125 Years
Innovations in Shipbuilding
Navigare Necesse Est

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Navigating into the future
First, we brought light onto ships and now we are putting all our energy into creating the fully electrical ship.

Exploring, conquering, fishing and trading are just some of the many reasons why people take to the water and have been doing so for thousands of years. Seaworthy canoes made of tree trunks existed even in prehistoric times. Phoenicians, Romans, Vikings and Hanseatic states conquered countries and markets by gaining access to them by sea. Spaniards, Dutchmen and the English established world-wide imperiums on the strength of their fleets.

The paddlers in a boat made of a single tree-trunk only had muscle-power. Galleries in which hundreds of slaves worked themselves to death marked the pinnacle and limits of the principle of hand-powered craft. But then came the idea of using the wind: from the simple sail to a mast and then the complex tackle of the fast clippers.

After this, it was a long time before a third source of energy was taken on board. In 1838, the first crossing of the Atlantic by a steamship took place. As early as 1879, Siemens supplied lighting systems for ships and introduced electricity on board. Siemens devices were soon being used for navigation, machine control and ventilation as well and, when the diesel propulsion system started its triumphal march in ship-building, Siemens technology spread to the whole of the ship: from the generation and distribution of electrical energy to drives for winches and steering gear and the main propulsion system.

In the context of a globalized economy, cargo transport by sea is continuing to increase. There is also a demand for modern ferries, cruise ships and seacraft for the navy. Against this background of growth, environmentally acceptable, electrical power generation – in the form of fuel cells – as well as electrical propulsion systems – in the form of superconductive engines – are playing an increasing role on the basis of technologies for which Siemens is the pace-setter.

This brochure is intended as an invitation to you to take part in a voyage through time: through 125 years of exciting Siemens ship-building – right up to the present day and even further into a promising future.

Welcome on board.
The interior of the large machine hall at the International Electrical Engineering Fair in Frankfurt am Main with a view of the heavy-current exhibition area of Siemens & Halske, 1891.
The rapid development of technology is inextricably intertwined with legendary names – names of men who were pioneers in their field, who developed an idea with genius and determination until it was ripe for implementation. One of these names is Werner von Siemens, a man who combined vision, technical knowledge and business skills at the same time. There is hardly anyone in history who advanced the use of electricity to the same extent as he did.
The needle telegraph: the first step
In 1847, Werner von Siemens, who was 31 years old at the time, and the mechanic, Johann Georg Halske, set up the "Telegraphen Bau-Anstalt" (= Telegraph Construction Institute) in Berlin. Their first product was the needle telegraph, which Siemens had improved. This was basically the first step towards their involvement in ship-building. A little later, Siemens would use related technology for shipside communication and control. He was also involved in the production and laying of telegraph cables at a very early stage. This was actually the direct reason for Siemens technology being subsequently adopted on board ships.

Siemens makes light on the Faraday
In 1874, the English branch of Siemens bought the Faraday, a specially designed ship, to lay the transatlantic cables between England and America. To enable work to be continued at night, Siemens installed a generator and a bright arc lamp on the Faraday in 1877. It was thus the first electrified ship in the world. From 1879 onwards, many others followed suit. A precondition for this development was Werner von Siemens’ discovery of the electro-dynamic principle in 1879. This made the practical application of electricity possible for the first time in 1866. With his dynamo machine, mechanical energy can be converted into electrical energy economically.

Siemens starts the world moving
The next thing Siemens dedicated himself to was the reverse process: the generation of propulsion energy from electric current. In 1879, he put the first electric locomotive on the rails and, just a little later, the electric tram was a characteristic feature of many cities throughout the world. In ship-building, it took a little longer until the electric drive became accepted. But Werner von Siemens, himself, showed the way forward: in 1886, he built the small "Elektra", the first electrically driven ship.
At the Berlin trade fair, 1879: the first electrical railway in the world (with power supplied from outside), built by Siemens.

Twenty years later, this made it possible to build the first useable submarines. Siemens was the one who had demonstrated that it was possible.

Pathbreaking: The gyro compass

Werner von Siemens also showed himself to be a progressive thinker in his search for a better compass. In 1888, he acquired the patent for a gyro compass that would also work behind the thick steel walls of modern ships. The difficulties, however, appeared to be insurmountable – even in principle. A second attempt in 1904 also came to nothing. Competitors were hardly any more successful until, in 1908, Hermann Anschütz-Kaempfe presented a halfway usable gyro compass. And the Siemens patent of 1888 played a continuing role in the struggle for vaguely formulated patent descriptions. The complex problems of the gyro compass at the time took research and development to their limits. Later, inventors such as Anschütz-Kaempfe and Boykow offered their ideas to large companies such as Siemens, where large teams were able to carry on the development work they had started.

