PERPETUAL PIONEERING

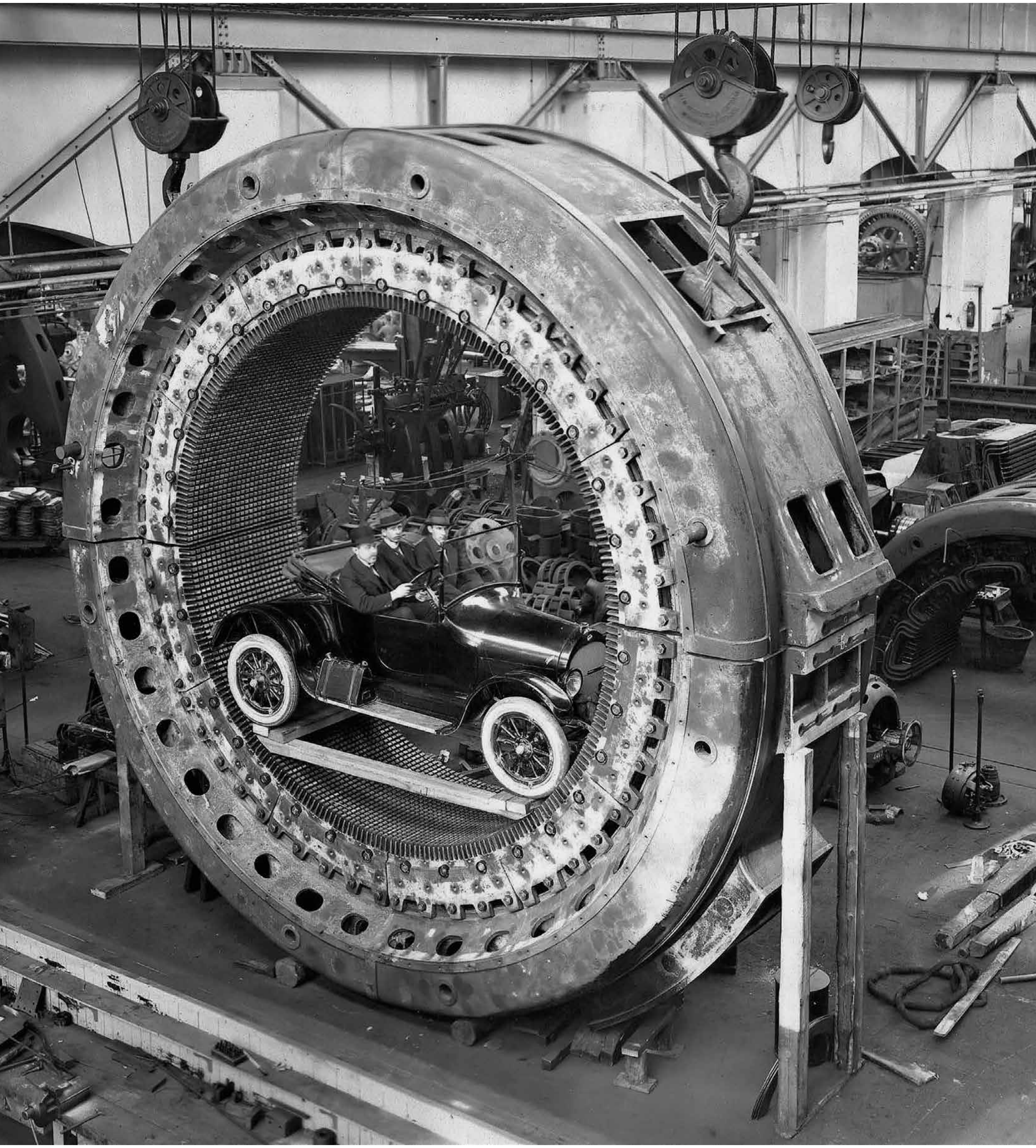
140 years of ASEA

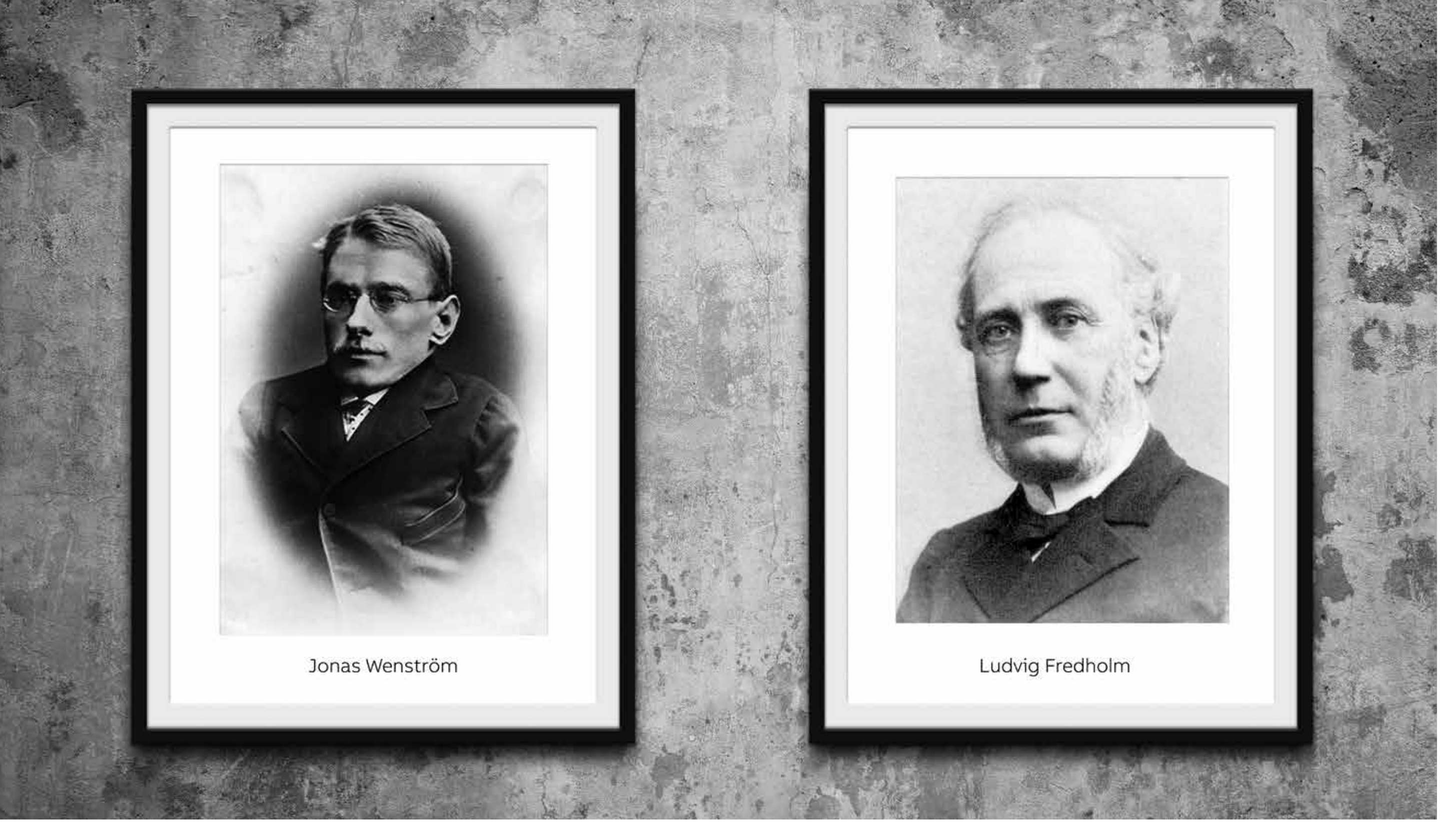
It is almost impossible to imagine what life would be like without electricity. And yet, only as recently as the childhoods of our grandparents and great-grandparents, electric power was a luxury few people had access to, and many had never even heard of. This article examines how the spirit of curiosity and invention, sparked in the late 19th century by two entrepreneurs from Sweden, gave rise to innovations that changed the world, both in the realm of electricity and beyond – and set the stage for the formation of today's ABB; a company that now employs over 100,000 people and has sales of more than $30 billion.

Andreas Moglestue
ABB Review
Zurich, Switzerland

andreas.moglestue@ch.abb.com

Arthur F. Pease
Writer and journalist
Munich, Germany





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Only by chance did the gifted inventor, Jonas Wenström, meet businessman Ludvig Fredholm →01. The two men founded Elektriska Aktiebolaget on January 17, 1883, in Stockholm. Seven years later, in 1890, Elektriska merged with Wenström's brother's company to become Allmänna Svenska Elektriska Aktiebolaget, later shortened to ASEA (which eventually became the A in ABB).

