Leybold

1850

2020

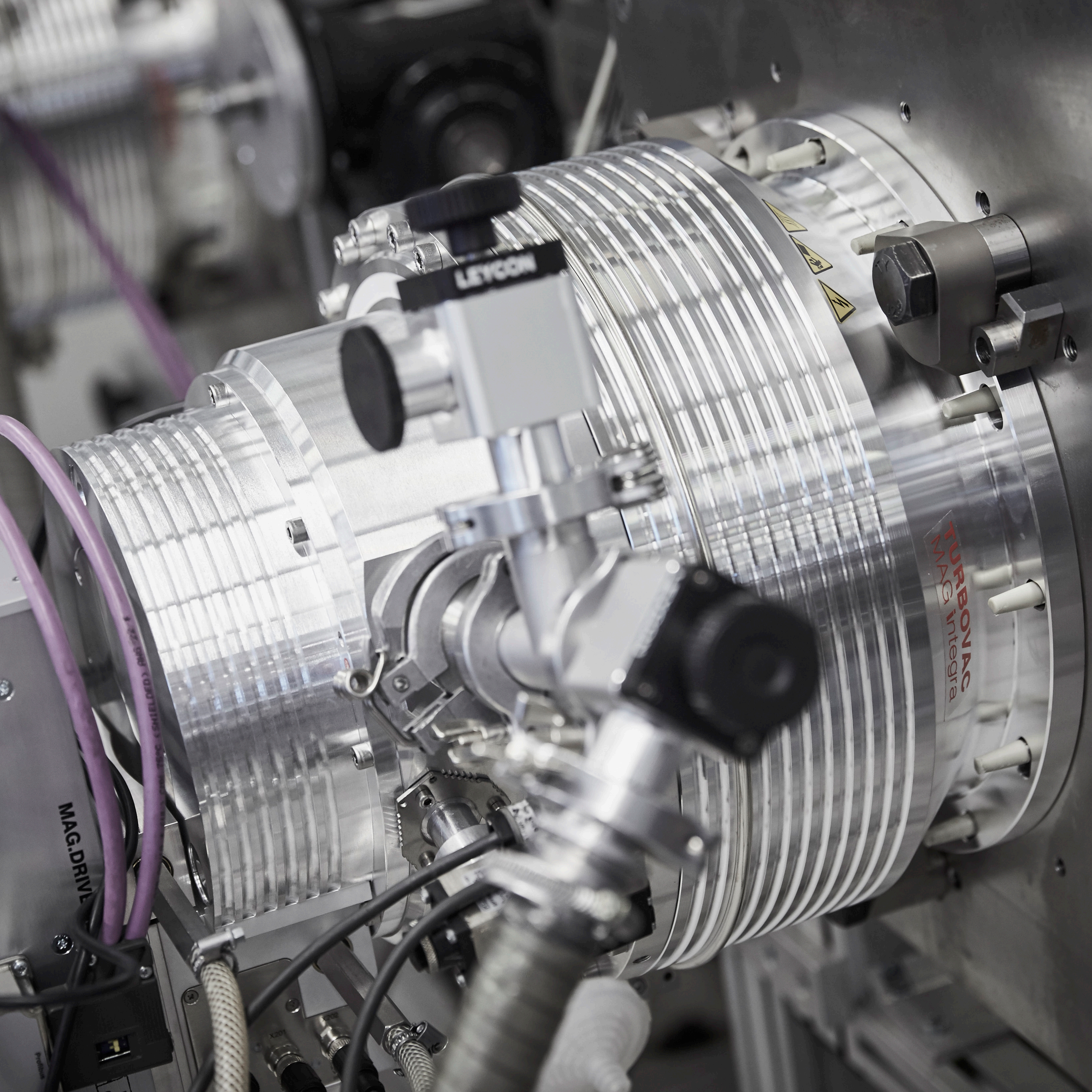
PIONEERS FOR 170 YEARS

Successes from one of the
most innovative companies in the world

1850

2020

PIONEERS FOR 170 YEARS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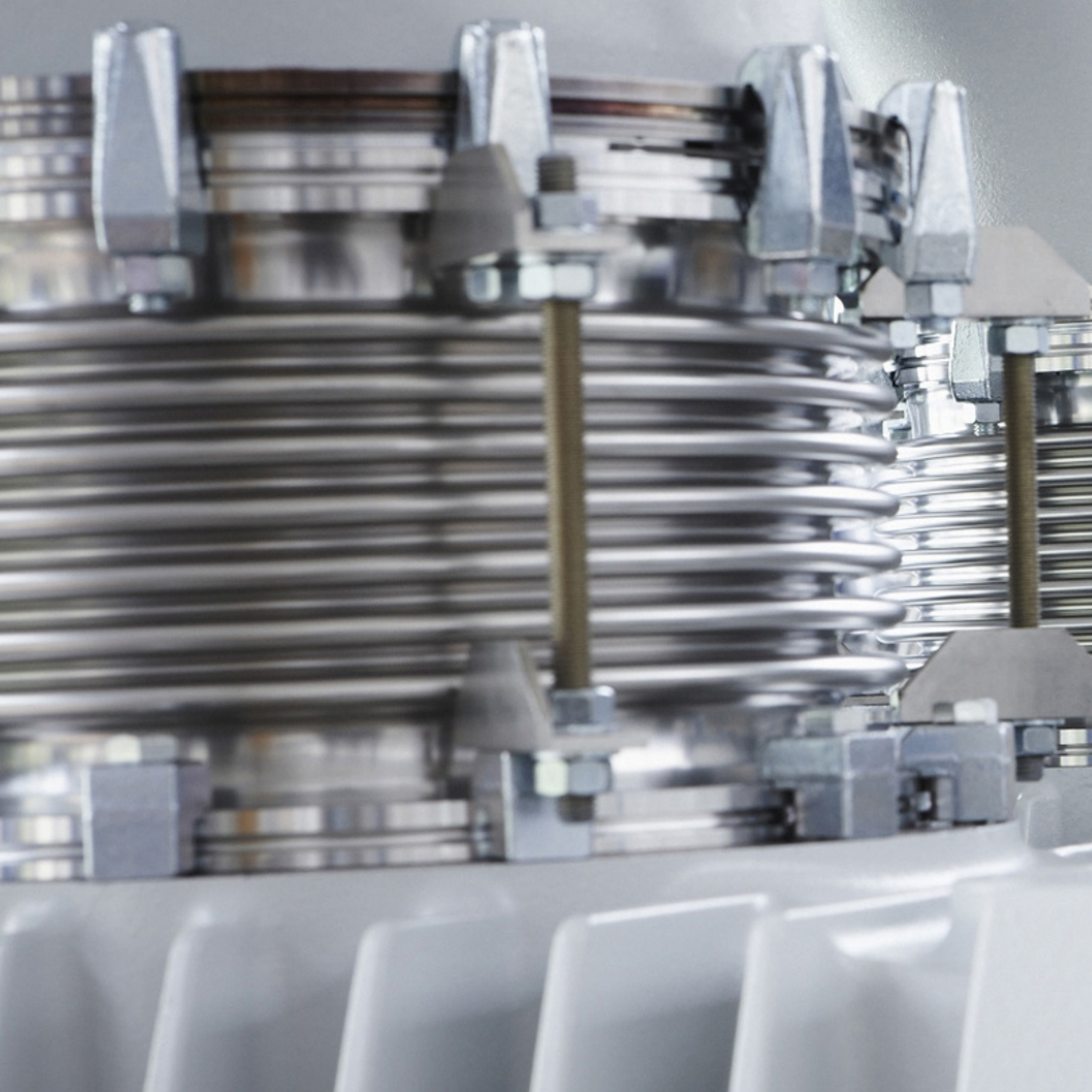



Leybold

Geert Follens
Business Area President,
Vacuum Technique

LEYBOLD, PIONEERS FOR 170 YEARS

If there is **one constant** in our group's history, it is innovation. And since Leybold's founding in 1850, it has been **a pioneer in vacuum innovation.**

As the world's oldest vacuum pump manufacturer, Leybold's pioneering inventions, such as the first molecular air pump in 1909, paved the way for other vacuum technologies, including turbomolecular pumps, which are critical in many modern-day applications.

For 170 years, Leybold's passionate employees have been at the heart of the company's success. Their innovation, commitment and expertise are the reasons that Leybold is trusted by customers around the world.

You can learn more about Leybold's long and illustrious heritage as well as its people – some of whom are the third generation of their family to work for Leybold - in the pages of this special commemorative book.

In 2016, Leybold joined the Atlas Copco Group. Since then, the company has continued to provide innovations in vacuum technology with its brand promise of 'Pioneering Products, Passionately Applied'. Today, Leybold is recognized globally as a leader in industrial and high vacuum applications as well as for its strong engineering competence and superior next-generation products.

On behalf of Atlas Copco Group's management, congratulations to Leybold on reaching this wonderful milestone! I look forward to us celebrating many more future successes together.


Leybold

CONTENT

ABOUT LEYBOLD

With its **comprehensive product line,** Leybold is one of **the most successful suppliers of vacuum technology to the world market.**

In the last 170 years since its founding in 1850, Leybold has written its chapter in industrial history and, not least through the groundbreaking inventions of Wolfgang Gaede, founded the worldwide vacuum industry. From the first industrial applications in the production of light bulbs 100 years ago until today, the company has reinvented itself again and again to adapt to the requirements of the global market.

Today, vacuum technology is a key technology that has become indispensable in many applications. Users can be found in all industrialized regions throughout the world, and Leybold continues to count itself among the market leaders of this industry.

Leybold's pumps and vacuum systems create the necessary production conditions for the industrial manufacturing of semiconductors, data carriers, displays, coated architectural glass and solar cells. Vacuum systems are used among in the refinement of steel and the processing and packaging of food. Vacuum is also indispensable for the operation of mass spectrometers and electron microscopes as well as in almost all areas of modern research. At Leybold, highly trained and experienced employees are the foundation of a comprehensive customer service. Innovative products combined with state-of-the-art production technology in a global manufacturing network all come together to form a successful business. The world's largest service network with a multitude of service offerings completes the product line.

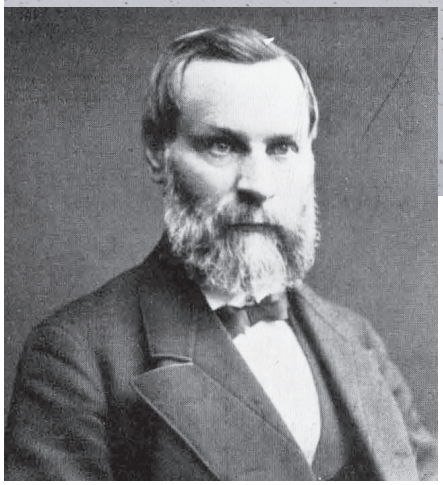
Innovative, modern vacuum technology supports the megatrends of the global economy and thus contributes significantly to sustainable progress.

Pioneering products. Passionately applied.

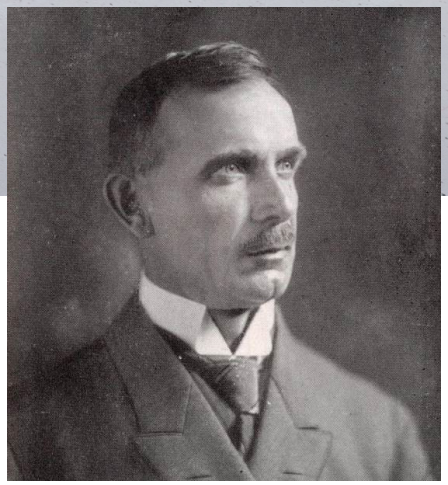
1850 2020 PIONEERS FOR 170 YEARS

OUR FOUNDERS

Ernst Leybold combined a **willingness to work hard** with the ability to recognize when a **good business opportunity** presented itself. Wolfgang Gaede personally held close to **40 patents in Germany** alone for **vacuum technology.** Dr. Manfred Dunkel expanded his predecessor's accomplishments **to move the company forward.**



Ernst Leybold
Our Founder & Namesake
(1824–1907)



Wolfgang Max Paul Gaede
Pioneer of modern vacuum technology
(1878–1945)

Dr. Manfred Dunkel
Company Owner and founder of the GAEDE Archives
(1898–1985)

OUR VISIONARIES TODAY

Our current executive team draws its **inspiration from our founders.** There are still places to go in **the worlds of invention and innovation** in this exciting time we live in. **Leybold** is determined to be at the **forefront in the field of vacuum research and solutions.**

Koen Lauwers
Industrial Vacuum

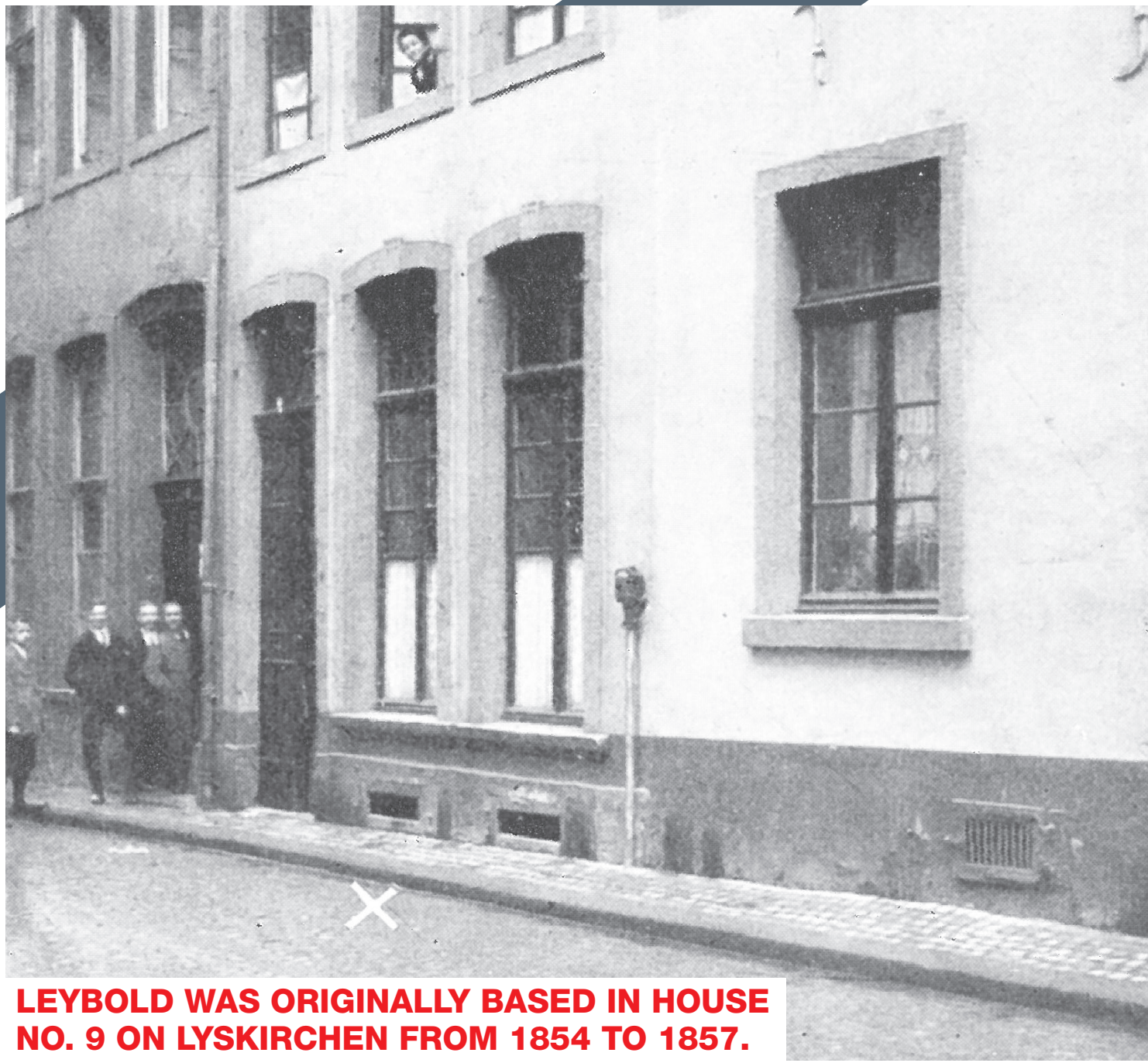
It is our duty to invent and lead with vacuum technologies that enable critical industries to create a better world. This is what Leybold did in the past 170 years and we shall respect that tradition.

Carl Brockmeyer
Scientific Vacuum

Science and Research were the foundation of Leybold's business model 170 years ago and continues to be at the core of our mission today. We help science improve our lives with vacuum technologies that enable scientific research and deliver real-world solutions.

Eckart Röttger
Vacuum Technique Service

Convenience, Quality and Customer Value are at the heart of everything we do. We understand our customer's needs – to make their service our priority.



LEYBOLD WAS ORIGINALLY BASED IN HOUSE NO. 9 ON LYSKIRCHEN FROM 1854 TO 1857.

