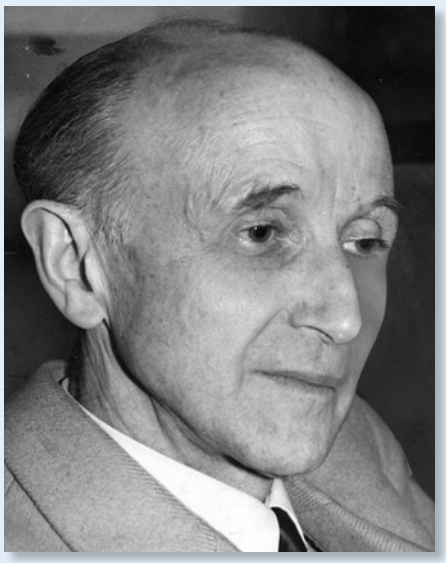
A Tribute to the Memory of

Baltzar von Platen

1898–1984



Carl Munters

1897–1989

by Professor emeritus Eric Granryd

Royal Swedish Academy of Engineering Sciences (IVA)

A Tribute to the Memory of

Baltzar von Platen
1898–1984

Carl Munters
1897–1989

Presented at the 2014 Annual Meeting
of the Royal Swedish Academy of Engineering Sciences

by Professor emeritus Eric Granryd

The Royal Swedish Academy of Engineering Sciences (IVA) is an independent, learned society that promotes the engineering and economic sciences and the development of industry for the benefit of Swedish society. In cooperation with the business and academic communities, the Academy initiates and proposes measures designed to strengthen Sweden's industrial skills base and competitiveness.

For further information, please visit IVA's website at www.iva.se.

Published by the Royal Swedish Academy of Engineering Sciences (IVA),
Professor emeritus Eric Granryd.

IVA, P.O. Box 5073, SE-102 42 Stockholm, Sweden
Phone: +46 8 791 29 00
Fax: +46 8 611 56 23
E-mail: info@iva.se
Website: www.iva.se

IVA-M 447 • ISSN 1102-8254 • ISBN 978-91-7082-881-2

Editor: Maria Dollhopf , IVA
Layout and production: Hans Melcherson, Tryckfaktorn AB, Stockholm, Sweden
Printed Kaigan AB AB, Stockholm, Sweden, 2014

Foreword

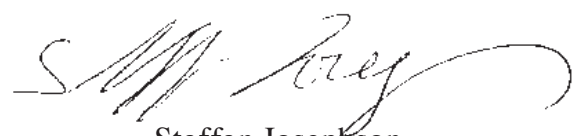
Every year, the Royal Swedish Academy of Engineering Sciences (IVA) commemorates a person whose scientific, engineering, economic or industrial achievements were of significant benefit to the society of his or her day. The person to be recognised must have been born at least 100 years ago and active in Sweden.

The Commemorative Booklet is published in conjunction with the Academy's Annual Meeting. This year the two inventors, Baltzar von Platen and Carl Munters, who revolutionised domestic refrigeration, are commemorated.

While still young engineering students, the two men together developed the first cooling apparatus without moving parts, later known as the Platen-Munters refrigerator. After publishing their work in their degree theses at the Royal Institute of Technology (KTH) in Stockholm in 1922, they went on to develop the product for the market. At this point it became clear that they were not only exceptional inventors, but excellent business men as well.

After a couple of years of successful work at Electrolux the two men went separate ways. However, their joint success in the early years was the boost that propelled them into a life of developing new products and technologies. von Platen and Munters had different but remarkable careers as inventors, no doubt influenced by their different personalities. Their work still affects our daily lives, often without us even noticing it.

Björn O. Nilsson
President of the Academy



Staffan Josephson
Chairman of the Medals Committee

Contents

Introduction

Inventors Carl Munters and Baltzar von Platen are linked by their joint invention, the Platen-Munters refrigerator. Coming from different backgrounds and having very different personalities, they met as students at the Royal Institute of Technology (KTH) in Stockholm. They both graduated with a Masters degree in engineering in spring 1923 and shared a desire to develop new products.