Wenström, driven by incessant curiosity and entrepreneurship, became one of the leading pioneers of electrical transmission →02. His inventions enabled the construction of power plants and transmission lines as well as the electrification of cities and factories →03. As early as 1893, the

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By the time it merged with Brown, Boveri & Cie (BBC) in 1988 to form ABB, ASEA had grown into an industrial giant.

young company built Sweden's first three-phase electrical transmission, a 15 km, 9.5 kV line from a hydro plant at Hällsjön to a mine in Grängesberg [1]. Tragically, Wenström died of pneumonia that same year, aged only 38.

Wenström's spirit of creativity and innovation lived on at ASEA. The company supplied locomotives and power supplies for railways, including the 1926 electrification of the Stockholm to Gothenburg railway. Starting in 1978, ASEA supplied AEM-7 electric locomotives to Amtrak (United States).

Research was valued highly at ASEA. As early as 1916, and well ahead of the trend of industrial corporations doing so, ASEA opened a dedicated Central Research Laboratory in Västerås, Sweden [2]. The company's endeavors included the first commercial HVDC transmission →04, and the first synthetic diamonds →05.

In 1952, ASEA completed the world's first 380 kV AC transmission line, linking Harsprånget to Hallsberg (Sweden), a distance of about 1,000 km with 500 MW capacity [3,4]. This voltage class was later adopted internationally for long-distance transmission, and is still widely used today.

ASEA built Sweden's first nuclear power plant in 1972, and went on to build nine of the country's 12 reactors.

By the time it merged with Brown, Boveri & Cie (BBC) in 1988 to form ABB →06, ASEA had grown into an industrial giant and had become one of the world's ten largest groups in the electrical field and a world leader in HVDC technology.

Today, ABB is a major player in the world of industrial robotics. This journey began in 1974, when ASEA launched one of the world's first industrial robots, the IRB 6 →07.

What follows is but a tiny selection of the company's manifold achievements and lasting legacy.

—
01 Jonas Wenström (1855–1893) and Ludvig Fredholm (1830–1891).

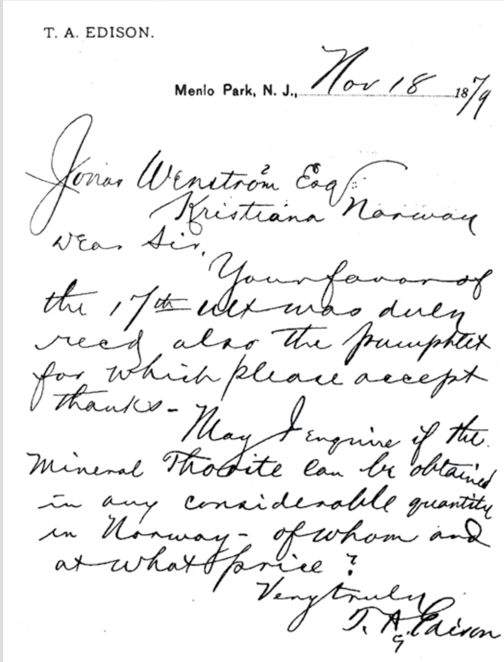
—
02 Three-phase pioneers.

02a Hand-written, note from Thomas Edison to Jonas Wenström, enquiring about the availabilty of Thorite.
Source: Från Wenström till Amtrak, Västerås 1983.

02b Assembling a large three-phase transformer in an ASEA factory.

—
THREE-PHASE PIONEERS

Throughout the history of technology there have been windows during which radical new opportunities have arisen, and progress has shifted to a higher speed. The 1970s and 1980s, for example, saw such a revolution transform personal computing. Similarly, the early 2000s witnessed the boom of the Internet and social networks. Such technological revolutions are golden ages for entrepreneurship, offering seemingly unlimited opportunities for bold and creative minds – people who change the world forever. This is what happened to electricity in the 1880s and 1890s →02a.