The cornerstone of success

This important anniversary would not have been possible without the tireless commitment and work of several generations of dedicated employees. However, the businessman Ernst Leybold laid the foundation stone for success when he moved from Rothenburg ob der Tauber to Cologne in 1850 and founded his first company – initially as a commission and forwarding agency for medical glassware, ointment pots, thermometers and scales. In 1854 he expanded his range of products to include physical, pharmaceutical and chemical apparatus. In 1870 Leybold finally sold his business, which, however, continued to operate under the name of E. Leybold's Nachfolger.

ERNST LEYBOLD

Our Founder & Namesake

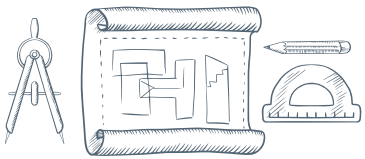
* 11/17/1824 Rothenburg/Tauber (Germany)
† 2/10/1907 Cologne (Germany)

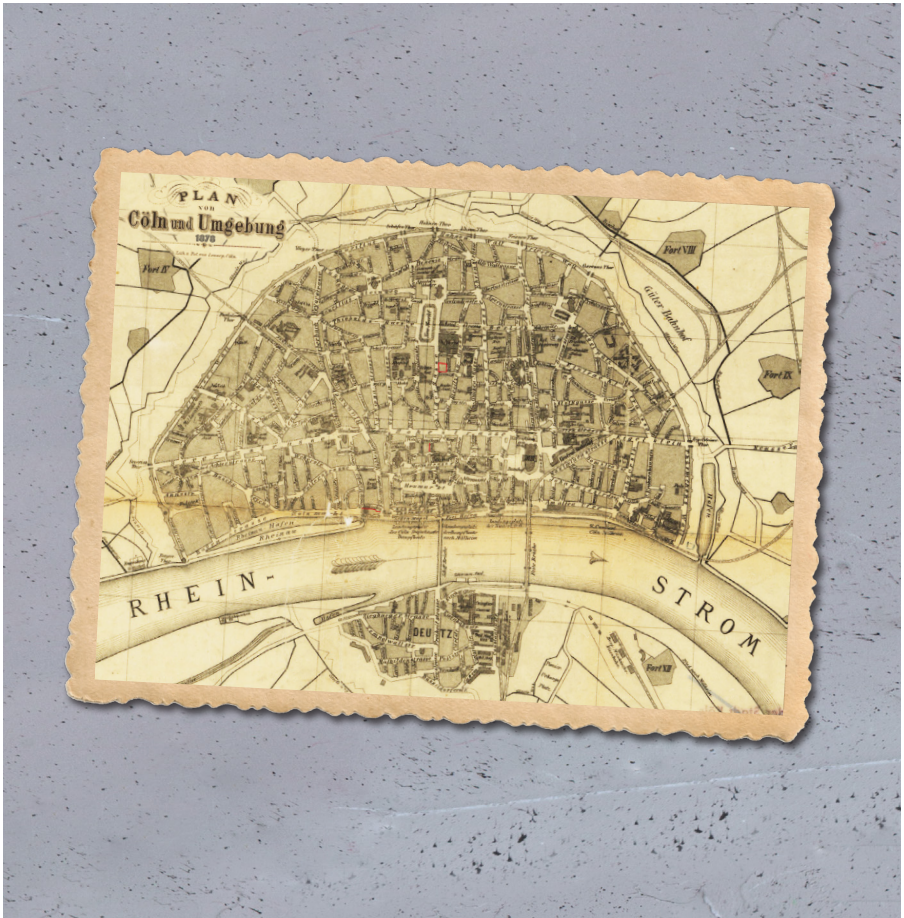
Ernst Leybold, like his father and grandfather, started out as a merchant. In 1846, he left the house he outgrew in the small town of Rothenburg and took up a sales position in Cologne with Böcker, an import company. By 1850, he was working with a coffee import agency. In 1851, his landlord, Martin Kothe, a sales agent and importer of foreign wines and various pharmacy supplies, died suddenly and left behind a wife with no business experience, so Leybold stepped in to help.

First, he continued simply running the business. He then became involved financially, and finally took over the company in 1863, under the name E. Leybold (formerly Leybold & Kothe). As part of the settlement with Kothe's heirs, Leybold expanded the pharmacy supplies business line. This decision proved to be a good one. The business of physical and pharmaceutical apparatuses, along with accessories, was so successful that Leybold soon owned his own house and began to acquire land.

In 1864, he opened his main shop in a new building in the Schildergasse/ Brüderstraße. At this time, he also had a modest amount of in-house production. Due to its economic success, in 1865, Leybold and Julius v. Holleben also founded a glassworks company in Ehrenfeld one year prior (since 1872 Rhein. Glashütten AG). In 1870 Leybold decided to sell his first company to his partner Otto Ladendorff and the merchant Emil Schmidt, who successfully continued the company as “E. Leybold’s Nachfolger” (Company Name).

At the beginning of the 1860’s, Leybold had already been dabbling in property speculation and had been successful with various real estate transactions. He then turned his attention to a spectacular urban planning project, the construction of the Marienburg Villa Colony south of Cologne. He had purchased the Marienburg estate along with the manor house and another 500 acres of land for a modest sum. He moved into the manor house himself in 1873, and leased out the land. Leybold did not limit himself to simply selling the parceled out land, for example, the area between Cologne’s current traffic arteries, the Bayenthal Belt, Gustav-Heinemann-Ufer, the Military Ring Road and the Bonner Straße. Instead, he tried to increase the area’s residential value. This included road construction measures within the colony, giving it a solid infrastructure with sewers and gas connections, as well as negotiations with the authorities in order to improve transportation connections to Cologne (e.g. a tram). As such, Leybold dedicated the last years of his life more to urban development and various real estate projects than to the further development of vacuum innovations or other scientific projects. He is still considered one of the most influential persons in the 170-year history of Leybold GmbH. His flexibility and complexity is still reflected in the values of the company today.



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WHAT IS VACUUM?

In physics, **a vacuum is a theoretical concept** which is used to describe the **(total) absence of matter in space.**

In everyday language, the word vacuum is used to describe a space that's largely devoid of air. There are different definitions for this term depending on whether we're talking about natural sciences, philosophy, technology, chemistry or physics.

In technical practice, a vacuum is a space with a virtual absence of matter. There are no solid objects or liquid. There is very little gas, and this results in extremely low gas pressure. In physics, a vacuum is a theoretical concept which is used to describe the (total) absence of matter in space.

The idea of vacuum became important in the twentieth century with the introduction of the incandescent light bulb and the electron tube. A technical vacuum is created by using a pump to remove (gas) molecules from a sealed space.

Pumping creates a vacuum, i.e., pressure within a space that is lower than the ambient pressure. If the pressure falls below 300 mbar and progressively more molecules are removed from the space, the result will be one of the following:
Rough vacuum
Fine vacuum
High vacuum
Ultra-high vacuum

The question of whether an absolutely empty space can exist is still being debated by physicists today. According to quantum field theory, virtual particles are constantly being created and destroyed everywhere. A vacuum is generally understood to mean only the absence of matter. Electromagnetic radiation and other physical fields may be present in the space being considered, which means it's not empty.

NO ELECTRIC LIGHT BULBS WITHOUT VACUUM!

Electric Bulbs (1879)

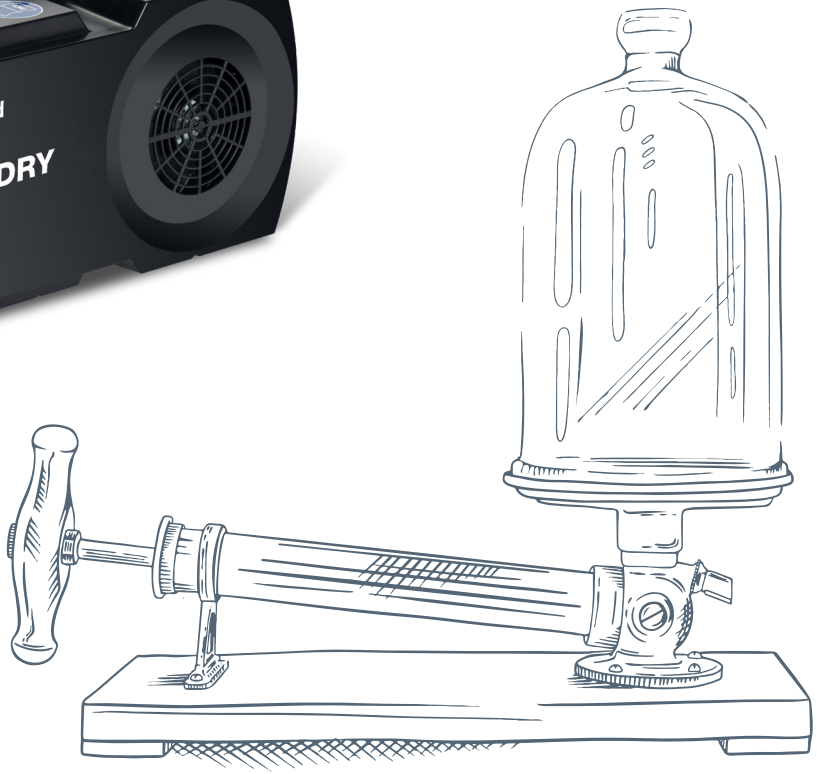
The invention of electricity allowed us to light up places which were previously unlit. Vacuum tubes were essential in the production of all light bulbs. Conventional light bulbs and the more modern "Leuchtstoffröhren" and halogen (energy saving) bulbs need vacuum to prevent the presence of harmful oxygen and humidity. Modern LED lamps need vacuum, as the manufacturing process involves vacuum coating and baking.

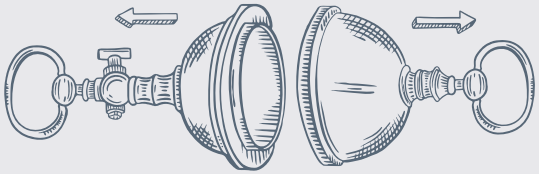
> Leybold has consistently succeeded in combining tradition and innovation again and again in the course of its company history. Because of this, the company is proud to celebrate a very special milestone in 2020 with its 170th anniversary.

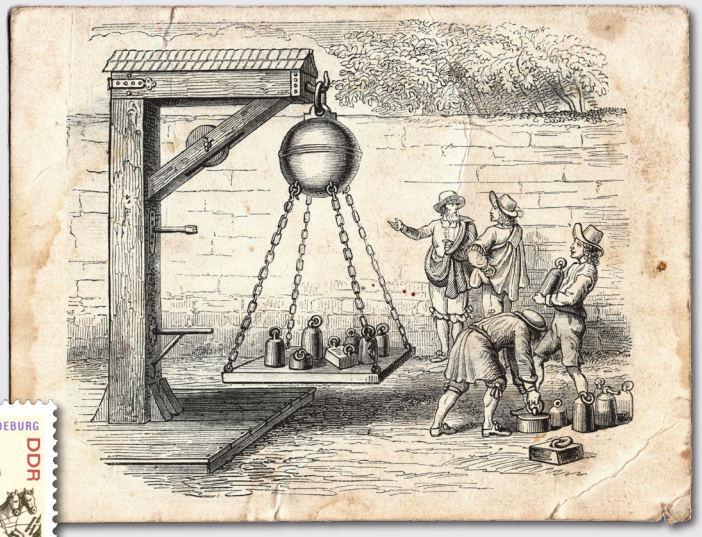
FROM OLD TO NEW

In 1899 *E. Leybold's Nachfolger offered one of the first air pumps for sale.*

In 2020 *the company introduces the latest innovation of dry vacuum pumps to its customers.*





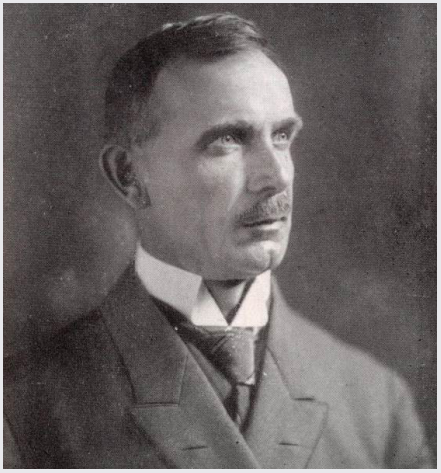


THE MAGDEBURG HEMISPHERES (1657)

The Magdeburg hemispheres, invented by German scientist and mayor of Magdeburg, Otto von Guericke, are a pair of large copper hemispheres, with mating rims which were used to demonstrate the power of atmospheric pressure. When the rims were sealed with grease and the air was pumped out, it created a vacuum that even a team of horses could not pull apart! Magdeburg hemispheres were originally invented to demonstrate an air pump that von Geurick had invented, in addition to the concept of atmospheric pressure. The first artificial vacuum had been produced a few years earlier by Evangelista Torricelli, and this had inspired von Guericke to design the world's first vacuum pump, which consisted of a piston and cylinder with one-way flap valves. Magdeburg hemispheres first became popular in physics lectures as a way to demonstrate of the strength of air pressure, and are still used in education. The original hemispheres are housed in the Deutsches Museum in Munich.

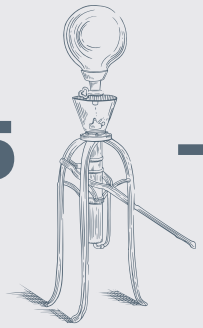
> **The weight of air and its absence are forces that can be put to work!**

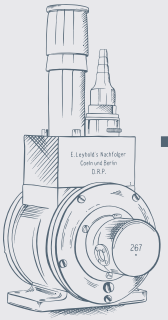
Otto von Guericke *(1608 - 1647)*
When he invented the first piston vacuum air pump in 1649, he would never have dreamed what might be possible with this empty space some 370 years later. His pump principle remained nearly unchanged for more than 200 years before further development took place through the design of vacuum pumps.

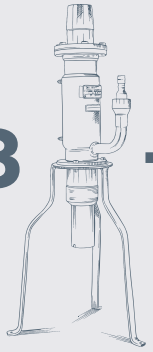


Wolfgang Gaede *(1878 - 1945)*
In 1906, E. Leybold's Nachfolger began working with Wolfgang Gaede. Various types of research on the Volta effect in vacuum led him to his life's work: the creation of an entirely new and effective apparatus for generating and measuring the high vacuum. Gaede held nearly 40 patents in Germany in addition to numerous patents abroad.

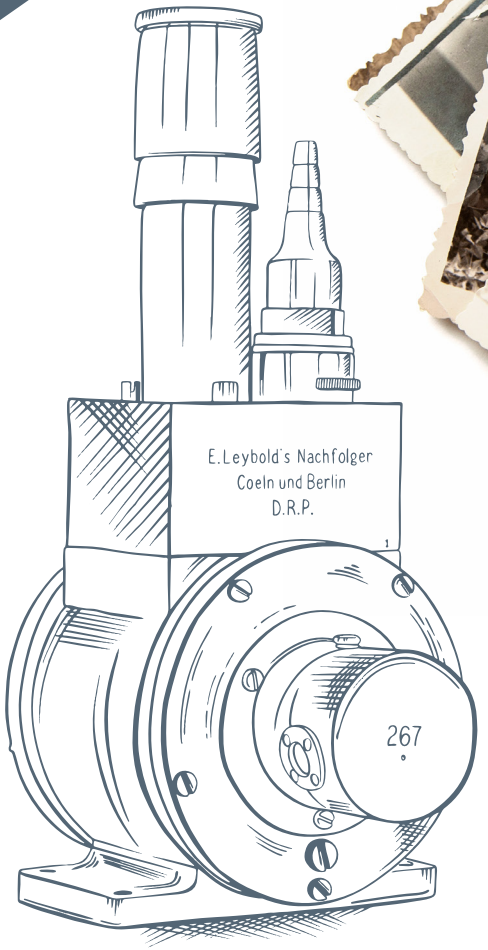
1655 → **1911** → **1913** →







“When I pursue an idea out of scientific interest, I always come up with an invention.”



01/03/1909

Granting of the **Rotating Vacuum Pump patent**
(patent for the molecular air pump)

PROF. DR. WOLFGANG GAEDE

Pioneer of modern vacuum technology

* 05/25/1878 in Lehe, Bremerhaven (Germany)
† 06/24/1945 in Munich (Germany)

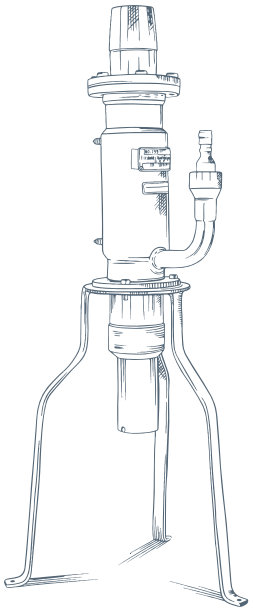
Another person who had a significant influence on the fate of the company at the beginning of the 20th century was Prof. Dr. Wolfgang Gaede. In 1897, Gaede began studying medicine at the University of Freiburg in Breisgau, but soon switched to the Institute of Physics, where he received his doctorate in 1901 through his thesis entitled, "*On the change in the specific heat of metals with temperature*".