Pioneers at Siemens: It can be done!

In the spirit of “It can be done”, men at Siemens have repeatedly come up with pioneering achievements. Sigmund Schuckert, for example, whose Nuremberg factories were merged with Siemens in 1903. In 1886, he succeeded in making and grinding the first glass parabolic reflector for electric projector lamps – against the advice of experienced opticians. The manufacture of ships’ projector lamps was then one of the main bulwarks of Siemens ship-building for decades after. Another pioneer was Otto Krell, the first manager of the ship-building department. He played a decisive role in developing electrical systems for the navy as well as for the merchant navy. Another was Hans-Joachim Kosack, Grell’s successor from 1951 to 1966. He fought against many sceptics and successfully introduced three-phase current for ships. Today as well, people at Siemens are still working in the spirit of the former pioneers: for example, on the all electric ship of the future. It can and will be done.
Shipping – Motor for cargo
When most people talk about means of transport today, they usually mean cars, aircraft and trains. In contrast, ships and the romanticism of seafaring seem to belong to the past. What a mistake! The only thing that is right about this idea is that the ship is no longer a favored means of transport from A to B. After the Second World War, the great passenger ship lines were soon in competition with large propeller-driven airplanes and, later, against the jets, they had not the slightest chance. Nowadays, many ferries are being replaced by bridges or tunnels.

Of course, having fun on cruise ships is a pleasure more and more people are turning to, but on the whole, what counts is that over 80% of freight is now transported by sea. World trade without ships is simply no longer conceivable. The English language hits the nail on the head by simply referring to all methods of dispatching goods as "shipping".
Shipping – Motor for cargo transport

The fleet continues to grow
It may be true that the romanticism of seafaring is a thing of the past but cargo transport by ship only really began in the last 100 years and rapid growth did not start until after the Second World War. Here are just a few figures that speak volumes: in 1900, the world’s total mercantile fleet had 29 million gross register tons. In 1950, this was already 85 million – almost three times as much. But only 20 years later, it had again almost trebled to 227 million. Ten years later, it had practically doubled to 420 million. Then, at this particular time, shortly after the oil crisis, the growth appeared to have ended. But by 2003, the fleet had increased again by 100 million to the over 500 million gross register tons of today.

Global network
The fact that the world’s population has grown dramatically in recent decades explains part of this development. Oil also played a large role in that it was only after the war that oil became the main raw material and source of energy for the world economy. It had and still has to be transported from the oil extraction regions to the consumer, the result being that 40 per cent of the world’s shipping tonnage is accounted for by oil tankers. Finally, there is the process of globalization, the increasingly closer interconnection of national economies, that is continuing to intensify the flow of goods all over the world.
Better and better ships

All this only became possible thanks to the progress made in ship-building. Wood was replaced by steel, sailcloth gave way to steam power, then came the steam turbine and finally the diesel engine, whose efficiency was constantly enhanced. Container ships also enabled much quicker transshipment of goods. Last but not least, Siemens and the electrical engineering industry played a large role in this development. Without lighting and electrical auxiliary propulsion systems, it would not have been possible to build such large ships. And without electrical and electronic control units, they would not be so efficient and safe.

Siemens stays on course

In cases where very high speeds are not so important, ships are an unbeatably inexpensive and energy-saving means of transport, although the need for even more economical and more environment-friendly propulsion systems is growing. The solution will be found in highly modern electrical drives. And even if the global fleet of mercantile ships does not grow any further, old ships have to be replaced by modern ones every year. Just as 125 years ago, Siemens is setting the pace of technical progress.

With the help of the additional "tree winches", plane-parallel loading of containers, for example, is possible or precise "spot-loading" of automobiles (middle of the nineteen-sixties)

When the container was invented, a completely new type of ship was to be seen in ports: the container ship.

Container ships required completely new loading and unloading equipment as well as completely new ports.
Siemens brings into the dark
Whether fishing boat or frigate, sailing ship or steam cruiser, everything was dark below deck 125 years ago. When the captain made entries in his logbook, the loading master looked for stowed cargo or the sailor read a letter from his loved-one in his berth, they had to do so in the dim murky light provided by stinking oil lamps. This did not change until Siemens came on board and created light where it was dark, right in the bowels of the ship.
Turning night into day

Siemens first venture onto water was in 1874, when its English subsidiary, Siemens Brothers, operated a special ship called the Faraday to lay transatlantic cables between Europe and America. In order to avoid having to stop work at night, an electrical system was installed on the Faraday in 1877, the first in the world on a ship. The equipment consisted of a direct-current generator and a large arc lamp. This lamp contained two carbon electrodes to which voltage was applied until a bright arc light was created between them. It thus became possible to completely light up the deck of the Faraday.