At that time, around 1920, artificial refrigeration was becoming quite common, although it was essentially only used for large-scale cold storage. The domestic refrigerators on the market were bulky and not particularly effective or reliable. Ice cabinets were still being used, but only by people who could afford such a luxury. "Harvesting" ice from frozen lakes in the winter, and storage and distribution of ice blocks was a big industry and one that involved a lot of heavy manual labour. There was clearly a demand for domestic refrigerators and it was evidently Carl Munters' father who hinted to his son that this might be something he could work on developing.

The two students, Munters and von Platen, enthusiastically took on the task alongside their studies. In a surprisingly short space of time they came up with a ground-breaking idea for a cooling apparatus without moving parts that worked in actuality – the Platen-Munters refrigerator. The process still carries this name and is described in almost every

text book on the subject of refrigeration around the world. The two men presented their work to Professor Hubendick at KTH who encouraged them to use it as the topic of their degree thesis. They each wrote a paper – the thesis was to be an individual endeavour – and submitted them in the spring term of 1922. Although their theses were very different in structure and focus, they both described and analysed the new process. A couple of years later in 1925 when the results were presented in a demonstration for a larger audience, the refrigerator became big news. After several rounds of complicated negotiations, they managed to sign a favourable agreement with Axel Wennergren, majority owner of the young Electrolux company. A period of intense development ensued.

A few years later Baltzar von Platen and Carl Munters went their separate ways, but their joint invention was the starting shot for two different but remarkable careers. Their subsequent activity as inventors is a clear example of the saying "success breeds success".

Baltzar von Platen

Carl Munters

Childhood

Carl Munters was born in 1897 and grew up in Stockholm with his parents Anders Johan Munters, an engineer at AB Separator and his wife Hilma Bernhardina Helling. The family roots were in Järna in the province of Dalarna where Carl's great grandfather on his father's side, Anders Nilsson, was one of the central figures in the village; he was a farmer, a shopkeeper with a business adjacent to the church, a church warden and an innkeeper. Carl's paternal grandfather owned a smithy.

At school Carl Munters was a successful athlete and captain of the pentathlon team of the "Norra Real" school. He also had a head for business. While still at school he produced and sold a soldering solution (made from zinc and hydrochloric acid). After receiving complaints that his solution was too strong, he simply added tap water and sold his diluted brew for twice the price. *"That was my first experience of successful product development"*, he would later say. He finished school at Norra Real in Stockholm in 1917 and then joined the navy to become a naval engineer. He applied and was accepted to the Royal Institute of Technology in 1918 and began his studies in naval architecture.

He filed his first patent application on 29 November 1918 for a safety starting crank. The patent applicants were listed as A.J. E:son Munters and C.G. Munters, i.e. father and son. C.G. Munters is listed as the sole inventor. Reading the patent which is entitled *"Start-*

ing crank for explosive engines" it is easy to imagine that Carl received a good deal of help from his father, an experienced engineer with several patents of his own. The application was granted in 1921 (Swedish patent no. 49482) and Carl managed to sell the patent to Scania Vabis in Södertälje. The income he received supplemented his student budget at KTH.

Carl always had the reputation of being a placid and unassuming person; not one to seek limelight. In this regard his future colleague was quite the opposite.

Baltzar von Platen (not to be confused with his namesake who was born more than a century earlier and who is famous, among other things, for his work on designing and constructing Sweden's famous Göta Canal) was born on 24 February 1898 and grew up in Ystad in Skåne County. He was the son of county bookkeeper Philip Ludvig von Platen and Eva Hedda Ingeborg Ehrenborg. Baltzar's grandfather, like several generations before him, was an officer and the family owned several estates on the island of Rügen which belonged to Sweden at the time. His grandfather moved to the southern Swedish mainland and established a home in Hjälmsund, Skåne. Baltzar's father, who decided against becoming an officer in favour practicing law, was very well-informed and a brilliant speaker. His mother was a gifted artist and pianist. Baltzar had three sisters.