Subsequent research on the Volta effect in vacuum was unsuccessful, however, because the level of vacuum that could be achieved with the pump technology at the time was insufficient. This problem led him to his life's work, the creation of an entirely new, effective apparatus for generating and measuring high vacuum. In 1905, he presented his rotating mercury air pump at the natural scientists' meeting in Merano and caused quite a stir, despite the fact that this pump (along with his oil capsule pump) were only technical improvements of already known principles. In 1906, E. Leybold's Nachfolger began working with him. From 1906 until his death, the consulting contract with E. Leybold's Nachfolger in Cologne enabled him to continue his research in his private laboratory, first in Karlsruhe and later in Munich.

His creative mind put previously held opinions to the test such as the idea, for example, of using the laws of motion for gas molecules themselves (contained in the kinetic gas theory) to create a vacuum. After studying the fundamentals of this theory in depth, the molecular pump was introduced in 1912, followed in 1915 by the diffusion pump: magnificent creations of unknown effectiveness. And, as is the case with groundbreaking inventions, Gaede was forced to abandon some of his previous beliefs when he developed this principle. And with great success: today, the diffusion pump dominates laboratories and factories all over the world.

In 1919, Gaede moved to Karlsruhe Technical University as Professor of Experimental Physics, where he worked in the following research areas: vacuum technology, radio and communications engineering, processes for obtaining pure hydrogen and mercury, research into lightning protection devices, and movement of liquids in a rotating hollow ring.

Gaede held almost 40 patents in Germany as well as numerous patents abroad.



09/25/1913
Granting of the **Patent Device for Evacuation**
(patent for diffusion pump)

TRADITION MEETS MODERNITY

After 170 years of company history, the development and production of vacuum pumps **continues in the tradition of Ernst Leybold and Wolfgang Gaede...**

Leybold, part of the Swedish group Atlas Copco, is today one of the world's leading suppliers of vacuum technology and system solutions. With subsidiaries, dealers and representatives worldwide, the company offers its customers one of the most extensive service networks in the vacuum technology industry. Its product line includes backing pumps, high and ultra-high vacuum pumps, vacuum systems, vacuum gauges, leak detectors, components and valves, as well as consulting and engineering for complete vacuum solutions for specific customer applications.

Through the DRYVAC product line for example, the company launched a compact dry compressing screw vacuum pump for industrial applications. The integration of a frequency converter directly on the pump helps save costs when connected to the electrical periphery.

To run existing vacuum processes as optimally as possible, the versatile functions of their frequency converters can be individually adapted. These robust pumps are able to withstand applications that generate large amounts of dust and vapor.

But back to the history: In 1967, E. Leybold's Nachfolger merged with Heraeus Hochvakuum GmbH. Up to this point, Dr. Manfred Dunkel had led the company for 36 years and had made significant contributions to the company's worldwide recognition through expansion of the product line. On October 1, 1987, Leybold Heraeus was renamed Leybold Aktiengesellschaft, and the company headquarters moved from Cologne to Hanau. In 2006, the trademark was used exclusively by Leybold Vacuum.

1850

Working independently of each other, company founders Ernst Leybold in Cologne and Wilhelm Carl Heraeus in Hanau lay separate foundations for subsequent high-tech firms

1967

Leybold merges with Heraeus Hochvakuum to form Leybold-Heraeus

1994

Oerlikon-Bührle acquires Leybold Group and merges it with Balzers to form Balzers & Leybold

Oil Diffusion Pumps

2004

Rebranding to

Leybold vacuum

2006

Rebranding to

œrlikon leybold vacuum

2016

Rebranding to Leybold, now part of the Atlas Copco Group

Leybold

NO DIGITAL COMMUNICATION WITHOUT VACUUM!

Computer (1941)

The microelectronics revolution is closely related to the vacuum technique. Beginning in the 1950s with the growth of tailored semiconductor materials, the size of transistors (MOSFETs) had been dramatically reduced. Harsh processes under low pressure challenged vacuum equipment from the start. Vacuum pumps developed for this industry have become standard. Nowadays XUV lithography requires enormous vacuum equipment just to generate the light that is used to pattern the semiconductors.

DR. MANFRED DUNKEL

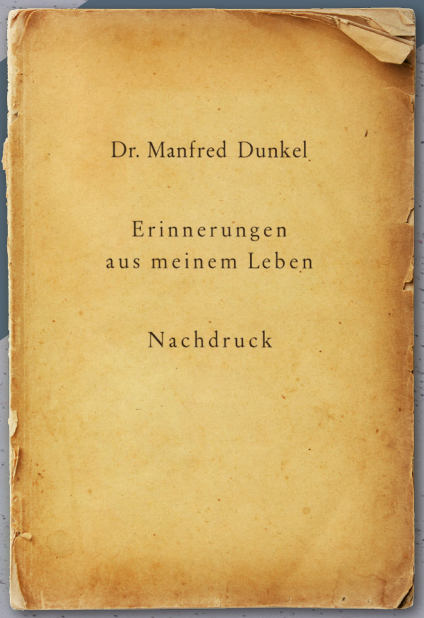
Company owner and founder of the GAEDE Archives

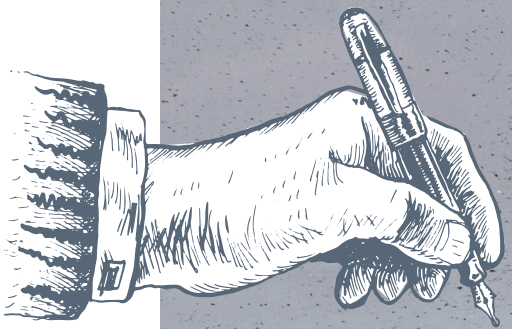
* 11/27/1898 in Bremen (Germany)
† 04/26/1985 in Cologne (Germany)

Manfred Dunkel took over the Cologne-based company, a special factory for high-vacuum pumps and scientific teaching materials founded by E. Leybolds' Nachfolger, from his father-inlaw, Alfred Schmidt in 1931. Using the vacuum technology developed by W. Gaede, a university professor in Karlsruhe, he succeeded in expanding the process of high-vacuum technology. In 1952, he founded the subsidiary Leybold-Hochvakuumanlagen GmbH. In 1967, under his direction, the two companies merged with the Heraeus vacuum department in Hanau to form the Leybold Heraeus GmbH & Co.

In 1968, he retired into private life. Dunkel held numerous honorary positions and received numerous awards. From 1964 to 1966, he was chairman of the metal industry's employers' association in Cologne, and from 1950 to 1969, he served as a board member of the association of German precision-mechanical and optical industry e.V. as well as a lay judge, commercial and employment judge in Cologne. Manfred Dunkel established the GAEDE Foundation in 1984 and laid the groundwork for its assets.

Dr. Manfred Dunkel
Company owner and GAEDE Archive founder





Memories from my life

At Leybold in Cologne

I have reported on the turbulent events at Leybold in Cologne in the summer of 1931 and on the redevelopment measures carried out at that time in the company's history in addition to my meeting with Gaede. I became good friends with him after the performance in Mannheim, had visited him in Karlsruhe and saw his work. We then went skiing on the Feldberg at Easter to discuss our problems. There, I also met his sister, Hannah, who was his evil spirit. Whenever the "little wolf" was interested in a female being, Hannah stepped in. Staying on the Feldberg, the friendship between Gaede and I became stronger, especially since he had already declared at that time that I was better suited to the management of Leybold than my father-in-law.

On Easter Saturday or Easter Sunday, a holiday dinner was held at the Feldberger Hof, with all the gentlemen in dark suits or tuxedos and the ladies in elaborate evening dresses. Who can describe my horror when Hannah – arriving so late that everyone could see her – walked through the hall! I must say that she was a stately apparition in the manner of the Wagner singers of past decades.

She probably originally wanted to be on stage, but later became a singing instructor. She wore her hair in an Art Nouveau style with snails above her ears, and from there on her body grew bigger and bigger, since she was a reformer and apostle of nature and, of course, did not wear a corset. She appeared in a grey cardigan, with slippers on her feet, and took her place at our table, where I would have liked to sink into the ground. Not a word was heard in the hall. The first words that were audible were Hannah's expressed disapproval of the change in customs at the Feldberger Hof. In earlier years, no one would have thought of coming to a winter sports hotel in a dinner jacket. I could only gesture my horror to two nice Jewish girls at the next table, with whom I had become friends and who were as shocked as I was.

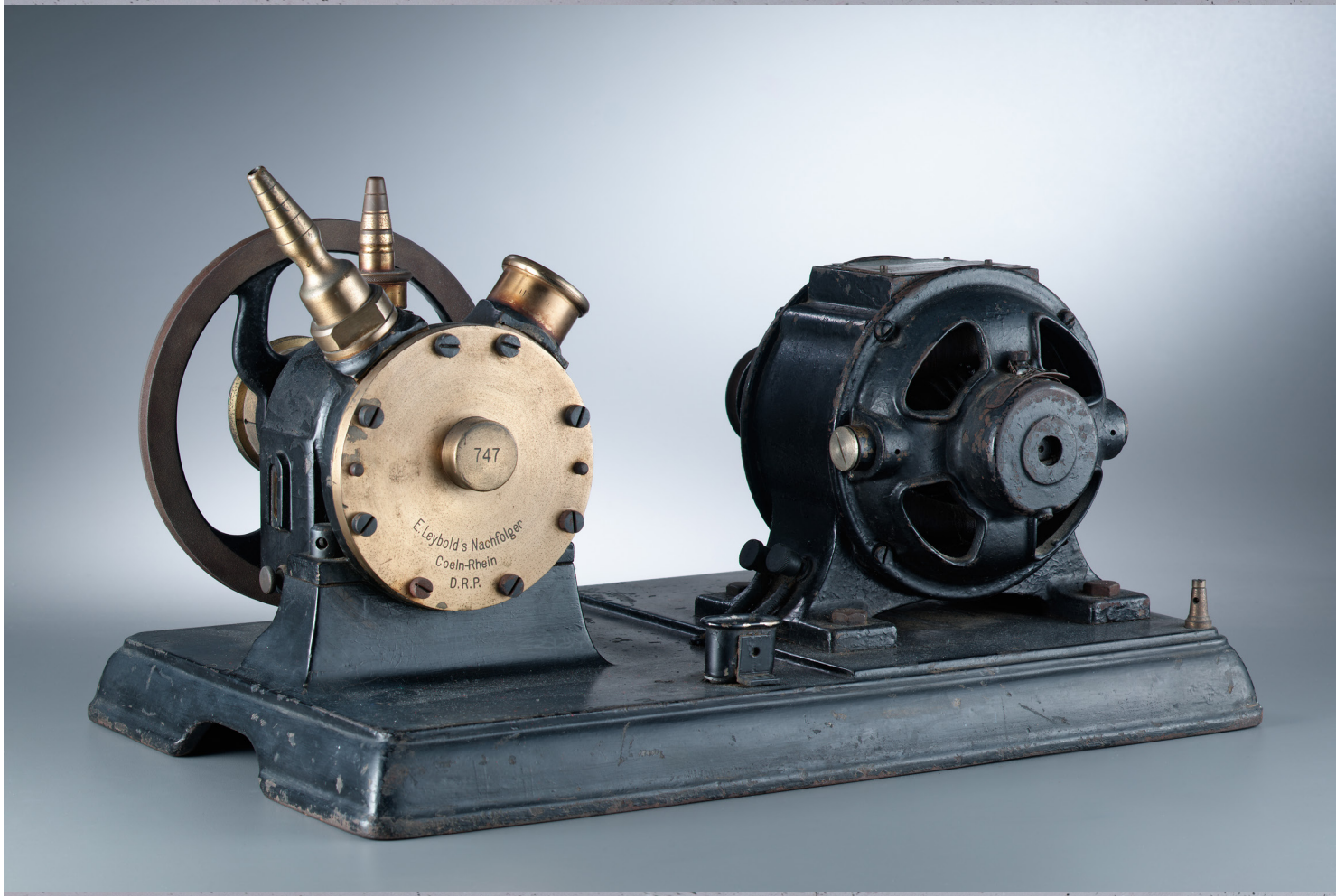
Gaede was not Leybold's only intellectual asset. Dr. Krönke in Berlin had made a connection with Manfred von Ardenne, whose cathode ray tubes, including control units, were distributed exclusively by Leybold. Orders eventually increased so much that v. Ardenne could not keep up with deliveries, so we founded a joint company for production and distribution.

Another major event was the takeover of the Sprenger teaching materials company in the summer of 1932 and the entry of Albin Sprenger into the Leybold's management team. As described in detail in the company history, the second half of 1931 was entirely devoted to restoring financial liquidity and reorganizing Leybold. My wife was actively involved in that process, and from January 1932, I had the company firmly under control.

However, the efforts and excitement had taken over my wife and I so much that we supposedly went skiing in the southern Black Forest over Christmas but in reality, we slept in for ten days. I used the second half of December to visit Leybold's foreign representatives, who did not meet my financial expectations.

Autumn 1981

Manfred Dunkel


747
E. Leybold's Nachfolger
Coeln-Rhein
D.R.P.

Gaede-Stiftung

Donated in 1984 by Manfred Dunkel,
it is commonly known as the
“GAEDE-Stiftung Preis”.

The GAEDE Prize, donated by Manfred Dunkel and sponsored by Leybold in Cologne, has been awarded annually since 1986. The prize is awarded in recognition of outstanding work in research and applications in the following fields: vacuum physics and technology, thin films, surface physics, materials and methods of solid state electronics and nanoscience and technology.

The prize consists of a certificate, a model of Gaede’s molecular (air) pump from 1912 and a cash prize of 10,000 euros. Considered are outstanding achievements of young scientists who, at the time of the proposal, have not yet been offered a permanent position as a university professor or similar position in a research institution or in industry, and are generally less than 40 years old.

The research achievements to be awarded must be published in peer-reviewed scientific journals. In addition, reference may be made to recognized doctoral or habilitation papers or other evidence. Both third-party nominations and self-nominations are accepted.

NO COLD FOOD WITHOUT VACUUM!

Refrigerators (1876)

Servicing refrigerators and air conditioners requires unclogging the cooling circuit and adding refrigerant. While the manufacturing method for refrigerators has remained largely unchanged, the type of refrigerant used is now less harmful. To ensure a humidity-free state, a vacuum of 10^{-2} mbar is used, which is typically achieved with two-stage rotary vane pumps. Vacuum is also used in checking compressor and charged cooling circuits.

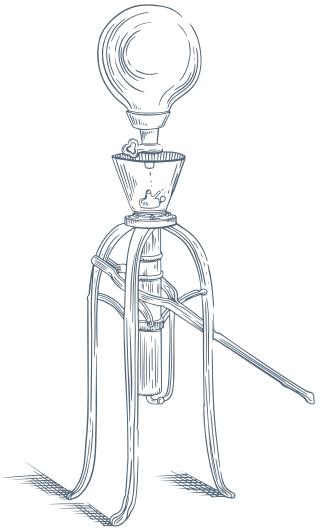
1850 2020 PIONEERS FOR 170 YEARS

INTERVIEW WITH DR. GERHARD VOSS

Studies: **Diploma in Physics**
Highest Degree Completed: **Doctorate**
Joined Leybold: **December 1, 1984**

Dr. Voss is one of Leybold's longest-serving employees. He is in his 60s and still works two half-days per week. Dr. Voss heads up the Gaede Archive and enjoys collecting old pumps and historical documents.

When did you first start working at Leybold? What department did you work in?
I started in the Technical Sales Department VV3 at the end of 1984. I was selling refrigerators for superconducting magnets used in magnetic resonance imaging.



You were with Leybold for a very long time. Looking back, what was your best time?
That would've been my last ten years, from 2005 to 2015, when I was head of the Vacuum Academy. We really got to know our customers along with many interesting people.

When was the Geade Archive established?
The Gaede Archive was established by Dr. Günter Reich († 1997) around 1990. Dr. Reich collected the exhibits on the life and work of Wolfgang Gaede, and it's these pieces which form the actual collection. I took over the Gaede Archive on July 1, 2017, and tried to make the exhibits more appealing to visitors.

Where do you see the Gaede Archive in the future?
We need to keep Wolfgang Gaede and Leybold's past in our rear-view mirror. Without Wolfgang Gaede's inventions, Leybold would not have survived the world economic crisis which began in 1929 and lasted nearly ten years. In the future, I'd like to present the Gaede Archive in such a way that it's accessible to everyone. It contains so many interesting things from Leybold's history which, unfortunately, would otherwise be forgotten.

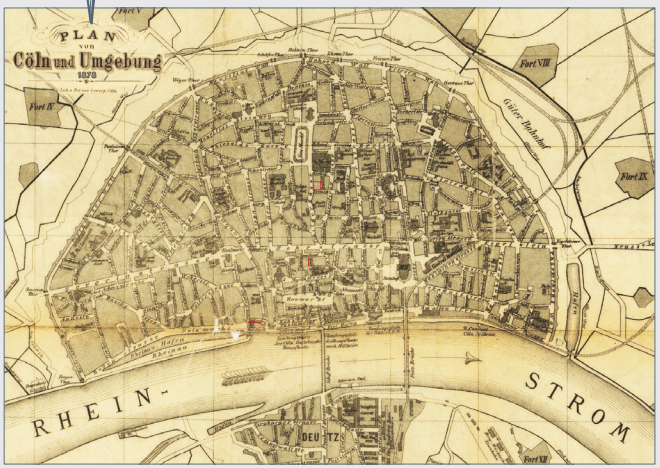
What is the most valuable exhibit in the collection?
Gaede's molecular air pump from 1912 and his rotary vane pump with its gas ballast device from 1936 (the year the Olympic Games were held in Berlin). Both are the world's first.