One year later, Siemens launched the differential arc lamp on the market, in which the carbon rods, which gradually burned away, were re-adjusted automatically. It was therefore possible to connect several lamps to one generator and use them to illuminate the ship. The arc technique was more suitable for projector lights but it was the best kind of lamp at the time, given that gas lighting on ships was not a possibility. In 1879, Siemens equipped three German ships with electrical installations: the Hannover, the Theben and the Holsatia were fitted out with generators, projector lights and interior lighting. In the same year, Siemens and Halske delivered a power generation and lighting system to England for the City of Berlin. These orders 125 years ago are regarded as the official start of a long history of success: Siemens had boarded and was to remain on board ship.

14,000 lamps on board

The great boom in ship lighting, however, did not begin until a few years later when usable filament lamps appeared on the market. In 1883, Siemens equipped a ship with such lamps for the very first time: the Elbe, a steamship belonging to Norddeutsche Lloyd. Just under twenty years later, Siemens celebrated what could be described as a festival of light when the Imperator, a fast steamship, was illuminated with 14,000 filament lamps. If the original, sensitive carbon

In 1905 Siemens brought the Tantalus lamp on the market. This lamp had considerable advantages over the previous carbon filament lamps: it shone much more brightly and had a much longer service life.

In the light of this progress, the small metal filament lamp triggered a new era in ship-building, making possible the construction of much bigger ships. Without it, the interiors would have been impossible to illuminate or use.
The most up-to-date technical stage systems are now a standard feature of cruise ships.

1912 – one of the largest steamships: the Imperator (52,000 gross register tons) belong to the HAPAG shipping company, equipped with electrical systems from Siemens.

Siemens-Schuckertwerke coastal searchlight with a glass parabolic reflector 2 m in diameter and remote control – 1912

Atmospheric lighting for a balmy summer evening at sea.

Siemens-Schuckertwerke coastal searchlight with a glass parabolic reflector 2 m in diameter and remote control – 1912

Projector and signal lights – The heart and soul of business

With its projector light on the Faraday, Siemens had established its maritime business and, for a long time, such lights were the main pillar of this business. Again, this was connected to pioneering work that was done – this time by Sigmund Schuckert in Nuremberg. In 1886, he manufactured a glass parabolic reflector for searchlights for the first time. The Schuckert factories were then able to supply the whole fleet of the German navy with the new, very bright projector lamp. After Siemens had taken over the Schuckert factories in 1903, the Siemens shipbuilding department achieved a third of its sales with searchlights and signal lights for many years to follow. It was only when electronic positioning and communication systems were developed that projector lights became less important, the end result being that Siemens handed over their manufacture to special companies.

For a long time, modern fluorescent technology remained dominant on ships – reliable, economical but not particularly striking. Occasionally, however, light effects are again being presented at sea, a reminder of the magnificent 14,000 lamp display on the Imperator. On passenger ships, especially cruise ships, boringly practical lighting is just not good enough. The right mood has to be created. With Siemens’ sophisticated stage systems, for example, night is made into day in the large dance hall.

filament lamps had been used, the 14,000 lamps would never have lit up at the same time. But, in 1905, Siemens had introduced the first metal filament lamp (the “Tantal”), a considerable improvement over the old type.
Without extensions Floating power stations
Prior to the use of electrical drives: Manoeuvring with a hand-operated capstan on a sailing ship.

The history of Siemens at sea began with electric light. Good light was needed on board and electric light was the best. The only problem, of course, was that electricity had to be provided and this had to be done on board as it was only possible to use extension cables in ports.
Without extension cables – Floating power stations

Growing number of loads

The source of energy on board was steam from the main engine. Steam was used to propel the ship and to operate all the necessary auxiliary machinery such as pumps. It was only for electric lamps that steam was of no use. In 1877, the Faraday was therefore given a direct-current generator with its own 4 horsepower steam machine to add to its new arc lamp. This method did not change much as long as lamps and later telegraphs were the only electric loads on board.