T. A. EDISON.
Menlo Park, N. J., Nov 18 1879

Jonas Wenström Esq.
Kristiana Norway
Dear Sir,
Your favor of the 17th ult was duly recd also the pamphlet for which please accept thanks – May I enquire if the Mineral Thorite can be obtained in any considerable quantity in Norway – of whom and at what price?
Very truly
T. A. Edison

02a

Early commercial electric motors had mostly used DC. The increasing adoption of (single-phase) AC in transmission in the 1880s (initially predominantly for lighting) encouraged inventors to pursue viable AC motors. One drawback of single-phase AC was that it is not easy to create a rotating magnetic field – the basis of an induction motor. Another is that in a single-phase motor, power transfer is not constant, leading to torque fluctuations and vibrations.

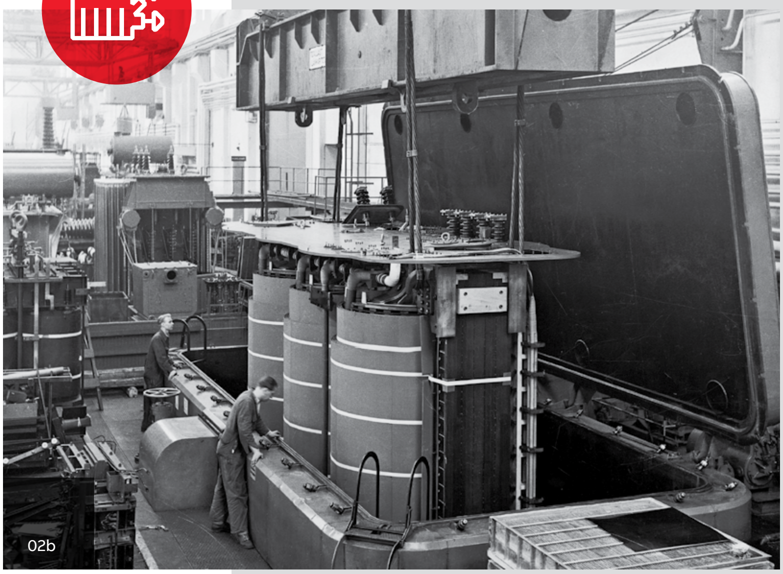
In 1885, the Italian physicist, Galileo Ferraris, demonstrated a two-phase alternator. The second phase was effectively a separate circuit whose phase angle was shifted by a quarter period. At this phase difference, the two phases between them permitted a constant power transfer as well as a smoothly-rotating electric field.

In the years that followed, numerous inventors pursued the polyphase concept. These included Nikola Tesla (working for Westinghouse in the USA), Mikhail Dolivo-Dobrovolsky (working for AEG in Germany) and, in Sweden, Jonas Wenström.

These inventors all adopted the three-phase system. As with two-phase, three-phase machines permit a constant transfer of power. Additionally, because the sum of the voltages of the three phases is zero, the neutral cable can be eliminated for balanced loads. Three cables can thus carry three times the power that a single-phase system based on two cables can carry, opening the door to huge savings in construction costs for transmission lines.

As a side note, while working for AEG, Dolivo-Dobrovolsky, partnered with another pioneer, Charles E.L. Brown, working for MFO (Maschinenfabrik Oerlikon, Switzerland) to build a three-phase transmission for the International Electrotechnical Exhibition of 1891, held at Frankfurt, Germany. Electricity was supplied by a 175 km, 15 kV three-phase link from a generator located in Lauffen am Neckar. This installation became a landmark achievement in the history of electrical engineering, demonstrating the viability of high-voltage three-phase transmission.

That same year, Brown left MFO and, together with Walter Boveri, started his own company, Brown Boveri & Cie (BBC). BBC acquired MFO in 1970, and merged with ASEA to form ABB in 1988. In 1989 the transmission and distribution business of Westinghouse was also acquired. ABB could thus lay claim to the heritage of several of the great pioneers →02b.