As a schoolboy he was often in trouble with his authoritarian teachers. In his memoires from 1975 *"Andar och perpetuum mobile"* (Spirits and perpetuum mobile), Baltzar writes that he *"failed every spring term"* from the time he *"was twelve and almost until he got his diploma – except for the final exam as there were examiners, thus witnesses"*. This comment perhaps reveals

something about his personality – he was independent and argued energetically with authority figures, especially with some of his teachers.

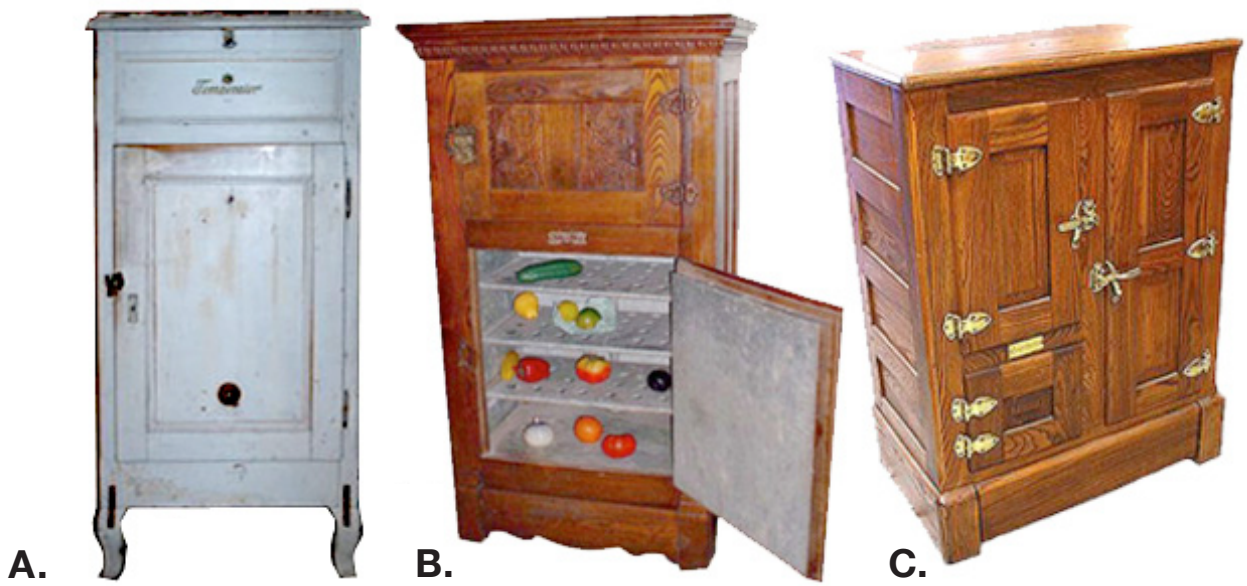
After school he went on to study physics at Lund University. There he got into a dispute with one of his teachers (Manne Seigbahn, later a Nobel Prize laureate in physics) about the *structure* of the derivation of Carnot's equation (a fundamental part of the second law of thermodynamics) and failed the class. Distressed, he decided to change course and to study to become a clergyman. But Latin was a stumbling block and his enthusiasm waned. This in turn led to a decision to study mechanical engineering at KTH in Stockholm. The notion of finding a way to circumvent the "second law" was one that would remain with him his entire life.

They met at the Royal Institute of Technology

Carl Munters and Baltzar von Platen did not know each other and it would be several years before they became friends. von Platen describes how within the first few weeks at KTH he had observed Carl Munters talking with friends about the invention he had sold to Scania Vabis. In his memoires, von Platen writes *"I could never be friends with that genius"*. It was not until spring 1921 that the two men met at lunch in the university dining hall. Munters described a camera "delay mechanism" which could allow the person taking the photograph to be in the photo. von Platen suggested an improvement and this made Munters noticeably irritated – not at von Platen, but at himself, because he had not come up with the idea. This was the beginning of a long friendship. After just a few days they agreed to work together on solving the problem of creating an efficient and simple refrigerator – an idea that Carl's father had apparently suggested.