But then, larger and larger ships were built, one of the main reasons being the new interior lighting systems. On such large vessels, steam pipes to remote machinery would have been far too long and complicated – with corresponding losses and potential sources of faults. Electric motors were therefore the next thing to be brought on board: for the steering gear, winches, fans and on-deck machinery. The luxurious passenger steamship, the Imperator, had 225 motors with a total of 1,200 kW on board in addition to its 14,000 filament lamps and equipment for the electrical transmission of control commands. Five turbo-dynamos with a total power output of 1,440 kW supplied energy to the loads via 800 kilometers of armored cable and 1,600 kilometers of rubber-insulated wires.

The first large diesel engine with an astonishing output of 12,000 horse-power, intended for the liner called Prinzregent Luitpold. Ordered in 1909, start of testing in 1914, completion in 1916.
Diesel and electricity – A powerful team

However, it was mainly the gradual triumph of the diesel motor that opened up the way for related equipment on board. Wherever a diesel motor propelled a ship, there was no longer any steam to operate the auxiliary machinery. The result is that electric motors are now to be found everywhere – in loading winches, maneuvering winches, steering gear and so on. Step-by-step, the task of power generation was also taken over by diesel motors – even on steamships. As early as 1912, the imperial navy generated its electricity with diesel motors on several steam-driven liners.

Turning the “tap” on – Power from the propeller shaft

At first glance, it was astonishing that a ship’s electricity was always generated with on-board auxiliary machines – whether a steam machine or diesel propulsion was used to power the ship. Initially, the obvious and energy-saving idea of “tapping” the continuously rotating propeller shaft and thus the ship’s own engine met with little interest because diesel oil, which powered the so-called main diesel, cost almost nothing at the time.

Later, the concept would have been welcomed but the new three-phase technology with a constant frequency demanded a constant speed of propeller rotation – an illusory goal at the time. It was not until semiconductor technology was introduced in the middle of the sixties that it became possible to transform the electricity obtained from the propeller shaft so that it was available with the necessary frequency. The more expensive fuel became, the more shipowners were interested in the new shaft generator system from Siemens.
Squirrel cage rotor and the clock trick: The secret of the new power system

Up to 1954, the world of electric equipment on-board ships remained a direct-current world just as it was 125 years ago. The fact that things then changed was essentially due to the pioneering work done by Siemens. At Siemens, people had long been aware of the potential advantages offered by a three-phase system in ship-building. Two Siemens inventions made the changeover possible: in the poetic language of the engineers, they were called the “constant-voltage generator” and the “pole-changing multi-speed motor”. In 1955, the first “three-phase” ship, the Cap Blanco from Hamburg, put to sea. Successfully.

There were, however, customers who had their doubts about using squirrel-cage motors to sensitively control three-phase loading winches. Siemens engineer Lutz Auer liked to take such customers to Hamburg to see his demonstration winch. He used to suspend a ten-tonne block of cement from the winch, five meters in the air. Auer persuaded his customers to place their wristwatches on the ground directly underneath the block, then he let it drop suddenly, stopping the block a few centimeters above the watch. Whether the relieved watch owners were solely responsible for the developments that followed is questionable but three-phase technology soon became a standard part of German ships and then in ships all over the world. Its triumphal march had begun.

Without extension cables – Floating power stations

38 kW pole-changing multi-speed motor for powering loading winches (1954)

In 1955, the Cap Blanco was the first “three-phase ship” of the Hamburg Süd shipping company.

The first three-phase loading winches used on board for the first time in 1955 on the Cap Blanco (cooling fan cover open).
Opening up new sources of energy

In the following years, Siemens worked continually on making on-board power generation and distribution more economically efficient, safer and easier to maintain. Semiconductor technology is a major factor in this respect. Electronic power management guarantees that the power system remains stable and can provide the necessary energy in any place at any time. Recently, Siemens played a leading role in placing the on-board supply of energy on a completely new basis. Generators and current limiters based on high-temperature superconductor technology (HTS) provide conventionally generated power in extremely stable on-board electric power systems in a highly efficient manner.

Fuel-cell technology provides a new power source on board. With fuel-cells, electrical energy is generated directly, economically and without making noise.

In future, HTS technology will also lead to considerably more economically efficient and safer solutions for the supply of power on board ships.

The on-board power stations supply the complete ship with electrical energy. As with land-based installations, short-circuits can occur when there is a defect. If a short-circuit takes place, current limiters switch the power off in good time, thus preventing subsequent damage that could prevent the ship from maneuvering or could even cause a fire.