02b

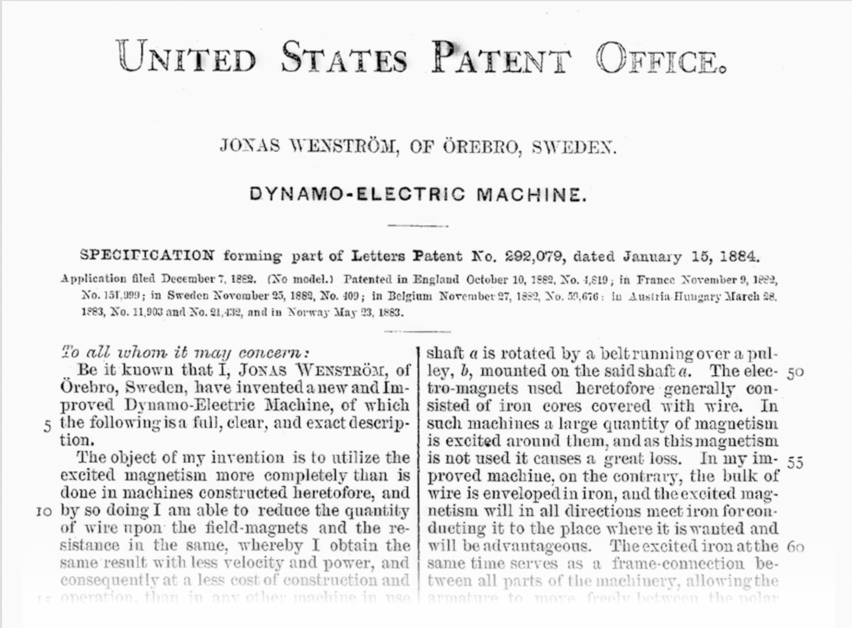
02

—
03 One of Wenström's patents (source: scan from Google Patents). Motors and generators remain an important part of ABB's portfolio today.

—
04 First commercial HVDC.

04a Installation of the Gotland cable.

04b Uno Lamm (seated), pioneer of HVDC, in the Gotland control room.



UNITED STATES PATENT OFFICE.

JONAS WENSTRÖM, OF ÖREBRO, SWEDEN.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 292,079, dated January 15, 1884.

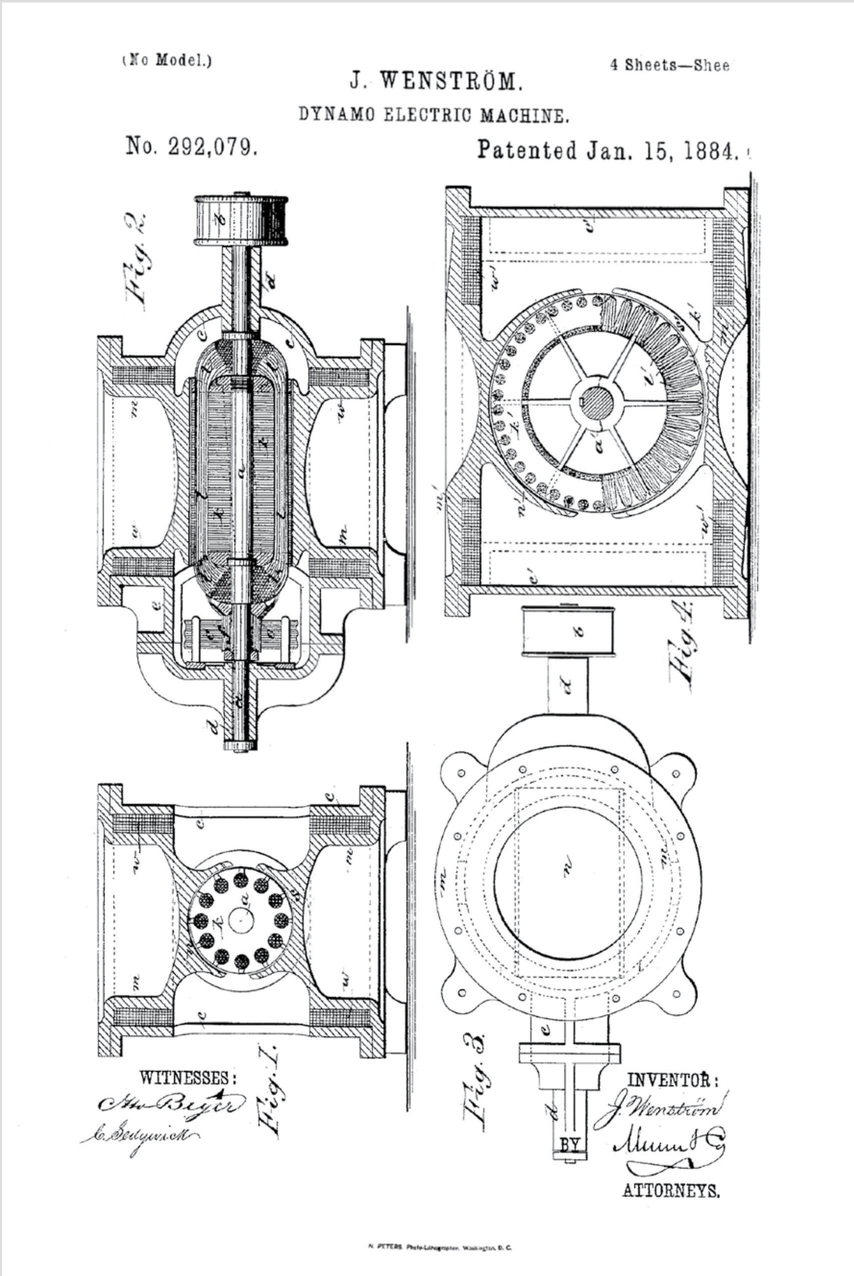
Application filed December 7, 1882. (No model.) Patented in England October 10, 1882, No. 4,819; in France November 9, 1882, No. 151,999; in Sweden November 25, 1882, No. 409; in Belgium November 27, 1882, No. 59,676; in Austria-Hungary March 28, 1883, No. 11,903 and No. 21,432, and in Norway May 23, 1883.