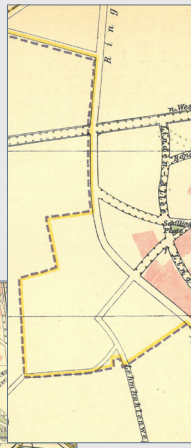
Would these interest young people in vacuum technology?
Yes, I would say, of course. You cannot see, hear, smell, or touch vacuum, but every microchip has gone through this state several times during its manufacturing process. Only under vacuum can you produce the objects that people today can't live without. Without vacuum technology, we'd be stuck in 1900. Though admittedly, one could live back then, too.


PT 450
COOLPAK
2000 A

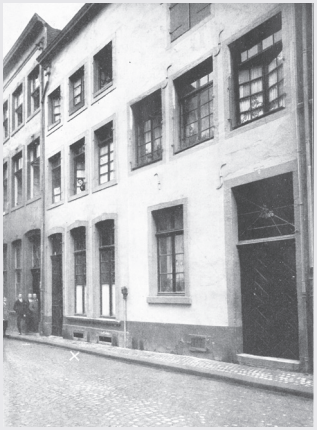
LEYBOLD: IN COLOGNE SINCE 1850

It was not until 1957 that Leybold moved to its current company headquarters at **Bonnerstraße 498.** Before that, several moves within the city had taken place...





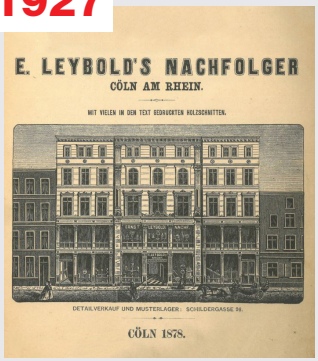
1863–1927



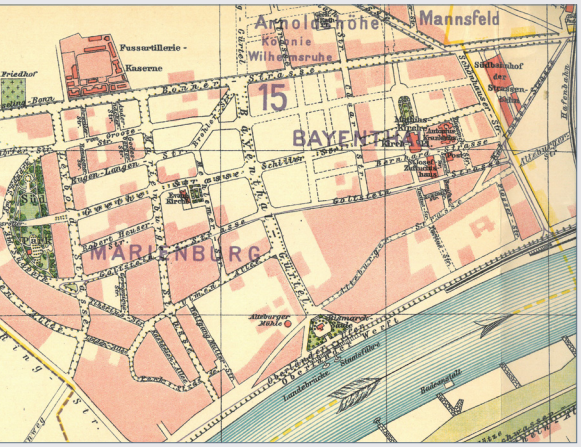
1854–1857
House no. 9 on Lyskirchen

1857–1863
Haus zum Pfau –
An der Sandbahn 10

Former brewers guild house on the Schildergasse



Schildergasse 96



1927–1983
Bonner Strasse 500

Brüderstrasse No. 1-7

Since 1957
Bonner Strasse 498

1850 2020 PIONEERS FOR 170 YEARS

Dr. Stefan Lausberg
Product Manager UHV

NOTHING ELSE MATTERS

Regarding the **dominance of vacuum in our universe.**

Vacuum is an unusual, exotic state for us humans in everyday life. Nothingness is difficult to comprehend and difficult to describe. The Universe, on the other hand, is "full" of Nothing. We have the pleasure to live on one of the rare islands of Something, which is virtually the opposite of Nothing.

If we could enlarge the smallest air particle to the size of a basketball, the distance to the next basketball, i.e., the next air particle, would be five meters. Between these particles, there is absolutely nothing. In other words, air basically consists of nothing and a small percentage of matter. The greater the distances in our universe, the more this disproportion is revealed.

If we now inflate the same basketball to the size of our sun, planet Earth would have only the size of a grain of rice. It moves around the sun once in a year at a distance of 23 meters. Again, there is nothing in between — apart from a negligible amount of residual gas and a few planets which would altogether be smaller than a mandarin orange.

The sun's closest neighbor is a star that – in these dimensions – would have only the diameter of a golf ball, and it would be as far away from the sun as Mumbai is from Cologne! When we move on to the more than one hundred billion stars in our Milky Way, the more than one hundred billion galaxies in our universe, and the distances between them, we encounter an ever-increasing empty space. We can be glad to live on such an exotic and wonderful planet as Earth, which is full of matter. Here, we even need to use vacuum pumps to create empty spaces for use in numerous applications.

ROUGH TO ULTRA-HIGH VACUUM: LEARN ABOUT THE DIFFERENCES

Rough vacuum pumps all the way to **high vacuum pumps** represent **specialized equipment.**

Rough and Medium Vacuum Pumps

Rough vacuum pumps range from atmospheric pressure and 1 mbar and medium vacuum pumps include pressures in the 1 to 10^{-3} mbar range. When working in rough and medium vacuum conditions, it is important to understand that each job needs to be evaluated to determine which pump is right for it. No single pump is going to be the right option for every job being performed.

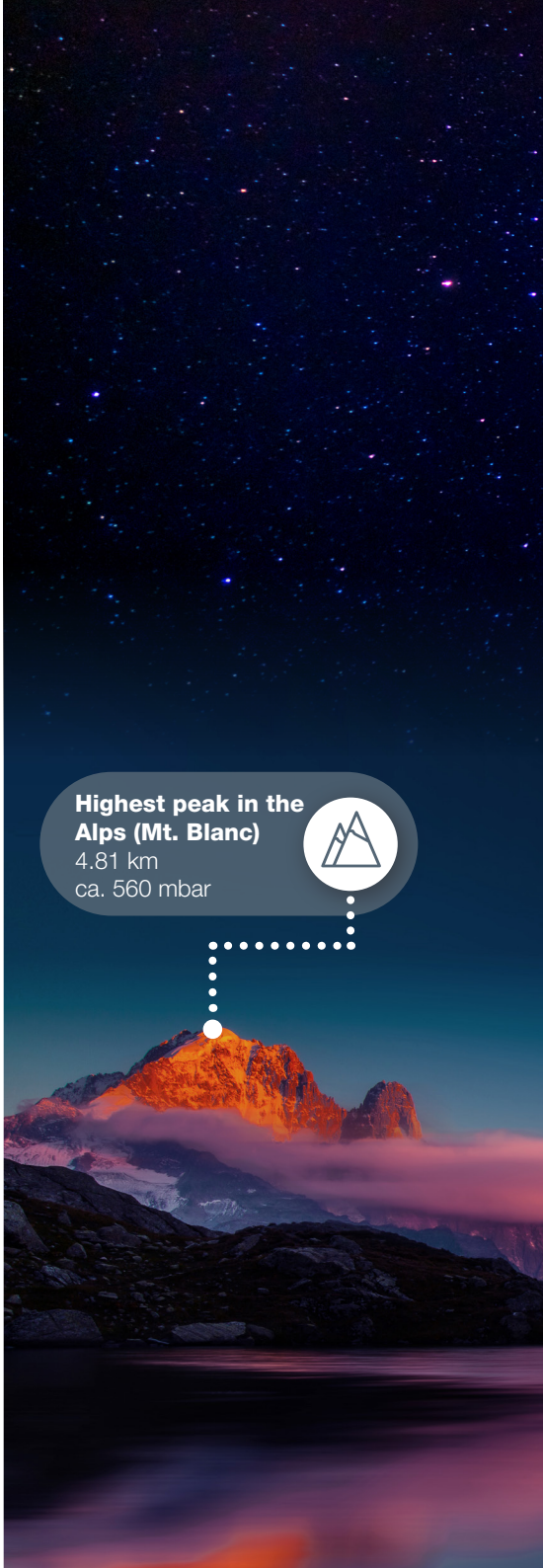
Many of these vacuum pumps are used to support higher-level vacuum pumps. If rough vacuum pumps were not used, the higher-level pumps would not be able to work efficiently. In some instances, they would not be able to work at all.

These categories include the following types of vacuum pumps:
Diaphragm pumps, Scroll pumps, Rotary vane pumps, Screw pumps, Roots pumps

High Vacuum Pumps

The pressure range for high vacuum (HV) pumps is between 10^{-7} and 10^{-3} mbar. HV pumps are generally used for industrial purposes.

These include:
Coatings, Composite plastic moldings, Electron microscopy, Flight instruments, Mass spectroscopy, Medical applications, Vacuum tubes



Ultra-high Vacuum Pumps

Ultra-high vacuum (UHV) pumps operate at pressures between 10^{-7} and 10^{-12} mbar. UHV pumps are generally associated with work being performed in the nuclear research and high-energy physics fields. At this level, turbomolecular pumps and ion getter pumps are used.

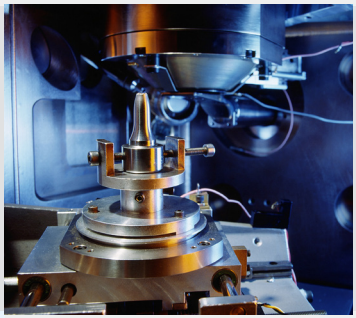
Extreme High Vacuum Pumps

The pressure range for extreme high vacuum (XHV) pumps is generally defined as readings of 10^{-12} mbar and lower. This type of pump is linked to levels found in outer space. One would expect to find these levels when working with orbiting satellites.

There is a specific pump that is appropriate for each type of application. Thoroughly analyzing the conditions and the materials being used is a key part of choosing the right pump and getting the best results.

FOCUS ON MARKET SEGMENTS

Analytical
Measurement and analysis technology, Electron Microscopes, Spectrometers, Leak detectors



Charging
Evacuation, Filling & Testing of Lamps, RAC cooling circuits, Brake-liquids lines, cooling circuits, gas-bottles, heat-pipes, etc.

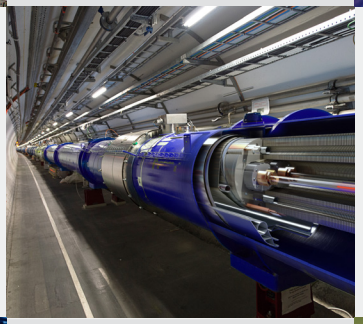
Semi & Solar
Production of wafers and solar modules. Photovoltaic and Semiconductor Coating, Lamination of solar modules, Si-crystal pulling

Coating
Large Area Coating (Architectural glass), Display (LCD-OLED), Wear protection, Optical coating, Reflector Coating

Chemical & Pharma
Chemical / pharmaceutical Industry, machine manufacturing for a.m. industries, incl. Pharma freeze dryers

Plastic & Composite Processing
Processing of polymers, plastics, rubber or composite materials. Production of related machines

Utility Vacuum
Pick & Place machinery, CNC routers, sewage or water degassing, bottle forming, stone or tile production, vacuum cleaning, etc.



Research & Development
Universities and Institutes, R&D equipment manufacturers, Big research centers, Space simulation

Energy & Electro
Energy Production, Electronic components, Transformer Drying UF6 enrichment, Fly Wheel, Energy Storage (e.g. Lithium Battery)

Food Processing and Packaging
Equipment for processing or packaging of food or similar products, food producers. Botanical processing.

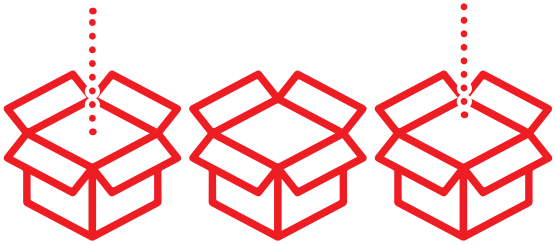
Furnace & Metallurgy
Steel or special metal production
Heat processing of metals in furnaces
Metal welding (E-Beam, Plasma

General Industry
Machines & parts e.g. for Industrial Cleaning, Sterilization, Plasma Applications, Leak testing, Drying, Laser. Vehicle construction (automotive)

SINCE 1850 EXPERIENCE

1906
Professor Gaede developed the first **Molecular Pump**

30,000
Products



More than
1,700
Employees Worldwide

58
Locations Worldwide

More than
50,000
Satisfied Customers

1850 | 1900 | 1950

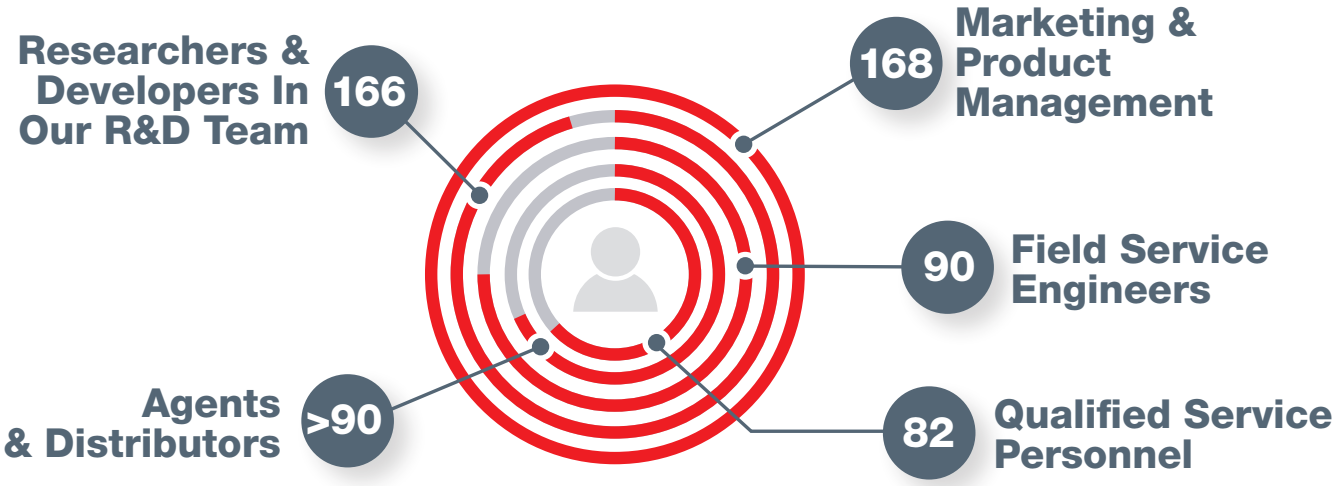
IN VACUUM TECHNOLOGY

Manufacturing Facilities
7

Service Technology Centres (STC)
10

Sales & Service Offices
32

Technicians In-House
84



1850 2020 PIONEERS FOR 170 YEARS

2000 2010 2020

LEYBOLD: ONE BIG FAMILY FOR 170 YEARS

Leybold is more than a one-generation-employer!

Looking back at the staff history, you will find that some names appear several times in different years and departments. Simply coincidence? Not always!

The **Meyer family** for example is represented with Leybold for three generations. First, Herbert Meyer joined in 1954 as a precision mechanic. 23 years later, his son Wolfgang started his apprenticeship in the sales Department. Well, it's no surprise to see that his grandson, Wolfgang's son Sven is now also working at Leybold!

The story of this family doesn't end here! Sven Meyer met his wife at Leybold and, who knows, maybe his own child will continue this successful family story at Leybold.

Out of 170 years of Leybold, the Meyer Family counts 96 years of employment.

From left to right:
Sven Meyer,
Wolfgang Meyer

Another example of long-lasting affiliation to the company is the **Werner family.**

The story began quite differently however: In 1978 Gotthard started his apprenticeship, and upon completion, began his new job in the accounting department where he still works to this day. In spite of the world economic crisis in 2008, Leybold still recruited young talents for securing the future. Among them was Gotthard's twins Hannah and Tobias! Both started their apprenticeship as industrial clerk that year.

Now both are still working for Leybold, Hannah in the demand center and Tobias at the service department.