The series of pictures from the laboratory for high-voltage switchgear illustrate the forces that can be released and destroy protective devices and components. Current limiters using HTS technology limit the current even faster and almost unnoticeably. In future, they will ensure even more safety on board.
Between steam and diesel – a gap for the electric motor. When Werner von Siemens installed his first electrical system on ships in 1879, steam power was the overall dominant force on-board. Electricity was generated with small steam machines and the propulsion force was produced by large and increasingly larger ones. They reached their high-point when the piston steam machine was developed in 1902, with monsters as big as a house with 17,000 h.p. Two of them powered the Kaiser Wilhelm II, a 19,000 tonne steamship. With cylinder bore holes of almost three meters, the technical limits of steam power were finally reached.
behind the scenes
The driving force behind the scenes

Full steam ahead

At the beginning of the 20th century the changeover to turbine steam machines took place, at least for large ships: In 1914, the Vaterland, a 54,000 tonne steamship, had a turbine system with an output of 60,000 horse-power. To enable the Vaterland to make use of its steam power, the ship had to bunker trainloads of coal, almost 9,000 tonnes, which then had to be burned in back-breaking work by 377 stokers and stevedores in 46 furnaces 24 hours a day. But this problem was soon solved by heating the water tanks of the large turbine ships with oil. At the same time, the diesel motor began its gradual but complete triumphal march in ship-building. It was not possible to say that there was a clear gap in the market for electric drives. Nevertheless, electricity on-board became the driving force behind the scenes.

Dynamo man:
Werner von Siemens

This was thanks to the efforts of Werner von Siemens. The inventive engineer and businessman left no stone unturned when it came to finding practical applications for electricity, for “his” electrodynamic principle. In 1886, twelve years after the Faraday, he built another ship, the Elektra, just under twelve meters long. Its 4.5 kW electric motor was supplied and controlled by four individually connectable accumulator blocks. The world’s first ship with an electric propeller drive had a maximum speed of 12 km/h and could travel at full power for three hours before the accumulators were exhausted.

The passengers were thrilled by the quietly humming boat which produced hardly any vibrations at all.
The boat. The challenge.

In the end, it was the submarine that made electricity into a necessity for watercraft propulsion. Because underwater travel with steam or combustion engines was impossible and because everything had to be concentrated in a very small space in below-surface vessels, the submarine became the great challenge for electrical engineers in the ship-building industry.

In Germany, the first submarines were built in 1904 – for the navy of the Russian tsar. And Siemens was involved, with the Siemens factory in Petersburg supplying the machines for all three boats. When German submarine production started in 1906, Siemens played a major role in the continuous improvements and, up to 1918, supplied almost 90 per cent of all electrical machines and switchboards for the 374 German submarines.

Improved propulsion

Constant improvement and further development of submarine propulsion systems were greatly enhanced thanks to Siemens engineers in the following decades and right up to the present day. Siemens developed the Permasyn motor, for example, first for the submarines of the German navy and later for submarines of foreign navies as well. This motor combines all the virtues that are so important underwater and can, indeed, be vital: it is relatively small and light, its output is infinitely variable and it runs very quietly; thanks to its high level of efficiency, it makes especially good use of the energy that is available and works reliably and steadily even under extreme conditions.

High temperature superconductors – New solutions

Even now, Siemens sets the pace in the development of new, even revolutionary ship’s propulsion systems. Most importantly, there is the high-temperature superconductor technology (HTS), which makes it possible to build motors and generators that are even lighter and more compact.
Electricity for icebreakers

Outside of submarine construction, the electric motor as a means of ship propulsion always plays a specialist role. This is not really surprising, given that propulsion is provided by diesel-electric and, rarely, steam-electric drives, which need diesel machines as primary and electrical machines as secondary motors (generator sets). This, however, is readily accepted since the diesel-electric drive has important advantages: the generator sets can be placed anywhere in the ship, separately from the drive motors. When the ship is moving slowly and therefore consumes little energy, individual generator sets are switched off. The degree of utilization and efficiency can thus be optimally adapted at any time. These advantages make them especially suitable for ferries, special ships, offshore vessels and icebreakers.

Motors for icebreakers are the biggest items of direct-current equipment that Siemens has ever supplied. In the nineteen-sixties, the Moscow, the Kiev and the Lenin – all Soviet icebreakers – were each fitted with an 8,100 kW motor from Siemens as well as two machines half this strength. The Deutschland, a ferry which belonged to German Rail (Deutsche Bahn AG) and was built in 1972, had two powerful motors from Siemens on board, each with 7,720 kW.