Few people were fortunate enough to have a refrigerator in their home at the beginning of the 20th century. To replace the ice cabinet, a few companies (including in Sweden) were trying to develop a refrigerator that used "artificial" cooling. One such company was Munktells Mekaniska Verkstad, an engineering workshop in Eskilstuna which in 1911–1912 was working on developing a refrigerator with a specially designed compressor

driven by an electric motor. However, it had serious reliability issues and financial ones as well, and the planned refrigerator production soon stalled. In 1912 AB Frigator launched an improved version of a domestic refrigerator which required a container filled with ice and salt on one side, enabling it to maintain a lower temperature than the earlier models.



A. Old Norwegian ice cabinet. The ice was placed in the drawer above the door.

B. Typical Victorian ice cabinet highboy model. The model is made out as a fine piece of oak furniture. Note tin or zinc shelving and door lining.

C. An exclusive oak ice cabinet that would be found in the well-to-do homes. Note the fancy hardware and latches. Ice goes in the left upper door. This model probably has a pull-out drip tray.

The big invention is developed

Refrigeration was an entirely new field for the two engineering students, but after studying it for a while it became clear to them that the so-called absorption principle which used ammonia and water and had been developed by Carré should be used for the refrigeration apparatus. The problem was how to get the ammonia, in both a liquid and vapour state, to circulate to produce the cooling effect. The existing refrigerators were bulky and unreliable and Carré's absorption cycle required a liquid pump. A German inventor called Hermann Geppert (1899) had patented a modification of Carré's absorption cycle where a gas, such as air, was introduced into the system. However, he failed to turn the idea into a workable product.

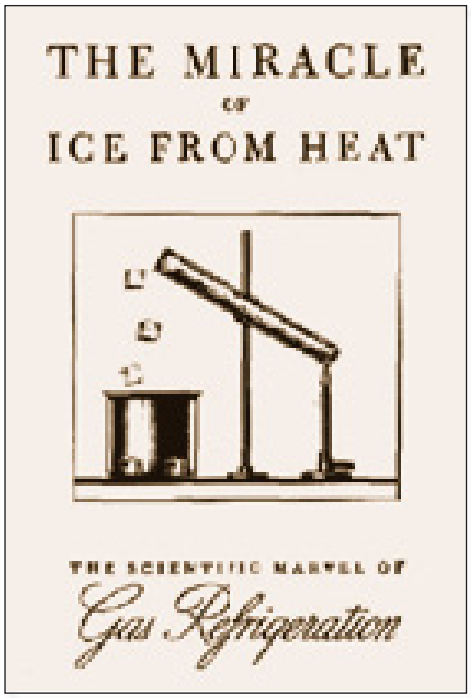
The two Swedish engineering students rented a two-room flat where they spent six months working on various ideas. One idea, which they quickly abandoned, was a system that worked intermittently and required valves and clacks. The breakthrough came when they (as proposed by Geppert) introduced an "indifferent gas" to level out the pressure gap in the system. *"It took about a year to solve the problem as we also had to focus on our studies"*, von Platen writes in his memoires. His description of their "invention process" is entertaining:

> *"We almost always started work at half past nine in the evening and finished at half past four in the morning, shortly after making tea and eating arrack cake. In the morning we slept and thus skipped our lectures at the university. But we still did the required reading so we did not fail our courses."*

The first refrigerator was constructed to test the principle. *"After one month and two days"* a prototype was ready. *"It worked brilliantly. It was minus 40° C inside the cold space"*, von Platen writes. He goes on to say:

> *"The experiment was conducted at Nordiska Armaturfabriken and the bill was sent to wholesale merchant Hugo Tillqvist. He was a particularly honourable and fine gentleman"... "who when he began working with us, Munters and myself, thought that it was interesting and exciting to see if two technology students, who also had to take care of their studies, could create a refrigerator without moving parts where a flame on the left gave rise to hoarfrost on the right."*

Their efforts resulted, among other things, in their individual theses which were approved by Professor Hubendick in the spring term 1922 at KTH. The two students and Hugo Tillqvist formed a company in 1923 called Platen-Munters Refrigerating System AB.