From left to right:
Hannah Werner,
Gotthard Werner,
Tobias Werner

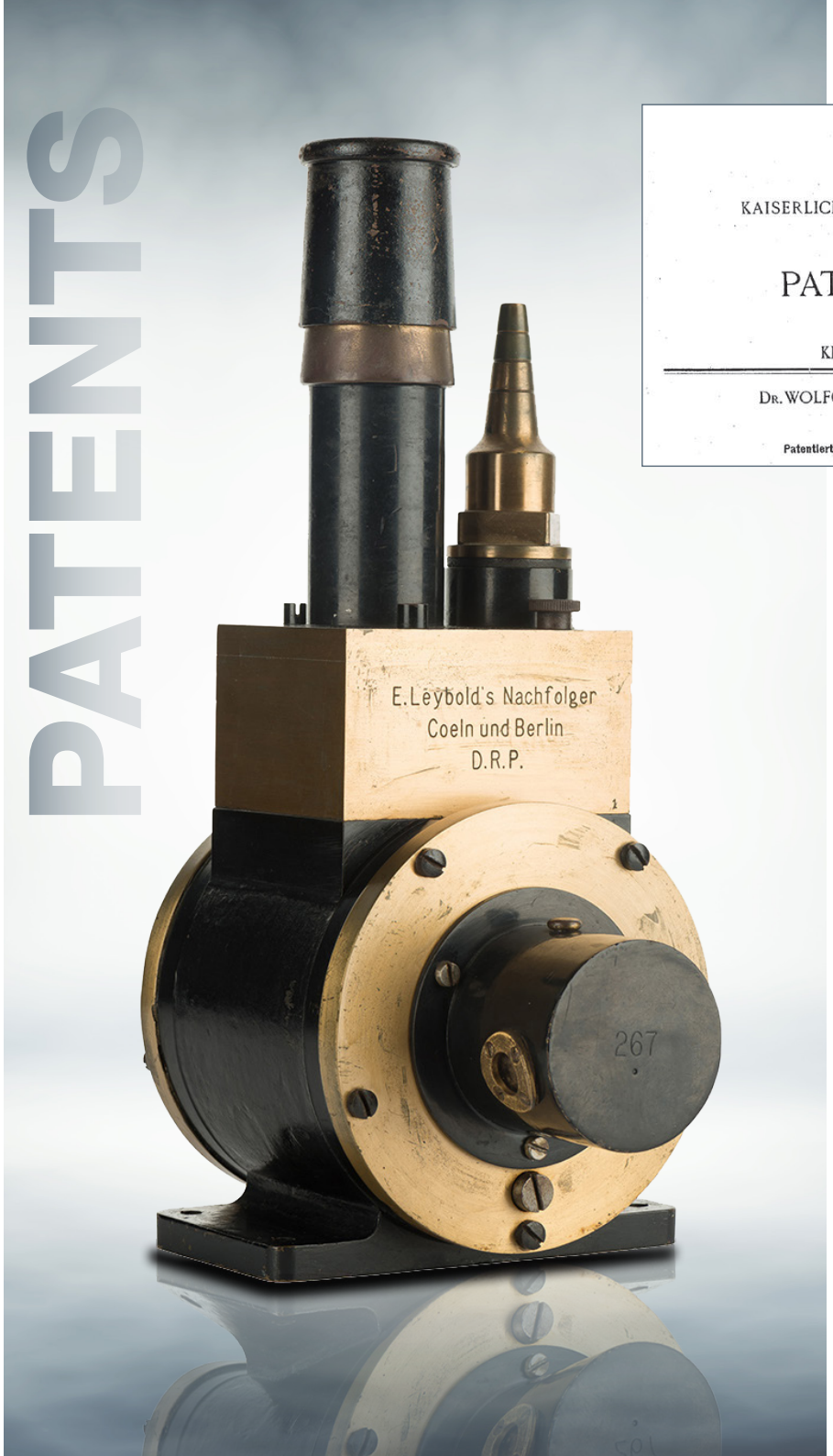
From left to right:
Severine Grimberg,
Lea Grimberg

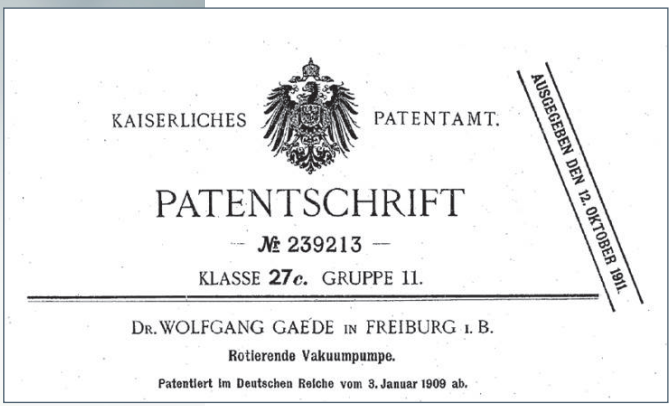
Our next family story is the one of the **Grimbergs**: Séverine started in 1998 at Leybold, her daughter Lea was one year old. Nobody knew at that time that Lea would also join the Leybold family in 2016.

Now Lea is working for the Service Department, where Séverine started and is also studying Marketing and Digital Media.

> These are just a few of the many examples of Leybold's ability to commit to its employees and even their family members. Leybold is proud to be a company with lots of multi-generation employees.

PATENTS





KAISERLICHES PATENTAMT.

AUSGEGEBEN DEN 12. OKTOBER 1911.

PATENTSCHRIFT

— № 239213 —

KLASSE 27c. GRUPPE 11.

DR. WOLFGANG GAEDE IN FREIBURG I. B.

Rotierende Vakuumpumpe.

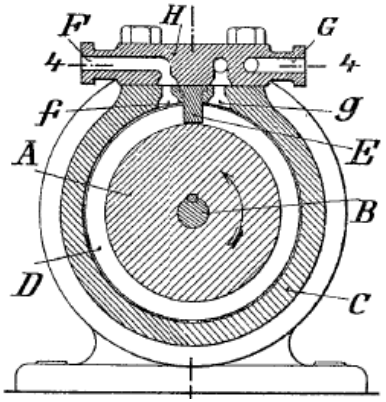
Patentiert im Deutschen Reiche vom 3. Januar 1909 ab.

In January 1909, the “Rotierende Vakuumpumpe” patent was granted by the Imperial Patent Office in Berlin. The patent’s owner was Wolfgang Gaede. His “Rotating Vacuum Pump” was the so-called “Molekular-(Luft) Pumpe” (Molecular Pump), the first dry compressing vacuum pump in the world which was oil-free and free of liquid mercury.

Later on, Gaede would describe the physical principle of his molecular pump in his habilitation treatise entitled, “Über die äußere Reibung der Gase”. “Äußere Reibung” refers to the fact that there is an interaction between a fast-moving wall and the gas mole-

01/03/1909

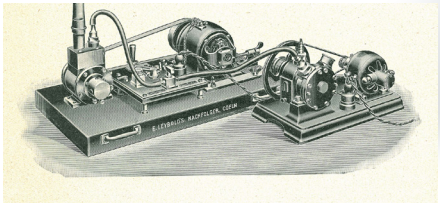
Granting of the
Rotating Vacuum Pump patent
(patent for the molecular air pump)



cules in a channel covered by this fast-moving wall. Gaede demonstrated that in such a system, gas molecules are dragged through the channel, generating compression. From the historical point of view, it's worth mentioning that Leybold manufactured Gaede's molecular pump exclusively for more than ten years, beginning in 1912.

Today, Gaede's basic principle on the dragging of gases through channels is used in thousands of turbomolecular pumps.

Gaede's "Molecular Pump" (left) and Gaede's "Rotary Vane Pump" (right)
Both pumps were built exclusively by E. Leybold's Nachfolger, Cologne, in a series. The picture is from the "Special Price List No. VI on molecular Pumps according to Dr. Gaede".



03/28/1908

Granting of the

Check Valve for the Outlet of Vane Pumps for pumping Gases

KAISERLICHES PATENTAMT.

AUSGEGEBEN DEN 2. OKTOBER 1908.

PATENTSCHRIFT

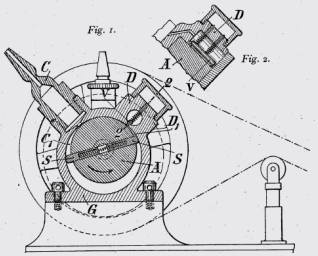
— № 225286 —

KLASSE 27c. GRUPPE 2.

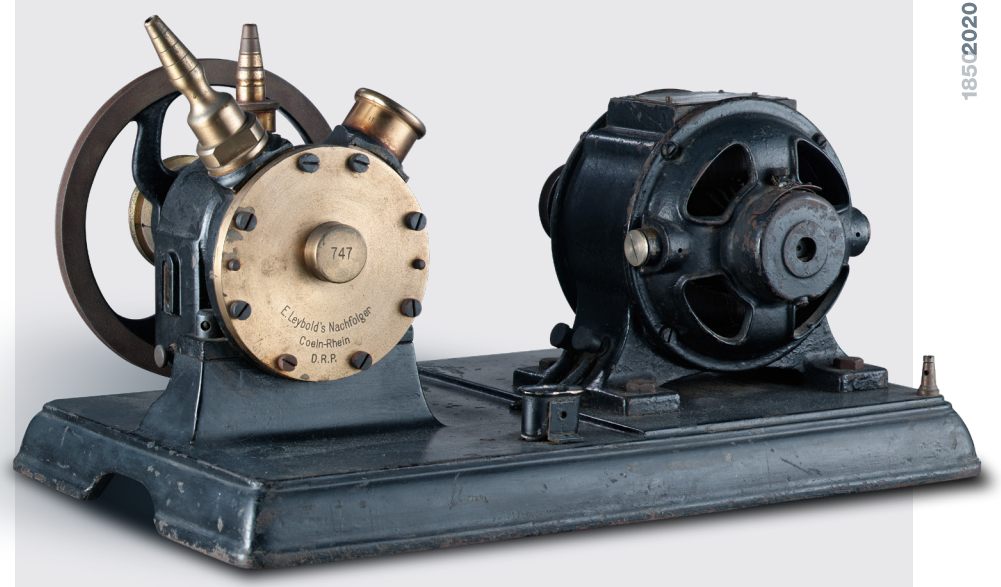
DR. WOLFGANG GAEDE IN FREIBURG I. BR.

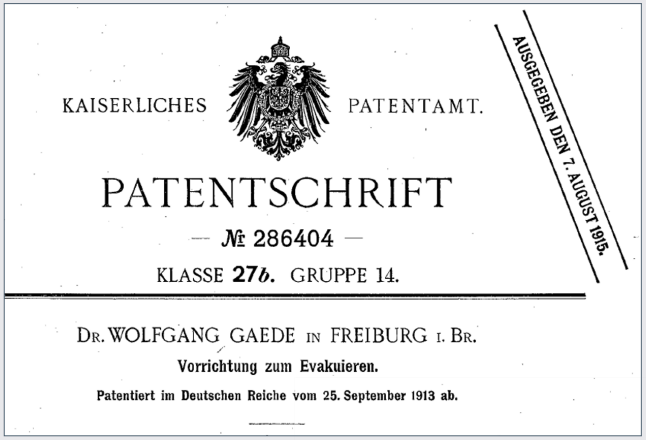
Rückschlagventil für die Austrittsöffnung von Kapselpumpen zur Förderung von Gasen.

Patentiert im Deutschen Reiche vom 29. März 1908 ab.



Gaede's patent implied that an oil-covered check valve for the outlet of a rotary vane pump improves the ultimate pressure of the pump significantly. As a consequence of this patent, Leybold's rotary vane pumps represented the benchmark for this type of vacuum pumps in the first half of the 20th century. Today, Gaede's patent is used in every rotary vane pump. E.g., Leybold's famous two-stage rotary vane pumps of the TRIVAC series achieve ultimate pressures of less than 0.001 mbar.





KAISERLICHES PATENTAMT.

AUSGEGEBEN DEN 7. AUGUST 1915.

PATENTSCHRIFT

— № 286404 —

KLASSE 27b. GRUPPE 14.

DR. WOLFGANG GAEDE IN FREIBURG I. BR.

Vorrichtung zum Evakuieren.

Patentiert im Deutschen Reiche vom 25. September 1913 ab.

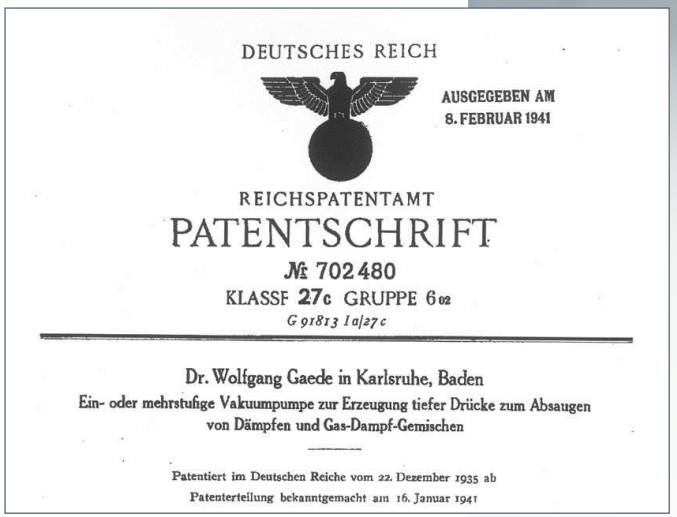
Wolfgang Gaede described the world's first propellant pump (better known as the "diffusion pump"): "The invention concerns a device for generating a high vacuum by means of diffusion." The patent title ensured that other developers with similar products would have to pay a licensing fee to Leybold in the early years.

09/25/1913

Granting of the
Patent Device for Evacuation
(patent for the diffusion pump)

84 years ago, in the Olympic year of 1936, Leybold began production of rotary vane pumps which featured a "gas ballast" mechanism. For the first time in the history of vacuum technology, these vacuum pumps had the ability to pump condensable vapors, in particular, water vapor. Wolfgang Gaede had developed "the gas ballast principle" between 1933 and 1935 in his private laboratory in Karlsruhe, sponsored by Leybold. Gaede's patent "Ein- oder mehrstufige Vakuumpumpe zur Erzeugung tiefer Drücke zum Absaugen von Dämpfen und Gas/Dampf-Gemischen"(*) was published in December 1935.

From a historical point of view, it's worth mentioning that Leybold held the exclusive rights to manufacture rotary vane pumps featuring Gaede's gas ballast mechanism. The gas ballast principle is characterized by "sophisticated simplicity" granting the ability to overcome the problem that vapors (in particular water vapor) condense in the pumping chamber of a vacuum pump during the compression cycle. Switching on the gas ballast creates a permanent gas flow which enters the pumping chamber of the pump during the compression cycle. Consequently, inside the pumping chamber, both the vapor and the ballast gas are compressed, however, in such a way that the vapor doesn't condense. Note that



DEUTSCHES REICH

AUSGEGEBEN AM
8. FEBRUAR 1941

REICHSPATENTAMT

PATENTSCHRIFT

№ 702 480

KLASSE 27c GRUPPE 602

G 91813 Ia/27c

Dr. Wolfgang Gaede in Karlsruhe, Baden

Ein- oder mehrstufige Vakuumpumpe zur Erzeugung tiefer Drücke zum Absaugen von Dämpfen und Gas-Dampf-Gemischen

Patentiert im Deutschen Reiche vom 22. Dezember 1935 ab

Patenterteilung bekanntgemacht am 16. Januar 1941

12/22/1935

Granting of the

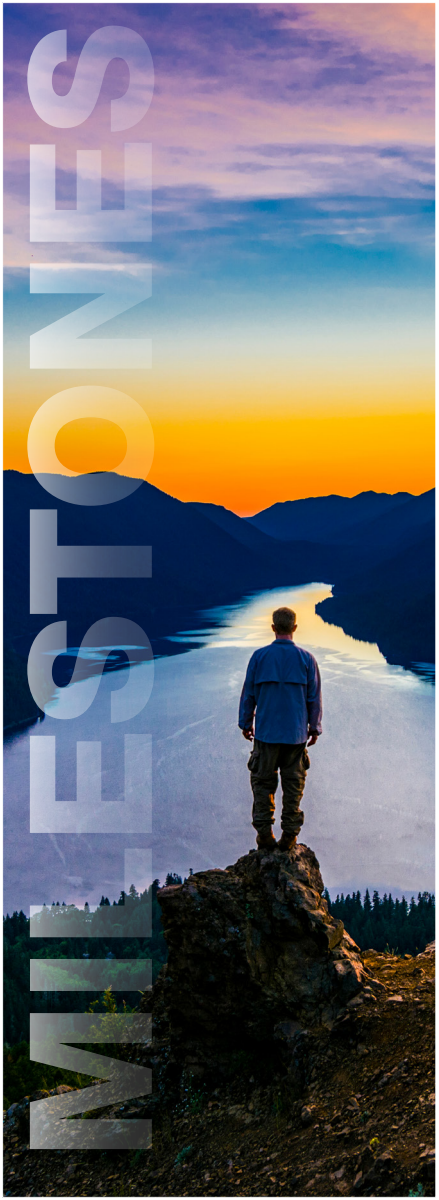
Single-stage or multi-stage Vacuum Pump for generating low pressures including the extraction of vapor and gas/vapor mixtures

(patent for the gas ballast principle)

the ballast gas flow is rated in such a way that the compressed ballast gas opens the exhaust valve (typically at 1200 mbar) before the compressed vapor condenses (in case of water vapor, this happens at a partial pressure of about 300 mbar). Consequently, and of prime importance, the vapor does not transform itself into a liquid but exits the pump as a vapor.

Nowadays, both rotary vane pumps and dry compressing screw vacuum pumps are fitted with the gas ballast mechanism. Generally speaking, each vacuum pump having the ability to compress the pumped gas to atmospheric pressure is currently fitted with the gas ballast mechanism.

(*) "Single-stage or multi-stage vacuum pump for the generation of low pressures for pumping vapors and gas/vapor mixtures"



PIONEERS WITH A PASSION FOR NOTHING

Leybold – from trading company to **world market leader in vacuum technology.**

When German politician and physicist Otto von Guericke postulated the existence of a vacuum 370 years ago in Magdeburg, he must have had confidence in his ideas. “Let’s give it a try,” was his answer to his critics. Their skepticism was not unexpected. They suffered from ‘horror vacui’ to such an extent that it caused them to blindly cling to the Greek philosophers’ school of thought that a vacuum could not exist. But Otto von Guericke was courageous and actually took a chance. His inclination to explore led him to experiment with the Magdeburg hemispheres, which he demonstrated using 16 horses. He placed two copper hemisphere shells on top of each other and sealed them with wet leather. After evacuation, the external air pressure held the hemispheres together so strongly that 16 horses could not pull them apart.