Today, modern three-phase synchronous motors are used. In the Grand Princess, a cruise ship, for example, two motors of this type with an output of 21,000 kW each provide an economically efficient drive system.

Quiet strength

In the nineteen-thirties, there were several passenger ships with an electric propulsion system. The French ship, the Normandie, with 79,000 gross register tons and four times 30,000 kW had one of the largest electric drive systems that had ever been built. In Germany, for example, the Potsdam and the cruise ship, the Robert Ley, had electric propulsion systems.

For some years now, electricity as a source of energy has been looked at in
**Installation of a modern 21,000 kW three-phase synchronous motor**

a new light, especially for cruise ships. The reason is that, for luxury liners, extreme speed is not as important as comfort, the latter being achieved by motors that run with very little vibration and produce very little noise.

**An ideal drive**

The idea for “Pod” drives was not particularly new but Siemens engineers applied their imagination and know-how in order to develop this principle further. Working with Schottel GmbH, they developed the Siemens-Schottel propulsor. The electric drive motor is outside the ship in a pod that can rotate 360°. Cooling is provided by seawater flowing around it. For the drive motor, Siemens uses a permanently excited motor such as the Permasyn motor. This drive combines a series of advantages. The whole steering system, for example, can be dispensed with, the ship is more maneuverable as well as being safer and more comfortable and yet there are less vibrations. And the operating costs are also low. An ideal propulsion system for passenger ships, ferries, tankers, special ships and so on.

Siemens is pleased to report that, once captains have maneuvered a ship with a pod, they never want any other kind of propulsion system for their ship.

**The promising future of Elektra’s inheritors**

The limited oil reserves and increasing environmental problems are forcing people to think about how the ubiquitous diesel motor can be replaced in ship-building. A lot speaks in favor of fuelcell technology as a source of energy. Direct electric current is produced which has to be converted into propulsion energy in the most efficient way possible – for example with the help of high-temperature superconductor technology (HTS). This still sounds somewhat futuristic but Siemens has already helped to develop both technologies to the extent that they are now ready for use in practice. In the foreseeable future, the electric propulsion system for ships will be even more important than it is today.

*Pod – Like a plane’s thrust-unit pod, the pod drive is suspended underneath the ship’s stern.*
Safety on board

The lightship ELBE 1 ensured the passage for international ships through the mouth of the Elbe up to 1988. Afterwards an unmanned lightship took over this function.
When we at Siemens first went on board 125 years ago, we brought power generators and lamps, initially to provide light. This was also, of course, a great step towards improving safety. Whether light is directed at the deck or narrow, shallow shipping channels, or whether it illuminates the spaces in the bowels of the ship, safety is always improved in that the seaman can see better. This was even more important when the old, murky petroleum lamps were still a considerable fire hazard.
More light, more vision, more safety
In contrast, electric light became better, safer and more reliable – from the arc lamp and the filament lamp to modern lighting systems. Siemens played a central role in this development process as well as in the improvement of projector lamps, which contributed to safety at sea for many years in the form of orientation aids and morse signaling devices.

“Aye aye Sir” – Making sure commands arrive
The clear and unambiguous transfer of commands is an important safety factor on ships in two respects. Firstly, commands have to be given to crew members who are often many meters and several decks away. Secondly, control commands have to be sent to machines and steering gear. If the captain wants to steer his ship “two dashes aport” and “half speed ahead”, this information must arrive down below in the engine room and astern at the steering system quickly, precisely and reliably. Otherwise, things can get dangerous. With speaking tubes and rope pulls, the limits on large ships were soon reached. As early as 1893, Siemens launched the electric ship’s telegraph which had a “six-roller motor” and was the leading product on the market for a whole ten years. Then Siemens followed this with the “electrical shaft system”, which then proved itself over many decades of use.

Special water-tight ship’s telephones “for noisy rooms” guaranteed that even the mechanic in the engine room could understand what was being said. The devices for transmitting commands were continually improved and, since the sixties, electronic components have been in use here as well.
The rear side of the marble switchboards on the steamship, the Europa, 1930

Modern switchboard on a ferry

On the right, a model of the projector lamp system supplied in 1902 for the Helgoland lighthouse (top), with three rotating lamps containing glass parabolic reflectors and one directional lamp, each reflector with a diameter of 75 cm.

Picture right on the top: Modern estuary control station at the river Elbe mouth

Being highly visible with Siemens beacons

Seeing and being seen. Light in shipping is not only important for lighting purposes. More, larger and faster ships increased the requirements that were placed on landside installations; the provision of better orientation for ships in coastal areas by means of lighthouses and navigation guides, for example.