To all whom it may concern:

Be it known that I, JONAS WENSTRÖM, of Örebro, Sweden, have invented a new and Improved Dynamo-Electric Machine, of which the following is a full, clear, and exact description.

The object of my invention is to utilize the excited magnetism more completely than is done in machines constructed heretofore, and by so doing I am able to reduce the quantity of wire upon the field-magnets and the resistance in the same, whereby I obtain the same result with less velocity and power, and consequently at a less cost of construction and operation, than in any other machine in use

shaft *a* is rotated by a belt running over a pulley, *b*, mounted on the said shaft *a*. The electro-magnets used heretofore generally consisted of iron cores covered with wire. In such machines a large quantity of magnetism is excited around them, and as this magnetism is not used it causes a great loss. In my improved machine, on the contrary, the bulk of wire is enveloped in iron, and the excited magnetism will in all directions meet iron for conducting it to the place where it is wanted and will be advantageous. The excited iron at the same time serves as a frame-connection between all parts of the machinery, allowing the armature to move freely between the polar



03

04a

FIRST COMMERCIAL HVDC

High-voltage DC (HVDC) is a form of electrical transmission especially suitable for underwater and underground cables, as well as for very long-distance overhead lines. Starting in the late 1920s, ASEA became first a research pioneer, and then a world leader in this technology. The first commercial application was the 100 kV, 200 A link

The first commercial application of HVDC was a 100 kV, 200 A link to Gotland, inaugurated in 1954.

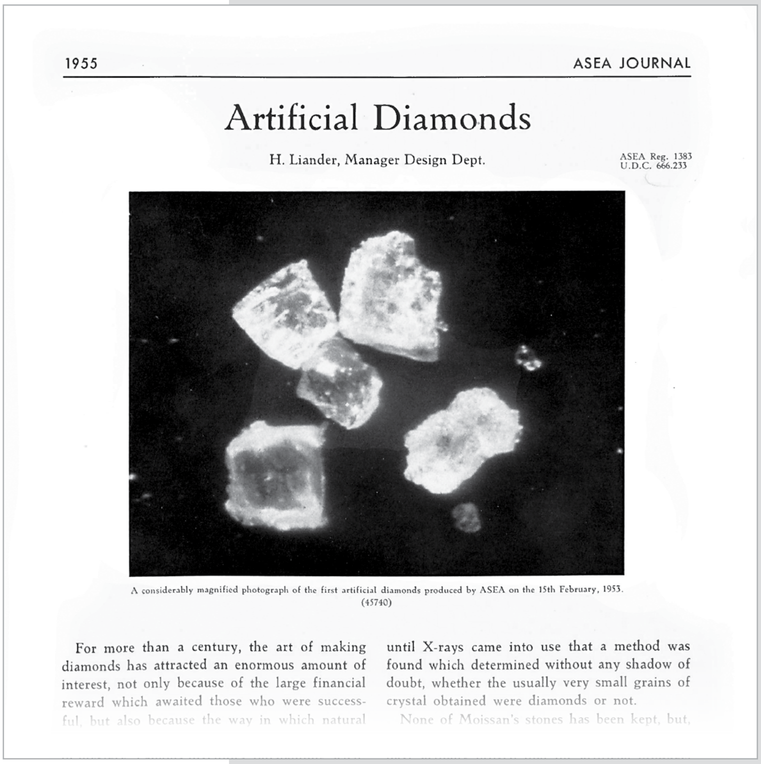
to the Swedish island of Gotland, inaugurated in 1954 →04a [5-7]. The link's converter stations used mercury arc valves. At the time (and for many years after) ASEA was the only company in the world able to supply valves of a high enough voltage. Uno Lamm, often called the father of HVDC →04b, had been able to increase their blocking voltage by using grading electrodes to limit the spontaneous triggering of arcs.

