–1914. Zum Verhältnis von Kapitalismus und Bürokratie in der deutschen Industrialisierung, Stuttgart 1969, pp. 281–282.
- 4 From a report in the *Berliner Tageblatt* of May 17, 1881.
- **5** SAA VVA, letter from AEG dated December 10, 1895.
- 6 SAA 13.Lt 742, Walter Reichel to Mr. Gleich, February 25, 1895.
- **7** ibid., letter from the military railway administration to the Studiengesell-schaft, October 9, 1901, [A.21].
- 8 Alt-Herrenzeitung des Akademischen Turnvereins zu Berlin 52 (1935), pp. 154–155.
- **9** *Die Woche*. Moderne illustrierte Zeitschrift, October 17, 1903, (issue 42), p. 1866.
- 10 ibid.
- 11 Historical Archives of Deutsche Bank, HADB S1430, Heinrich Schwieger to Arthur Gwinner, July 7, 1909.
- 12 M. Buhle/W. Pfitzner, Das Eisenbahnund Verkehrswesen auf der Weltausstellung in St. Louis 1904 (= Special publication of the weekly *Dinglers Polytechnisches Journal*), p. 4.
- **13** SAA 13.Lt 742, Walter Reichel to Siemens & Halske, June 7, 1902.
- 14 ibid., Walter Reichel to Heinrich Schwieger, June 9, 1902.
- 15 ibid., Heinrich Schwieger to Walter Reichel, June 11, 1902.

- 16 SAA 4305, correspondence on providing technical apparatus for teaching purposes; Wolfgang König, Technikwissenschaften. Die Entstehung der Elektrotechnik aus Industrie und Wissenschaft zwischen 1880 und 1914, Amsterdam 1995, p. 37.
- 17 SAA 13.Lt 742, Walter Reichel to Heinrich Schwieger, May 27, 1904.
- 18 König, Technikwissenschaften, pp. 37–40.
- **19** SAA 13.Lt 742, Walter Reichel to Heinrich Schwieger, July 8, 1902.
- **20** SAA 15.Lm 120, Walter Reichel, Bericht über eine Studienreise nach Nordamerika im August, September, Oktober 1907, p. 70.
- 21 SAA 12.Lh 583, Walter Reichel, Die Entwicklung des Dynamowerks der Siemens-Schuckertwerke A.G. [manuscript dated June 17, 1937].
- 22 Walter Reichel, Gestaltung elektrischer Lokomotiven, in: *Siemens-Zeitschrift*, vol. 4 (1925), issue 11/12, pp. 381–401, here: p. 381.
- 23 Walter Reichel, Rundschau über die Elektrisierung von Vollbahnen, in: Elektrische Kraftbetriebe und Bahnen, vol. 11 (1913), pp. 109–117, 209–217, 331–337, here: p. 331.
- 24 SAA 4.Lf 699, Walter Reichel to Carl Friedrich von Siemens, December 19, 1917.
- 25 ibid., Walter Reichel to Carl Friedrich von Siemens, January 20, 1918.
- 26 Flyer, November 20, 1918, available at http://www.dhm.de/datenbank/img. php?img=d2z24840&format=1 (last consulted: September 28, 2018).
- 27 SAA VVA Franz Paufler, Erinnerungen an einen großen Ingenieur, p. 14.
- 28 SAA 12.Lh 583, Reichel, Entwicklung des Dynamowerks.
- 29 SAA 35/37. Lh 963, Walter Reichel to Karl Rissmüller, August 15, 1934.
- **30** ibid.
31 SAA VVA, Walter Reichel, Schnellbahn 1903 – Schienenzeppelin 1933 – Schnellbahnverbindung Berlin– München–Rom anno 1937, manuscript, published in abridged form in various newspapers for the general public.

32 SAA 12.Lh 583, Reichel, Entwicklung des Dynamowerks.

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Publisher

Siemens Historical Institute, Berlin Concept and editing

Sabine Dittler, Dr. Johannes von Karczewski

Author Dr. Susanne Kill

Translation Wordshop Translations, San Francisco

Book design Lisa Neuhalfen, Berlin

Printing PH. Reinheimer GmbH, Darmstadt

Binding Buchbinderei Schaumann GmbH, Darmstadt

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- p. 66: Historical collection, Deutsche Bahn AG
- p. oo. mistorical conection, bedische bann

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Siemens Historical Institute, LIFELINES – Volume 7