In 1902, Schuckert supplied a powerful rotary beacon for the Helgoland lighthouse. The carbon arc lamps guaranteed that the light signal could be seen 20 sea miles away. In the years that followed, Siemens supplied several beacon systems of this kind, including the one for the famous lightship, the “Elbe 1”. Later, Siemens was involved when lightships were replaced by automatic stations and when radar systems were added. Siemens designed the workplaces of the radar controllers ergonomically so that they were able to concentrate fully on their highly responsible work.

Switching quickly and safely

The first electrical installations onboard ships were still very simple. The requirements for the switchboards, however, soon increased when the number of loads grew and more and more safety-relevant units were connected to the electric power system. On the one hand, the availability of the power system had to be guaranteed at all times and, on the other, reliable protection had to be provided against overloading, overheating and fire, for example. Finally, the crews also had to be protected against accidents caused by electricity, this being the reason why “deadfront” switchboards whose control panels no longer contained any live parts were introduced. Siemens was one of the leading suppliers of ship switchgear. The largest one the company supplied was for the French luxury steamship, the Normandie, in 1930.
Safety on board

**Chief engineer Proschnmann’s classic**

The Proschnmann switch, produced by Siemens for many years until very recently, was an inconspicuous “classic”. Chief engineer Proschnmann, who worked at Siemens switchgear factory in Berlin, developed it in 1934 as a direct-current circuit-breaker for propeller propulsion systems. The navy remained faithful to this very reliable and robust switch for many decades – there was simply nothing to beat it.

**More safety through automation**

A ship is only safe if all machines on board are working reliably. Otherwise, even a large ship is subject to the whims of current and wind. Because the vital machines for propulsion and control are often a long way away from the bridge, tours of inspection all round the clock used to be one of the crew’s more unpopular tasks. Gradually, electronic monitoring and control systems from Siemens took over this job. They can detect at all times whether the propulsion system and the steering gear are working correctly. They register faults immediately, signal the alarm and switch over to redundant units in a very short time so that the ship never gets out of control.

**Everything under control with the data network**

Today, Siemens supplies comprehensive solutions for ship automation based on the latest technology – for monitoring and controlling all the machinery, the tank and the ballast system and the holds, as well as for signaling the alarm in the event of faults and accidents. Innumerable sensors and measuring points are placed together in intelligent monitoring units and connected via a ship-wide LAN network composed of glass fiber cables. The data are processed to create easily understood, on-screen graphic illustrations. The crew is therefore always kept informed of the operating state of on-board components and can, if necessary, take corrective action immediately by means of control commands via the screen.
In the engine control room, all the measuring and monitoring data are brought together.

On today’s ships, measuring and monitoring data are permanently passed on to the on-board computer from all over the ship.

The computer detects the situation, displays emergency plans and gives the user instructions on how to solve the problem. Crews have never had their ships so much under their control and never have they been able to control it so precisely and safely as with such an on-board network of intelligent automation.

Protection against fire and water

A ship without water makes no sense at all; water is its element. But only outside the ship, if you please. If water penetrates into the hull for some reason, the danger is very high. This especially applies, of course, to fire on board. Like water, fire can be dangerous for a ship especially if it breaks out in a concealed location somewhere inside the huge hull. A widely spread network of automatic fire alarm and extinguishing units is therefore one of the most important safety requirements on board any ship. As early end of the nineteen-twenties, Siemens used to supply leak pumps that started operating automatically when water penetrated the hull without being noticed by the crew.

A name you can trust

For 125 years, Siemens has stood for more safety in ship-building – from the first electric dynamo to modern monitoring and control systems. Even nervous landlubbers enjoy a voyage much more when they see the familiar and reassuring name “Siemens” everywhere on board.
Heavy diesel engines in ships have never been beaten when it comes to efficiency, in other words the economical use of oil. Large engines are also happy with heavy oil, an almost tar-like residue of the oil refining process. Environmental protection, however, is setting clear limits to the use of heavy viscous, sulphurous oil. And, whether economical or not, oil is really too valuable to simply burn. Nevertheless, diesel-electric propulsion systems will continue to obtain their energy from diesel oil for a long time to come. It is therefore all the more important to work on finding new alternative methods of propulsion.
Realistic visions

The future at sea belongs to electrification

Siemens is leading the field in the research and development of alternative ship propulsion systems. The “green ship” of the future, which will be much more economical, safe and environmentally compatible, will be – what else – electric.