Following the success of the Gotland project, further HVDC links followed, achieving ever higher voltages and power ratings. From the late 1960s, solid-state valves using silicon began to displace mercury. ASEA took on a leading role in developing thyristors capable of handling the required currents and voltages [8-10].

In a move designed to refocus the company, ABB sold its high-voltage transmission activities, both AC and DC, to Hitachi in 2020. Medium and low-voltage AC and DC distribution remain central components of ABB's portfolio today.

04b

04


1955 ASEA JOURNAL

Artificial Diamonds

H. Liander, Manager Design Dept.

ASEA Reg. 1383
U.D.C. 666.233

A considerably magnified photograph of the first artificial diamonds produced by ASEA on the 15th February, 1953. (45740)

For more than a century, the art of making diamonds has attracted an enormous amount of interest, not only because of the large financial reward which awaited those who were successful, but also because the way in which natural

until X-rays came into use that a method was found which determined without any shadow of doubt, whether the usually very small grains of crystal obtained were diamonds or not.

None of Moissan's stones has been kept, but,

05a

Download the
1955 ASEA Journal
article

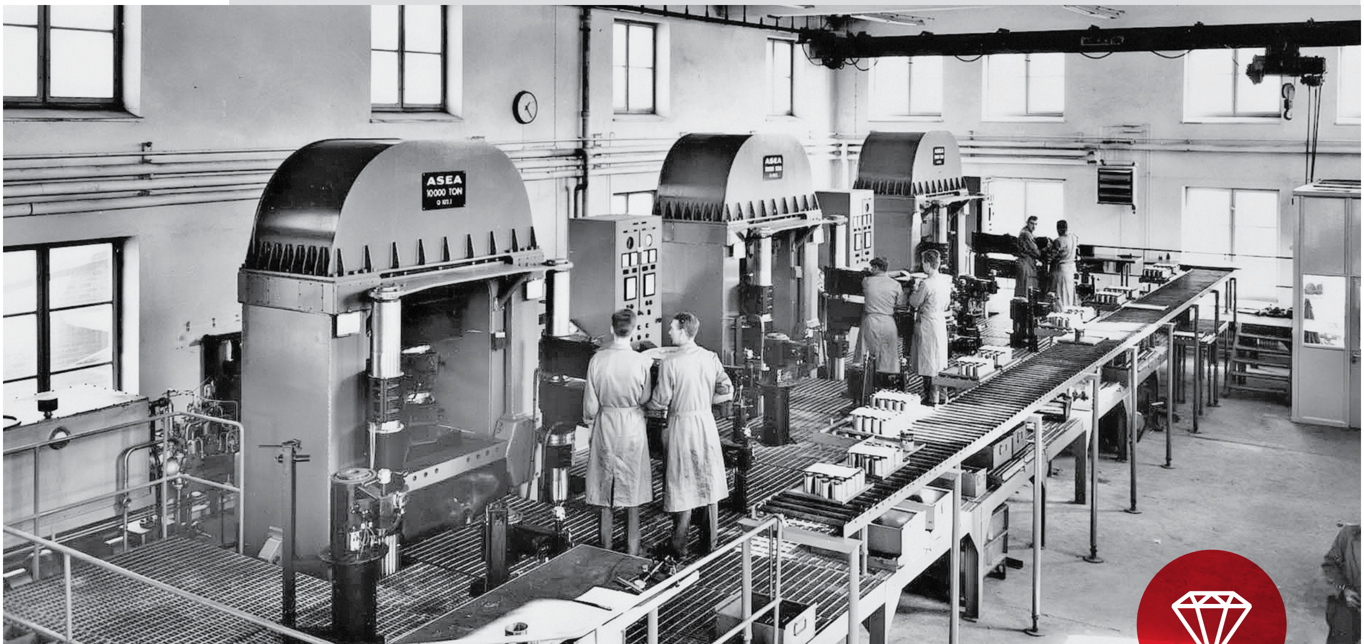
WORLD'S FIRST SYNTHETIC DIAMONDS

Following the discovery in the late 18th century that diamonds are made of carbon, there had over the years been numerous unsuccessful attempts to create them synthetically. The Swedish inventor, Baltzar von Platen, took up the challenge in 1937, realizing that the solution lay in building up sufficient pressure. In 1942 he convinced ASEA to provide financing and researchers. The project, code named 'Quintus,' was kept top-secret. Von Platen left the project in 1952, but ASEA continued the work with a team of five scientists under the leadership of Erik Lundblad [11].