The courage and business acumen of innovative personalities

Even before this performance, von Guericke had invented the first piston vacuum air pump in ***1649.*** In ***1643***, the Italian physicist and mathematician Evangelista Toricelli had even used a mercury-filled tube to prove that the air was empty - without a pump. However, nobody could have guessed how much more this nothingness would achieve. Some 250 years passed before economic benefits would be derived from these findings, whose development was also initiated by the courage and business acumen of innovative personalities.

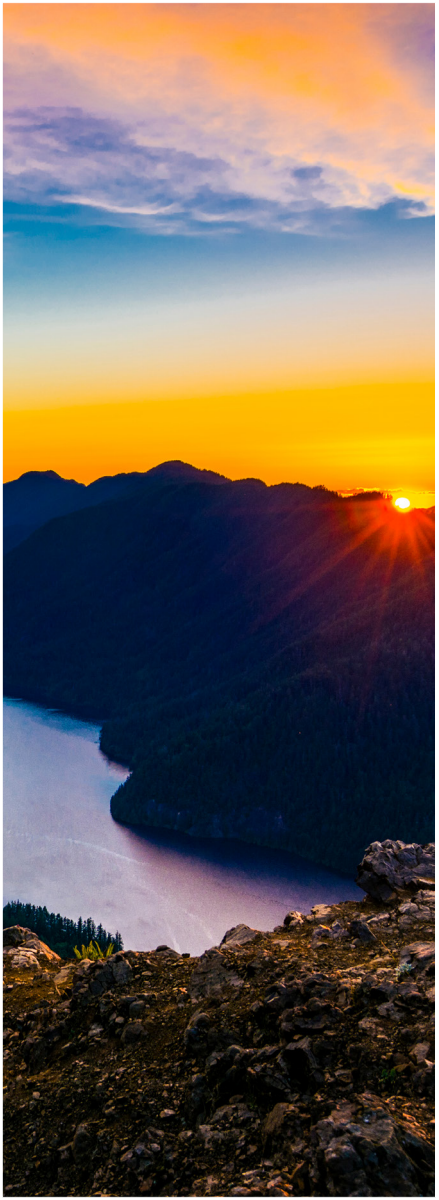
Businessman Ernst Leybold laid the foundation for this when he moved from Rothenburg ob der Tauber to Cologne in ***1850*** and founded his first company, which began as a sales and import business for medical

1850 **1860**

glassware, ointment pots, thermometers and scales. In ***1854,*** Leybold expanded his line of products to include physical, pharmaceutical and chemical equipment. In ***1863,*** he finally took over the company under the name E. Leybold. In ***1870,*** Ernst Leybold sold his business, which, however, continued to operate as E. Leybold's Nachfolger.

In ***1871,*** the product line included as many as 585 pieces of physics equipment, as well as "Physics Cabinets" (complete collections of equipment and instruments) which were offered for the first time. The company's history proudly records an order received from Quito University, Ecuador, worth 30,000 Thalers (approx. 250,000.- dollars by Today's standards}. This established LEYBOLD as a company of international reputation.

In ***1876,*** the first catalogue of physics equipment was published for use in secondary and high schools. This product line was gradually expanded to include chemical apparatuses for laboratories. A special brochure on Crookes' experiments followed four years later, from which we quote the following, "There is no doubt that the new and often exciting developments in high vacuum will incite further experiments". To demonstrate such experiments, the Toepler Pump, an early positive displacement vacuum pump which was manually operated by alternately raising and lowering a mercury column, was included in the catalogue.



1906

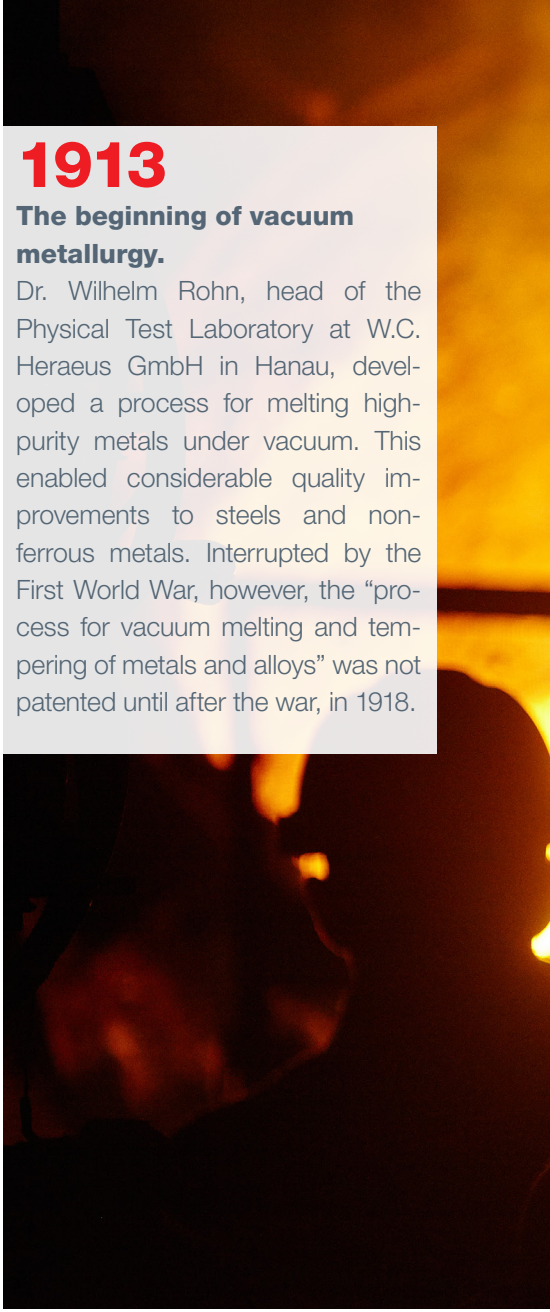
Innovations of undiminished importance.

The triumphal procession of vacuum technology began in 1906 through collaboration with Dr. Wolfgang Gaede, Professor of Physics in Karlsruhe. Gaede was a researcher par excellence whose credo was, “If I pursue an idea out of scientific interest, I always come up with an invention.” Leybold’s cooperation with Gaede was correspondingly fruitful. It produced important innovations that are still relevant today: the invention of the molecular air pump, the basic principle of the turbomolecular pump (1911) and the use of the diffusion pump (1913). Diffusion pumps have no moving parts. Their operating principle is based on vaporous propellants and results in reliable, lowmaintenance operation. These robust, inexpensive “workhorses” continue to be used in applications today. Gaede’s 1935 patented gas ballast device for the efficient pumping of vapors can still be found in many vacuum pumps.

1913

The beginning of vacuum metallurgy.

Dr. Wilhelm Rohn, head of the Physical Test Laboratory at W.C. Heraeus GmbH in Hanau, developed a process for melting high-purity metals under vacuum. This enabled considerable quality improvements to steels and non-ferrous metals. Interrupted by the First World War, however, the “process for vacuum melting and tempering of metals and alloys” was not patented until after the war, in 1918.



1929-1931

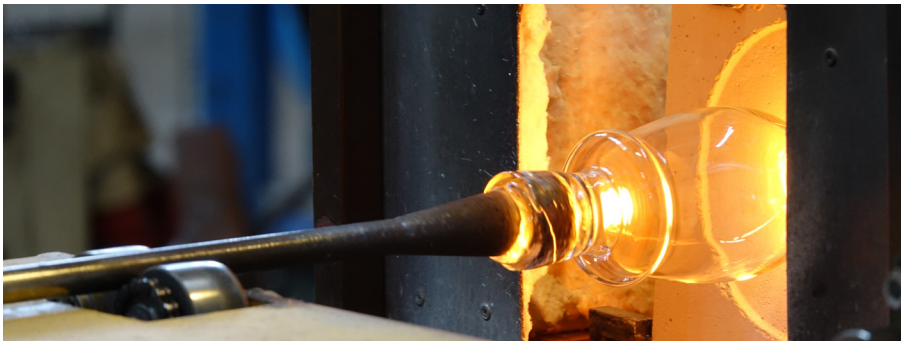
As a result of the world economic crisis, Leybold entered into insolvency.

1931

Wilhelm C. Heraeus succeeded in vaporizing metals onto glass.
This was another milestone in vacuum coating technology. In the same year, E. Leybold's Nachfolger, Dr. Manfred Dunkel, took over as managing director and successfully led the company until 1967. This era was significant, as vacuum technology was increasingly used in industrial applications during this time. Accordingly, in addition to technical and scientific knowledge, significant management skills were also required in order to transfer the findings to process engineering applications.

1934

On December 13, Gaede received the Siemens Ring.
The Siemens Ring Foundation was established by industry and scientific representatives in Germany in 1916 to commemorate Werner von Siemens' 100th birthday. In accordance with §1 of its statutes, the foundation pursued the goal of honoring individuals "who have rendered outstanding and generally recognized services to technology in conjunction with science. ... [The Siemens Ring] should therefore be awarded to representatives of technology who have stimulated science through their achievements as well as to representatives of science who have opened up new areas of technology through their research."



1939–1948

During the Second World War, Leybold serves the war effort, and is therefore progressively outsourced from Cologne beginning in 1941.

The most important new production facility is located in St. Andreasberg in the Harz.

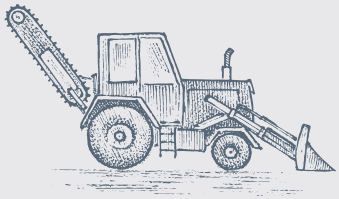
1945

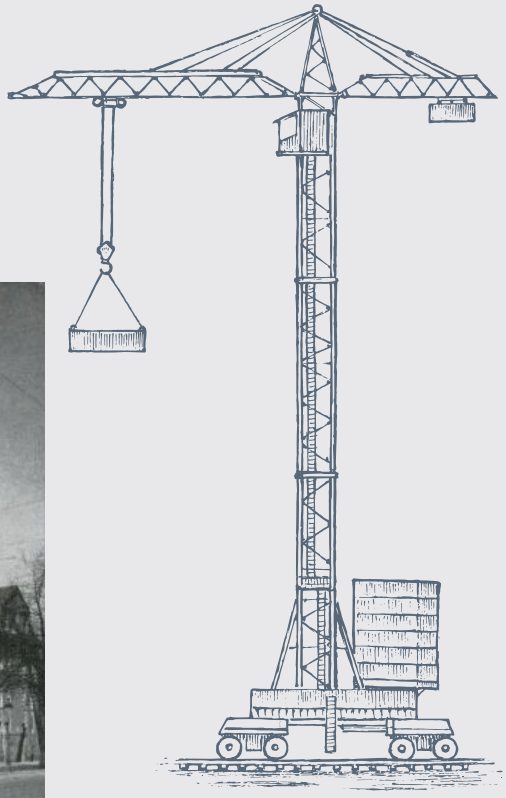
On June 24, Wolfgang Gaede dies in Munich from diphtheria.

1948–1957

Leybold gradually returns to Cologne.

The first half of the 1950s is marked by the company's reestablishment at its former location in Cologne.





1936

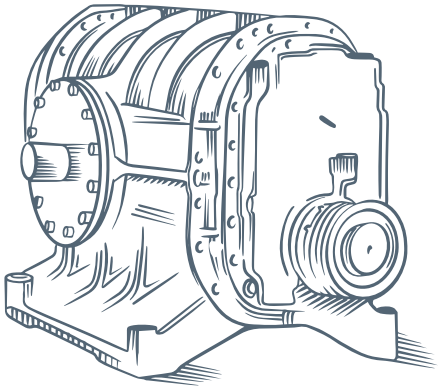
1945

1957–1967

These 10 years are characterized by the expansion and extension of Leybold's product portfolio.

Its most significant new designs center around "roots pumps" (today, referred to as "roots blowers"), "which meet the requirements of large-scale industry". The catalogue reads: "Modern vacuum process engineering requires high flow rates in the fine vacuum range for a significant part of its processes. In fine vacuum processes, for example, large quantities of gas and water vapor are produced at pressures below 1 torr. Vacuum technology is therefore faced with the task of economically/efficiently pumping off these quantities of gas."

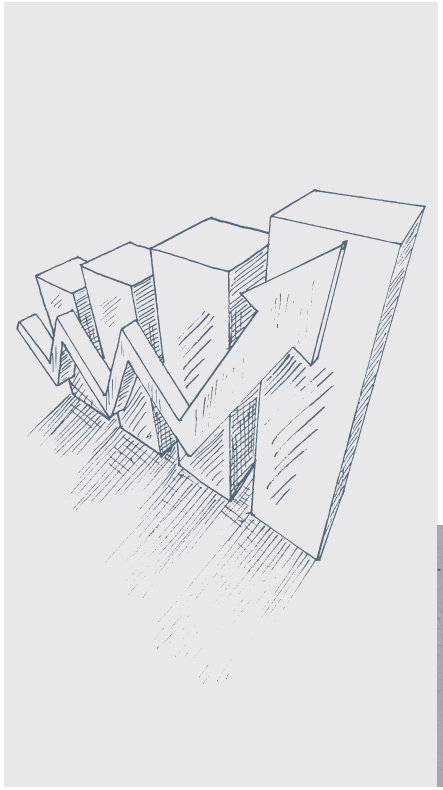
Major effort was dedicated to the fields of vacuum impregnation, chemical processing, pharmaceuticals and the freeze-drying of foods as well as high and ultra-high vacuum coating plants, metal degassing, etc. At the same time, E. Leybold's Nachfolger continued on a large scale the development of standard vacuum components, such as pumps, valves and gauges for all vacuum pressure lines, leak detectors and the steady expansion of its line of scientific and technological teaching tools.



1967

The merger of E. Leybold's Nachfolger with Heraeus Hochvakuum GmbH was confirmed.

The new company was named Leybold-Heraeus GmbH, and its shares were equally divided among Degussa, Metallgesellschaft and W.C. Heraeus



1967–1987

The expansion continues!

These years saw a significant expansion of the plants in Cologne and Hanau as well as a stronger presence in world markets. The 1980's in particular were marked by rapid growth.

1987 brought significant changes to the ownership structure. At the beginning of March, Metallgesellschaft AG withdrew as shareholder in the course of its restructuring measures. As a result, Degussa AG and W. C. Heraeus GmbH each became 50 percent shareholders. On September 30, W.C. Heraeus transferred its shares to Degussa, which then became the sole shareholder. Degussa, in turn, decided to transform Leybold Heraeus GmbH into a stock corporation effective October 1. Since then, the new company name has been Leybold Aktiengesellschaft: a Degussa Company. The registered office of Leybold AG was moved from Cologne to Hanau. Its physical proximity to Degussa's headquarters in Frankfurt facilitated cooperation between the two entities.

1994

Degussa sold the Leybold AG to the "Oerlikon-Bührle Group", located in Pfäffikon, Switzerland.

All divisions became independent GmbHs (LTDs). Cologne remained the headquarters for the vacuum-pump technology division, and Hürth remained the scientific teaching materials division. Vacuum-process engineering stayed in Hanau.

1966

1975

1975

The first Leybold magnetically-levitated turbomolecular pump was introduced.

In the mid-1970s, a new era of high vacuum technology officially began and was referred to as “the era of the magnetically-levitated turbomolecular pump”. Leybold-Heraeus was the first vacuum company in the world to make such a pump commercially available. In the 1980s and 1990s, the magnetically-levitated turbo molecular pump became the most important high vacuum pump in the semiconductor industry, due to it being a hydrocarbon-free high vacuum pump. Electromagnets are used in the “bearing” of the rapidly-rotating inner parts.

1983

The TRIVAC B oil-sealed rotary vane vacuum pump with integrated oil pump made its debut, and achieved great success.

This type of pump is, in fact, still widely used in many vacuum applications today. For customers who are able to accept oil molecules in their vacuum tanks, the rotary vane vacuum pump makes for an extraordinarily powerful and reliable pump for both rough and fine vacuum.