Frigate of the future

In the visionary project entitled “Frigate of the Future”, according to the developers, the many possibilities of computer-aided holistic design and simulation of the ship as a whole system are to be implemented. The concept developed by an industrial consortium headed by Siemens incorporates numerous technical solutions: stealth systems based on special materials and a special design for the drive units, a high degree of automation for reducing the number of crew members, equipment flexibility thanks to a modern design and, finally, the latest propulsion technologies.

Electricity from fuel cells

Whether for military or civilian purposes, fuel-cell technology is extremely important for the fully electrified ship of tomorrow. Hydrogen and water are chemically combined to produce nothing other than simply energy and water; no waste gases, no noise. The efficiency of fuel cells is far superior to all combustion processes. The energy which is released is directly converted into electric current, thus again automatically endowing the electric motor with a role in the technical plans being drawn up for the ships of the future.
Apart from fuel cells, high-temperature superconductor technology (HTS) will also play an important and complementary role in the ship-building of tomorrow. Certain materials called superconductors have no measurable electric resistance below a specific temperature. HTS conductors therefore have a current density which is fifty times higher than conventional conductors. This enables the construction of very compact and efficient machines. Siemens has already accumulated a great deal of experience in this field.

In ship-building, Siemens sees three main tasks for HTS:
- Small generators with a high power density for supplying on-board power systems
- Light, compact motors in pods and water jets for propelling large surface craft.
- Current limiters in order to improve the stability of these on-board power systems

U-31 is already diving with current generated by fuel cells

In the latest generation of submarines for the German navy, fuel-cell technology is already being used and is ready for series production. The Permasyn motor of the U-31 obtains its propulsion energy under water from fuel cells. The Siemens engineers are certain that the principle will soon be of interest for surface vessels. Initially, the aim will be to replace the on-board power supply generators, whose use in ports and fjords is increasingly regarded as unacceptable because of the emissions and the noise and will soon be subjected to stricter legal restrictions. Siemens is therefore working on a fuel-cell generator that can supply the on-board systems. In contrast to the fuel cells in the submarine, this type of generator will not run on oxygen from tanks but will “breathe” the surrounding air. High-output air-breathing fuel-cells are being included in the considerations for new ship concepts as a clean source of energy for the propulsion motors of large surface craft.
The Siemens cable-laying ship, the Faraday, is the first ship in the world to be equipped with an electrical system with generator and arc lamp.

Siemens sells the first electrical installations for ship lighting. The history of Siemens ship-building officially begins 125 year ago with ships equipped with the new systems: the Hannover, the Theben and the Holsatia.

Werner von Siemens builds the Elektra, the world’s first ship with an electrically powered propeller.

First use of the Siemens telegraph with a “six-roller motor”.

Siemens supplies the first filament lamps for the Elbe, a steamship.

The German navy ship, the Aegir, is the first to be fully equipped with electric auxiliary machines from Siemens.

Diving under the surface: Siemens supplies all the electrical machines for three submarines of the Russian navy. Submarine construction is and will remain the pace-setter in the development of electric propulsion systems and Siemens is playing a leading role.

First German submarine for the imperial navy.

The proud German passenger ship, the Imperator, is illuminated by 14,000 filament lamps supplied by Siemens.

Siemens presents electric leak pumps that start working automatically.

The Europa, an elegant, fast German steamship, is fitted with a complete electrical installation from Siemens.

Siemens launches the “Proschmann switch” on the ship-building market.

The Potsdam is the first large German ship with an electric propeller propulsion system. From Siemens of course.

Siemens introduces three-phase technology on ships. In the following years, this technology conquers the world market.

Siemens supplies huge propeller motors for the Soviet icebreakers: the Moscow, the Lenin and the Kiev.

Siemens produces system for ship automation, the first system for the automation of power generation, auxiliary machines and remote control of the main machine.

Siemens supplies the first thyristor shaft generator system for three-phase on-board power systems.

Siemens uses the Permasyn motor to optimize the propulsion of submarines. It is considerably quieter, smaller and lighter.

Siemens develops fuel-cell technology so that it is ready for series production.

Siemens builds the POD drive developed with Schottel into a tanker for the first time.

With HTS technology, Siemens again lends impetus to the creation of ship concepts for the future.

World’s first submarine with a fuel-cell propulsion system from Siemens set into service.
For further information, please contact:

Siemens AG
Industrial Solutions and Services
Marine Solutions
P.O. Box 105609
D-20099 Hamburg, Germany
Tel.: +49 (0)40-2889 2700
Fax: +49 (0)40-2889 3680
marine@siemens.com
www.siemens.com/marine

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