Success was achieved on February 16th, 1953 at the team's lab in Stockholm, when a pressure of 8.4 GPa and a temperature of 2,200 °C were maintained for an hour, creating about 40 tiny crystals with a size of about 0.1 mm each. Four of these were sent to Stockholm University, where they were certified by X-ray investigation to be diamonds. The experiment was repeated with similar outcome on 24th May and again on 25th November.

As ASEA's goal was to perfect the process before making an announcement, the breakthrough was initially kept secret. The company's hand was forced when GE created its own diamonds in December 1954, publicizing this in February 1955. Unaware of ASEA's success, GE was claiming to be the first. ASEA responded by announcing its accomplishment in April [12], later also reporting it in ASEA Journal (a predecessor of ABB Review) →05a [13].

ASEA's diamonds were primarily used in industrial cutting tools. Production was transferred from the lab in Stockholm to a factory in Robertsfors, Sweden, in 1962 →05b. ASEA later entered a joint venture with De Beers, selling its participation entirely in 1975.



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06a

THE MERGER

In 1986, two years before ASEA merged with Brown, Boveri & Cie (BBC) →06a, ASEA employed 71,000 people, reported revenues of $6.8 billion and had an after-tax income of $370 million →06b. BBC employed 97,000 people, reported revenues of $8.5 billion, and had an after-tax income of $132 million. Seeing a vast range of matching business interests and technological synergies, ASEA and BBC agreed to merge and form a new company – Asea Brown Boveri (ABB), with headquarters in Zurich, Switzerland.

06b

06

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05 World's first synthetic diamonds.

05a ASEA Journal article of 1955, announcing the successful production of synthetic diamonds.

05b Presses used for the production of diamonds in Robertsfors, Sweden, 1964. According to J. Asplund [11], the employees in the photo were positioned to obscure sensitive aspects of the installation.

—

06 The merger.

06a The merger of ASEA and BBC to form ABB took effect on 5th January 1988.

06b A motor being assembled in an ASEA factory.

—

07 Robot Revolution.

07a Leif Jönsson of Magnusson AB and Lennart Benz of ASEA demonstrated the IRB 6 robot in 1974. Magnusson became ASEA's first external robot customer, using the robot to polish stainless steel pipes for the food industry.

07b The SAAB Model 99 of 1975 was an early spot-welding application.

07c ASEA's IRB 2000 arc-welding robot grabbed industry-wide attention when it hatched out of an egg at a show in Brussels in 1986.

07d ABB's FlexPicker robots are designed for quick and agile movements in picking and placing tasks (this is the FlexPicker IRB 360).

07e Launched in 2015, ABB's YuMi is designed to work alongside humans.

—

ROBOT REVOLUTION

Today, industrial robots can be found in discrete manufacturing and handling environments everywhere. The advances they have made possible in terms of increased productivity, consistency, quality and workplace safety have been astounding. But one machine in particular stands out:

—

ASEA's IRB 6 was the world's first all-electric microprocessor-controlled industrial robot.

ASEA's IRB 6, the world's first all-electric, microprocessor-controlled, commercially available industrial robot →07a. Introduced in 1974, the IRB 6 was revolutionary. Until then, hydraulics had dominated robotics. But the new machine with its 6 kg capacity, was unique not only in terms of its drive system but also in terms of its anthropomorphic configuration and its innovative use of a microprocessor for accurate control – it used an 8-bit Intel 8008 microprocessor. The new machine also set new standards in footprint size, speed of movement and repeatability.

In the decades that followed, the scope of robot applications grew, as did the range and capabilities of robots. Today, ABB is one of the world's leading robotics and machine automation suppliers →07b-e. [14-17]

07a

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07

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07b

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07e

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Watch a video on the anniversary

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Photo fig. 07b: SAAB AB