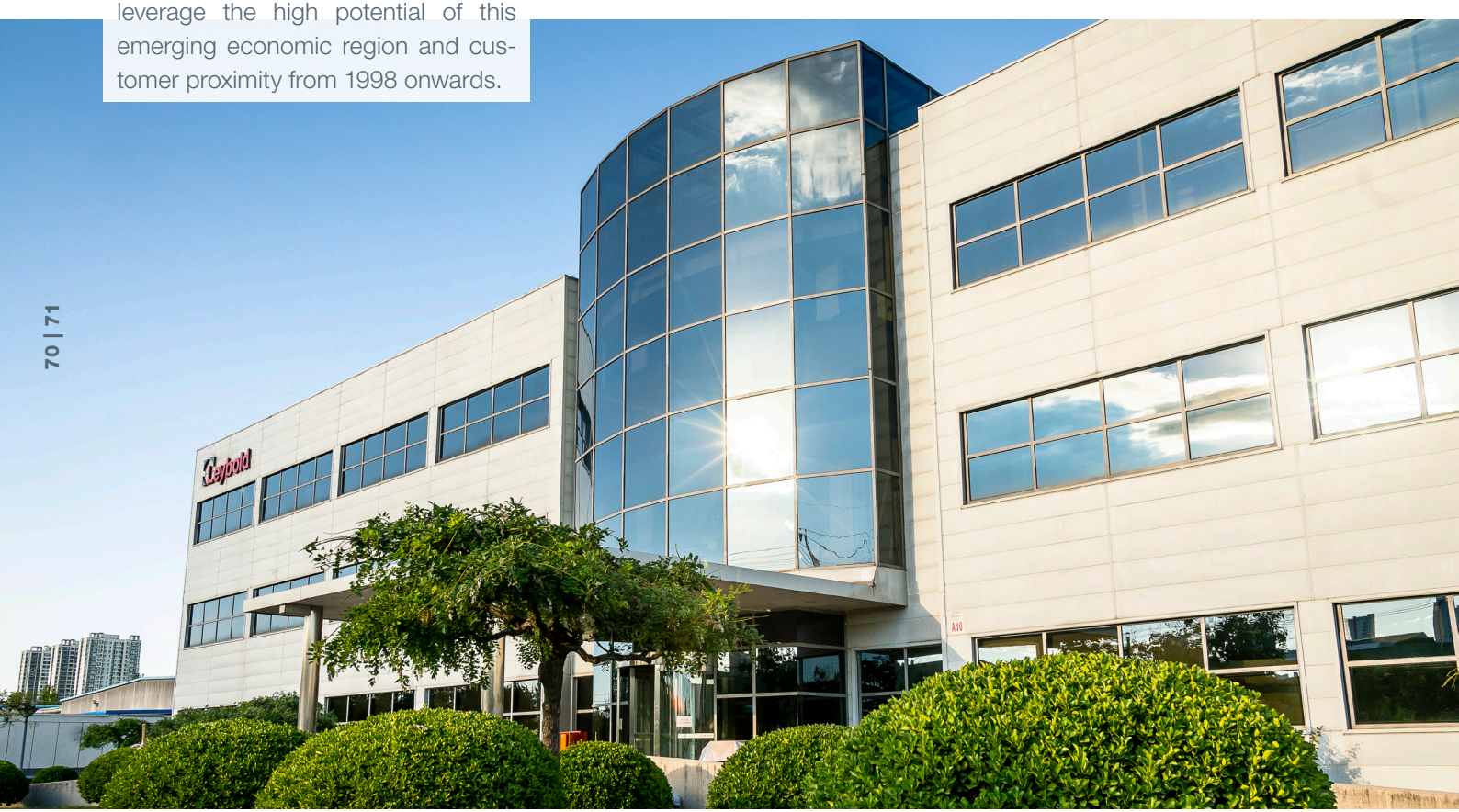
1989

The first turbomolecular pump with intelligent drive management was introduced.

1996

Leybold establishes a subsidiary in Tianjin, China - Oerlikon Leybold Vacuum's first Chinese location.

Leybold GmbH founded a wholly-owned subsidiary in China in order to leverage the high potential of this emerging economic region and customer proximity from 1998 onwards.



1996 1998

2000

The Oerlikon-Bührle Group was renamed UNAXIS, and underwent extensive restructuring focused on semiconductor-related technologies.

2001

The SCREWLINE dry compressing vacuum pump is introduced.

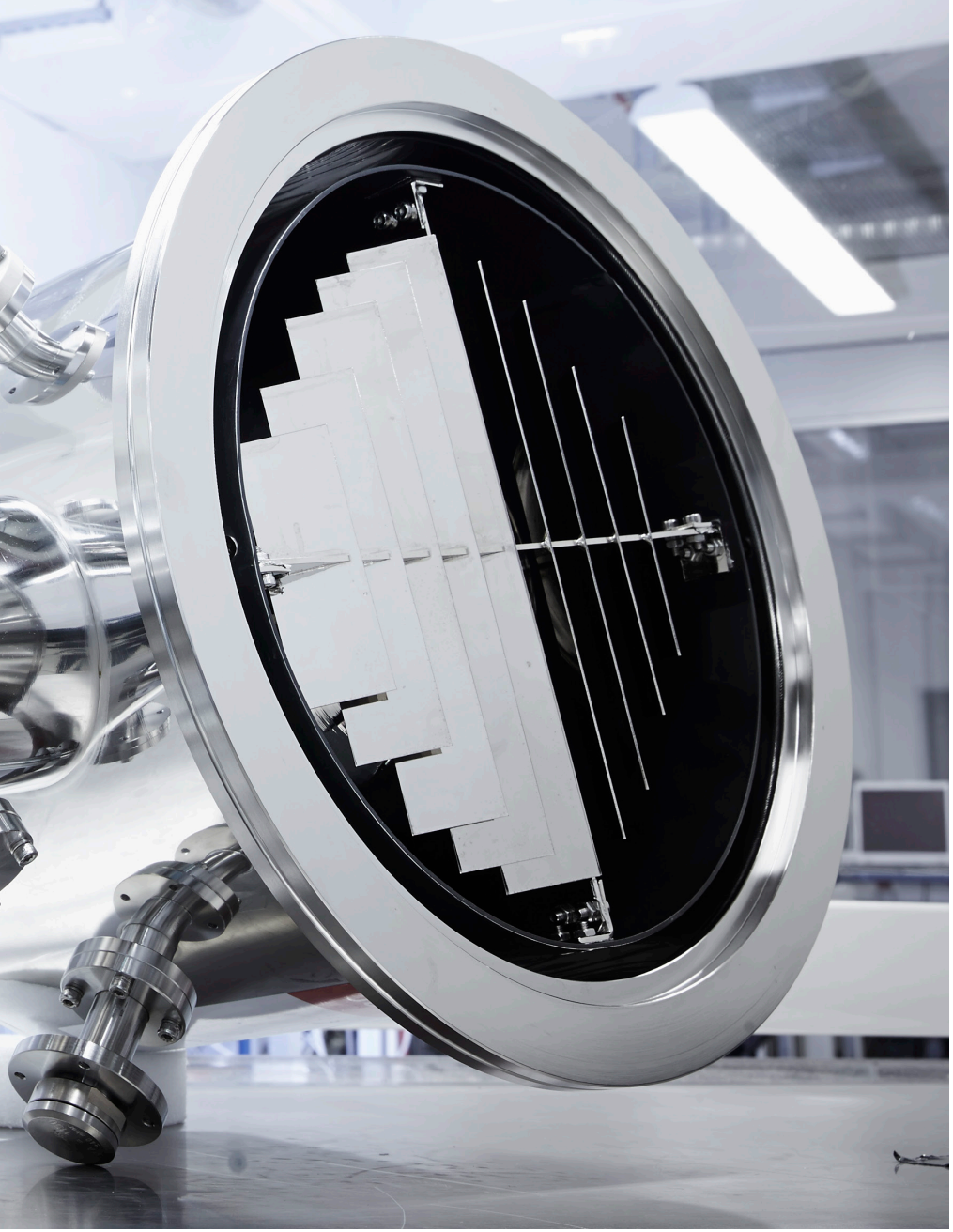
2004

The opening of the new Cologne production facility for high vacuum technology allowed Leybold to meet increased requirements in research and development work.

2006

Cryo pump production begins in Dresden, Germany.

Supported by economic growth, the UNAXIS Group was renamed Oerlikon. Leybold operated under the name Oerlikon Leybold Vacuum.



2007

The SCREWLINE dry screw pump for robust applications is launched.

With today's demanding research and industrial applications, dry compressing screw pumps like the SCREWLINE are the preferred backing pumps. Compared to oil-sealed pumps, they're more powerful and reliable, and their design allows for their use wherever reliable, compact and low-maintenance vacuum solutions are required. A major advantage is that they add a high degree of flexibility to various fields of application. In addition, they can be cleaned onsite by the customer during production breaks. Various connections also allow for easy integration into all systems.

2009

Expansion of the roots pump product line.

Leybold launches the RUVAC WH roots vacuum pump, which adds a high degree of flexibility to various fields of application. In addition, it can be cleaned onsite by the customer during production breaks. Various connections also allow for easy integration into all systems.

2010

A new dry compressing vacuum pump, the DRYVAC, celebrates its debut.

This pump is also based on dry screw technology and combines a compact design with features, including quiet operation, low-waste heat and low-cooling water consumption. An integrated frequency converter reduces installation effort.

2011

Leybold launches the MAGiNTEGRA, a flexible high vacuum pump, for the solar and coating markets.

Leybold's TURBOVAC MAGiNTEGRA magnetically-levitated turbo molecular pumps don't require the space that's usually necessary for a separate frequency converter and provide a compact, flexible design, excellent vacuum performance and a standardized line of accessories. It offers maintenance-free operation in most industrial processes, such as display, solar, coating and R&D applications.

2011

2012

2014

Inauguration of a new logistics hub in Cologne, Germany.

This year marked a great leap in vacuum technology with the launch of the TURBOVAC i.

Modern analytical instrumentation requires highly-developed components. In mass spectrometers particularly, these components need to be precisely matched to each other. Thanks to new turbomolecular pumps, analysis throughput is increased significantly. Leybold has confronted these performance challenges and has designed their innovative line of turbomolecular pumps. TURBOVAC i pumps: tailor-made for the analytical instrumentation market.

2015

Shift of service activities to Dresden, forming the EU center for service competencies.

2016

Acquisition by Atlas Copco.

The Swedish company, Atlas Copco AB, acquired 100 percent of Leybold. Atlas Copco is a multi-brand group with customers in more than 180 countries and approximately 37,000 employees. Leybold is now part of Atlas Copco's Vacuum Technique business. Atlas Copco relies on Leybold's traditional brand strength and complements the innovative technological expertise and market presence of the Swedes.


Leybold
TURBOVAC
90 i
Leybold
TURBOVAC
250 i
Leybold
TURBOVAC
350 i
VENT
PURGE


Leybold
TURBOVAC
Leybold
TURBOVAC 850 i
Leybold
TURBOVAC 950 i

2017

PHOENIX 4

After 15 years, Leybold launches the PHOENIX 4, a new family of helium leak detectors which meet increasing quality requirements. This innovative product is equally suited to the demands of research and development as for industrial applications - from securing the ultra-high vacuum demands of CERN's particle accelerator to industrial applications, such as leak detection in the Hyperloop vacuum transport system, or for the production of semiconductors.

SCROLLVAC plus

Users in research and industry increasingly rely on dry and robust vacuum solutions, which also provide flexibility of use. With the modernized, air-cooled SCROLLVAC plus, Leybold offers a simple, new and reliable fore vacuum pump which meets these requirements.

2018

SOGEVAC Neo D

The new generation of SOGEVAC vacuum pumps: triple-hitting vacuum technology for cleaner, quieter, longer-running performance.

VARODRY

The new VARODRY vacuum pump series is designed and produced in Germany by Leybold, specifically for industrial processes. Give yourself one less headache. With VARODRY, vacuum can be easy, efficient, reliable and dry.

2019

NOVADRY

Until today, oil-sealed rotary vane pumps were the norm. However, using such pumps bears risks, as the pump oil can end up polluting your workspace or, even worse, your food. To avoid these risks and to ensure product freshness, Leybold has developed the “NOVADRY”. This 100% oil-free vacuum pump revolutionizes the market.

2020

ECODRY plus

Dry, multi-stage technology receives further development with the new ECODRY plus generation which combines the advantages of a smaller size, smart operation, fast pump down times and environmental friendliness. These new dry compressing pumps are particularly well-suited for the operation in analytical applications.

TURBOVAC i

The development of larger hybrid turbomolecular vacuum pumps, with pumping speeds above 900 l/s, is one of the achievements which highlights the ever-lasting pioneering spirit at Leybold.

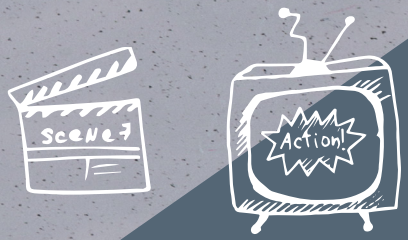
Leybold celebrates its 170 year anniversary.

OTHER NOVELTIES...

…would not be possible
without vacuum technology!

Even the car, the German's favorite child, would not exist without a vacuum technology. Glossy coatings are applied to headlights, tail lights and hubcaps. Air is pumped out of brake systems, which are then filled with degassed and drained brake fluid. Specially shaped parts for transmissions, torque converters and clutches made of highly-durable materials are cast or welded in a vacuum. Windshields are coated with a wafer-thin, electrically conductive layer of silver which survives both subsequent cutting and bending without damage. Heated windshields defrost within two minutes and in summer, only half of the sun's heat makes its way inside the car.

DISCOVER THE NEXT VACUUM TRENDS ...



NO HOME ENTERTAINMENT WITHOUT VACUUM!

Television (1932)

From Braun's tube to the ultra-modern flat-panel displays, a vacuum has been needed from the start! In the early days, low pressure was used to remove electrons. Today, modern display technologies like LCD, LED or recently OLED have resulted from advanced vacuum deposition techniques. Bulky tubes have been replaced by flat, microscopically patterned layers of light-emitting diodes with unprecedented brilliance. Large display-sizes have become affordable, which would have been impossible with evacuated glass tubes. Remember: "No home entertainment without vacuum"

HIGH-SPEED TRAVEL WITH VACUUM TECHNOLOGY

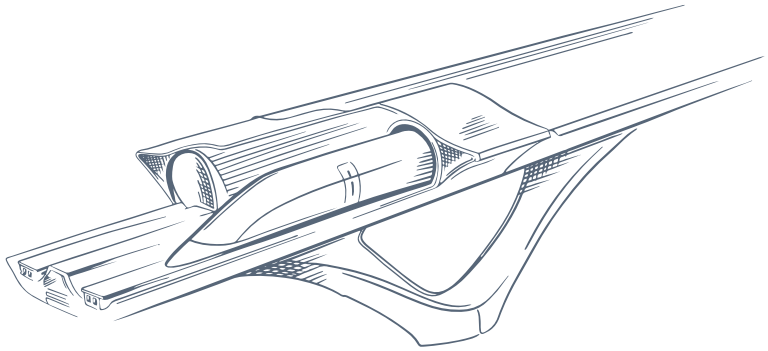
The Hyperloop is an exciting means of **mass transportation** using **vacuum tubes.**

What is Hyperloop?
The Hyperloop is not a new idea. First suggested in the early twentieth century as a way of transporting passengers by using low-pressure tubes, it likely seemed something from the world of fantasy or science fiction.

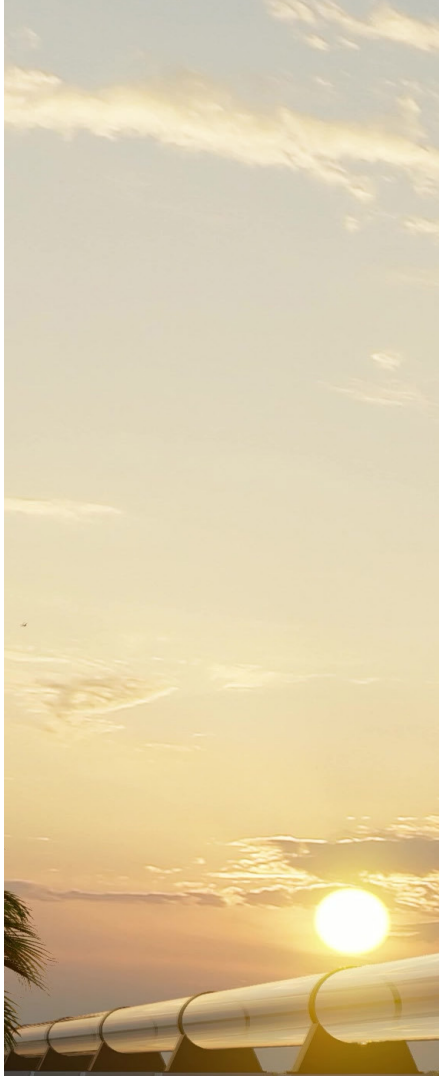
In layman's terms, the Hyperloop is a system where a passenger compartment can travel very smoothly on an air cushion or a similar technology. The compartment is able to achieve extremely high speeds. This forward motion is accomplished with a minimum of effort.

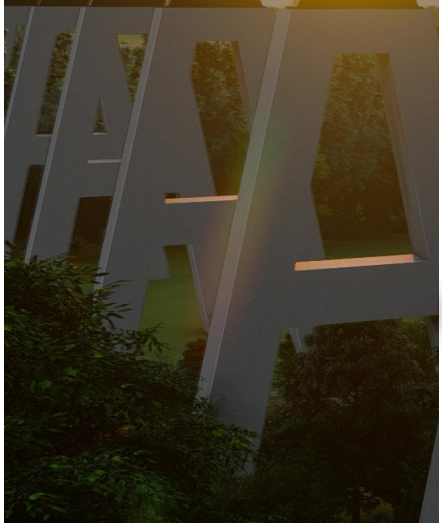
Why is Hyperloop the Future?
Hyperloop is considered the mass travel method of the future. With a tube measuring approximately the same size as a small commercial airliner (minus the wings), it floats effortlessly along a magnetic cushion inside a tube. The Hyperloop gives commuters with a streamlined, modern appearance and frictionless ride. The system is designed to operate at ground level, above ground, and even below ground level depending on local topography.

Once commuters enter the Hyperloop, they are fully protected from inclement weather, as well as delays caused by traffic crossings. They can sit down and simply enjoy the ride as they are transported to their destination quickly and efficiently. >>




FUTURE TRENDS



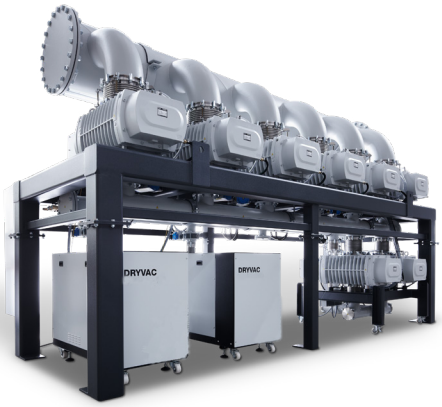


How is Vacuum Involved in Hyperloop?

A special vacuum unit is needed to create the low-pressure environment required inside the tube. This unit was co-developed by Leybold, which developed the vacuum pump. It fits inside a standard shipping container and offers a “plug and play” solution.

The system was developed to achieve and maintain low pressure inside the tubes with a minimum level of energy consumption. Maintaining a high level of operational uptime was also an important part of the equation when developing the Hyperloop. The containers will be placed at 6.2-mile intervals along the route.

Since the amount of air inside the tube is greatly reduced, the capsule can reach great speeds while consuming much less energy.



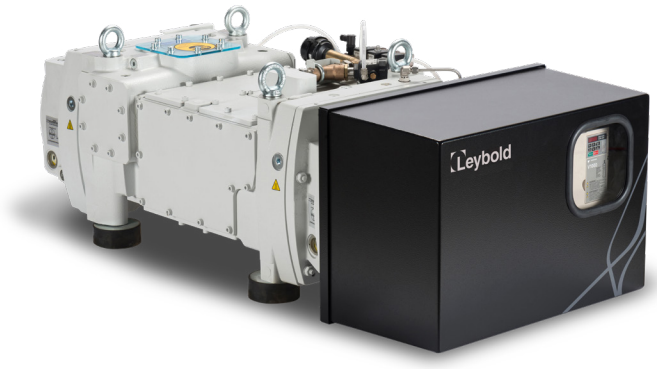
VACUUM TAKES OVER BAKERIES

Along with **an improvement in quality,** commercial bakery operations also **benefit from an increase in productivity.**

Baking is an ancient activity common in the food trade. Flatbread was commonly made from a simple recipe of crushed grain and liquid dating from 6000 BC. In comparison, vacuum technology is almost in its infancy. Vacuum has only been technically produced since the seventeenth century. Today, it is an indispensable part of modern technology. Our highly technological world needs vacuum. Technical devices that many of us rely on every day, such as our cell phones, would not be available without advances in vacuum technology.

Vacuum technology also brings changes to the commercial baking industry. Cooling baked goods are being revolutionized. The advantage of bread goods cooled under a vacuum is obvious: the loaf's crust is crispy. The volume consistency of the baked goods increases, resulting in a stable product with an extended shelf life. The interior remains soft, which is a desirable selling point, since many baked goods will become deformed in high-humidity environments.

Baked products with a uniform appearance look attractive to buyers. They also present an advantage over competitors' similarly-packaged goods. These factors may encourage consumers to make a choice.



DRYVAC
Modern oil-free screw vacuum pumps with integrated frequency converters are optimally suited for vacuum conditioning of baked goods.

Beginning of Industrial Bakery (19th Century)

Vacuum is also used in unexpected places. For thousands of years, the production of bread and pastries was done exclusively in standard ovens at temperatures of >200°C or higher. Modern industrial bakeries rely more on “vacuum baking” at much lower temperatures. Using a vacuum reduces total energy consumption, resulting in products with a better, fluffier texture. The packed bread’s shelf life is extended since the product is packed immediately after baking. This process does not allow contamination with yeast spores during a typical cool-down process of approximately three hours. Remember: “No perfect long life bread without vacuum”

Batch system for vacuum conditioning: rack trolleys enable fast loading.

The acceleration of the process reduces the likelihood of germ infestation. The temperature range of 30°C to 60°C, which is optimal for growing mold, is passed through in two-three minutes instead of two hours when vacuum cooling is used. Cooling in a closed chamber thus creates a kind of lock between baking and packaging the product. It significantly minimizes the risk of germ infestation and subsequent mold growth. No complex sterilization process is necessary after packaging to ensure mold resistance. Only clean air and inert gas could provide an additional extension of the minimum shelf life.

ENVIRONMENTALLY FRIENDLY RECYCLING OF LITHIUM-ION BATTERIES

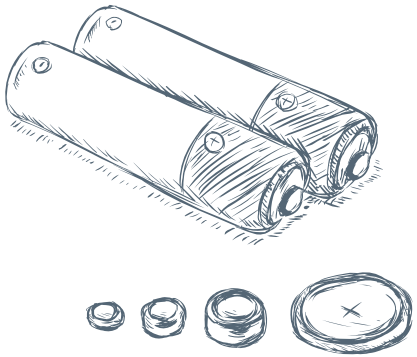
Thanks to **modern vacuum technology,** several components of the **battery can be reused.**

We know that lithium-ion batteries will primarily be used in electric cars in the future. Therefore, finding ways to recycle these batteries is a major challenge that must be addressed.

New, vacuum-assisted recycling processes for lithium-ion batteries achieve a significantly higher recovery rate than other methods. Thus, with the help of a vacuum, 91% of the battery components can be reclaimed. Valuable metals such as lithium, cobalt, nickel, and manganese can be used for other purposes.

After discharging the storage tank and dismantling the battery cell, the components are compressed. Vacuum distillation is used for separating the electrolytes from the other components. This process keeps the temperature low and thus prevents any toxic gases from forming.

The separated solvent is sent to the chemical industry for further processing. The recovered metals are then used to manufacture new batteries; almost complete recycling is possible using this method.

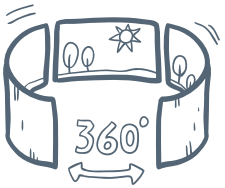


LEYBOLD'S SERVICE EVOLUTION

We are **leading the way!**

Leybold Service has evolved over the years, but one thing remains the same: the customer is always at the center of what we do, from oil and spare parts to service agreements to advanced services like **Remote Connectivity.** Using this technology, our customers can remotely manage their vacuum pump fleet with useful instant insights and our field service technicians can take proactive action when needed. Leybold Service is constantly evolving.

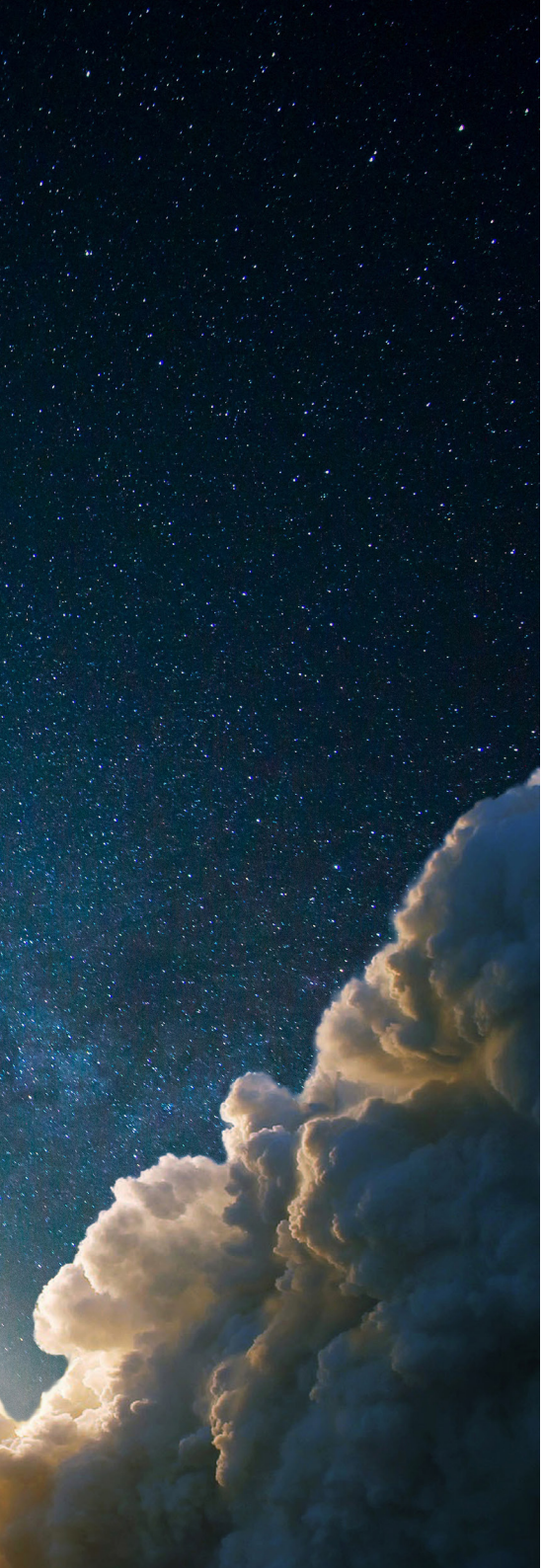
Backed by a 170 year track record in vacuum knowledge, our professional **Field Service** technicians and network of fully-equipped **Service Technology Centers,** we maximize customer uptime while reducing the risk of downtime to an absolute bare minimum. Wherever you are, Leybold, your vacuum service partner, is there to support you. We are constantly innovating to help our customers reduce their overall cost of ownership, offer even faster service, manage their maintenance needs, and provide the ultimate in professional expertise. The next evolutionary step has arrived.



The next evolution is here!

We are now using augmented reality (AR) to train our technicians. The HoloLens™ AR headset is essentially a hands-free computer that technicians wear while servicing actual pumps. 3D models showing complex service procedures are displayed holographically and scaled to the real-world. Technicians operate the HoloLens™ using a virtual touch-screen interface which enables them to view exploded or X-ray depictions of products more intuitively than is possible using traditional PDF diagrams. Our goal is to equip every technician with a headset so they can access realistic on-demand training as well as collaborate and assist each other on AR video calls. Combining this with customer-specific Internet of Things (IoT) data such as vibration and temperature history will help our technicians diagnose problems in the field. AR will empower the next global hands-on workforce. And we are leading the way!


SORRY
! NO !
Mojito with
STRAWS



NO PARTY IN A VACUUM

No matter how much you **turn up the music...**

Oh, how we benefit from the surrounding air! First, it keeps us alive but there are many more advantages, we only do notice when the atmosphere is taken away from us. Let's imagine we wanted to throw a fancy party on the moon. The pressure on the moon is so low that we can consider it to be an ideal vacuum.*

Before the VIP guests arrive in their spaceships, the location needs to be cleaned thoroughly. Apparently some astronauts left their footprints in the dust. Being well prepared, we brought a vacuum cleaner from Earth. But in trying to clean with it, we're soon disappointed to see that we're merely shifting the dust across the footprints, and none of it is entering the vacuum cleaner. Why?! On Earth, the vacuum cleaner creates a pressure difference that moves the air from the outside to the inside. The air particles hit the dust and drag it into the vacuum cleaner bag. On the moon, there are not enough particles left to make that happen. And how could a vacuum cleaner subtract something from nothing?

Well okay, the guests will have dirty shoes after the party. Let's get these helium balloons we brought from Earth to cheer them up. Oh dear, they're just lying on the ground like ships when the tide is low – there's no heavier fluid around to keep them floating. Some balloons are even expanding until they burst. We can see it, but we can't hear it, as sound also needs a medium in which to travel. Okay, we don't need to unpack the fireworks then. Maybe the Mojitos are preventing the guests from turning on their heels. Now all of them are sucking on their straws, but no one gets a single drop into their dry mouths. The surrounding atmosphere would have pushed the drink along the pressure difference through the straw. Without this pressure difference, no fluid can move. Now I know why the moon is considered to be so hostile to life. That's the last straw! I'm heading back to Earth.

* For nerds: please don't start a discussion here about there being no such thing as an ideal vacuum (#Casimir_Effect). For our considerations, an ideal vacuum refers to the absence of a laminar flow.

Dr. Stefan Lausberg

PRESENT AND FUTURE

Synergies between **Atlas Copco and Leybold.**

For 170 years, Leybold, headquartered in Cologne, Germany, has been developing and supplying vacuum pumps, systems, standardized and customized vacuum solutions and services for various industries worldwide. As a supplier of vacuum technology, Leybold is today a leader in numerous industrial applications, such as metallurgy and industrial coating technology. Supplemented by applications in analytical technology, display production and research & development, the vacuum pioneer is one of the leading suppliers worldwide. The synergies between Atlas Copco and Leybold in the fields of dry industrial vacuum pumps and high vacuum pumps for science and research has created a technological platform for the development of sustainable highperformance products for generations to come.

We'd like to extend a special thank you to all our colleagues, partner and clients around the world who have helped make this anniversary year an unforgettable experience for all.

Leybold

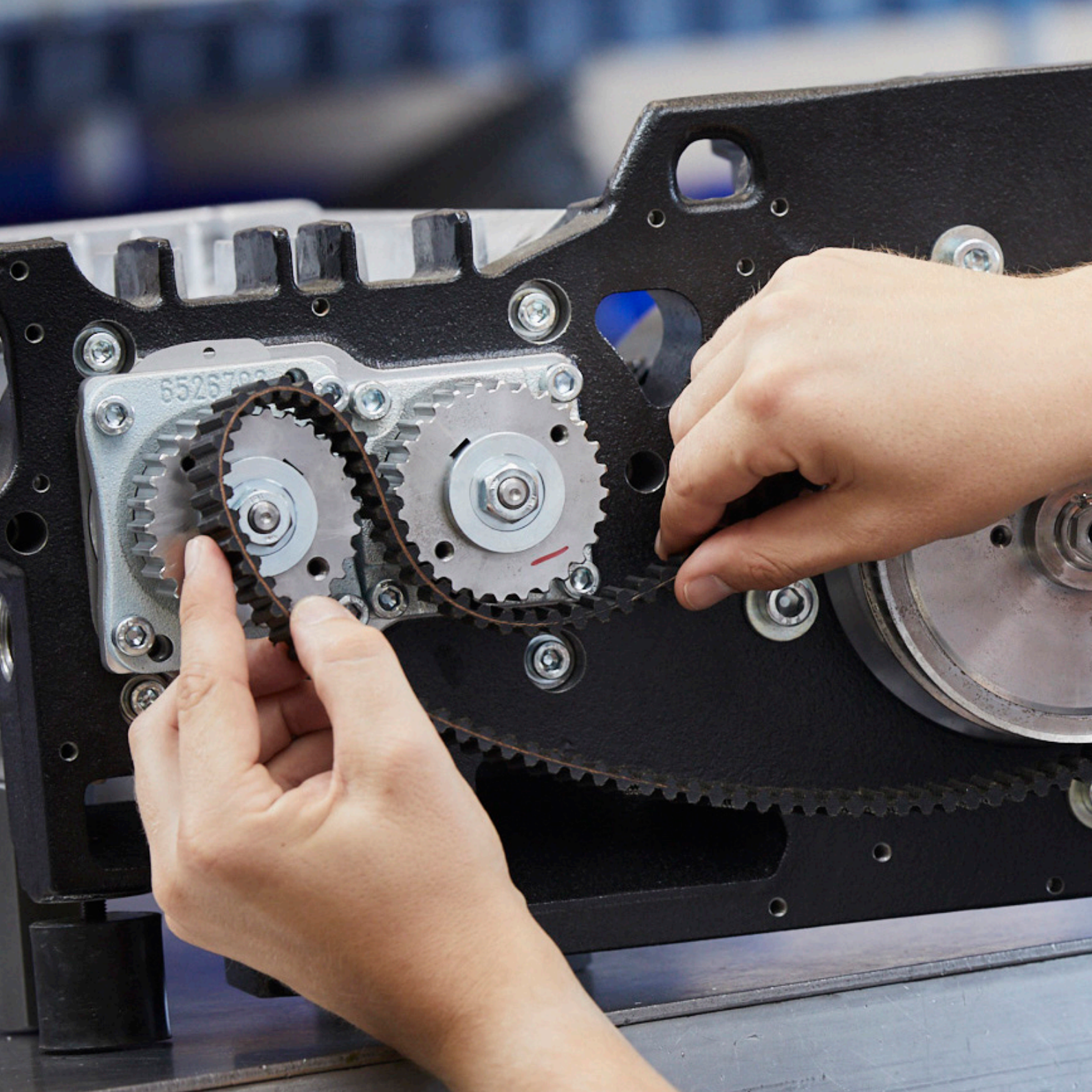
Pioneering products. Passionately applied.

1850 2020

PIONEERS FOR 170 YEARS


Leybold


LEYCON



Leybold

Pioneering products. Passionately applied.