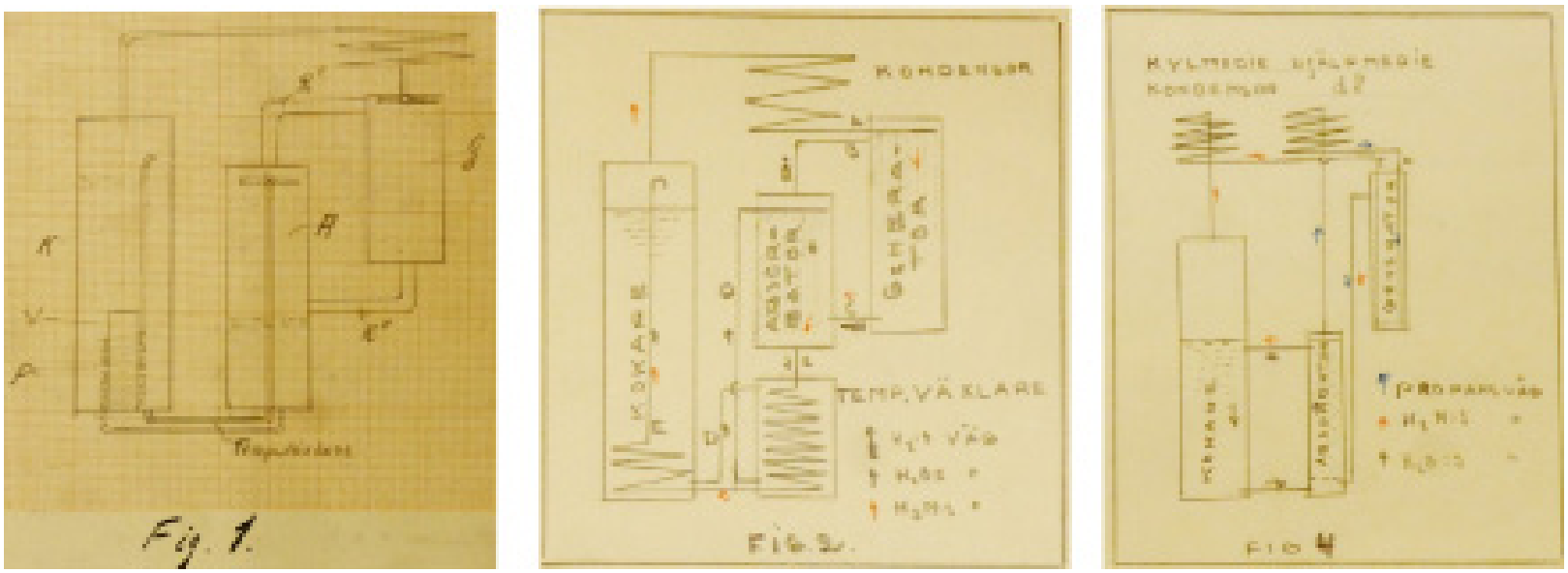
The illustration shows the phenomenon whereby it was possible to use a gas flame at one end of the apparatus to produce ice on the other. Fuel for the imagination!

The illustration is from the cover of a brochure (Electrolux/Servel, late 1920s). Albert Einstein, who learned of the patent much later on, said he was amazed by the brilliant ideas presented.

Who was responsible for the basic idea? Throughout their live the two friends claimed that they did the work together. The invention would be called the Platen-Munters refrigerator, but Baltzar von Platen writes:

> *"The fact that my name comes first should not be misinterpreted because we each contributed equally to solving the problem. If our names had been in the reverse order, the 's' in 'Munters' would have been perceived as genitive, which would have sounded odd* (translator's note: no apostrophe used in the genitive case in Swedish). *Although later on it became known as the Electrolux refrigerator, the original name lives on."*

The first refrigerator was bulky and inefficient. The prototype needed to be improved to become a functional product. The theoretical foundations were however established and several patent applications had been filed. The road travelled to bring the product to market was a winding and complicated one.

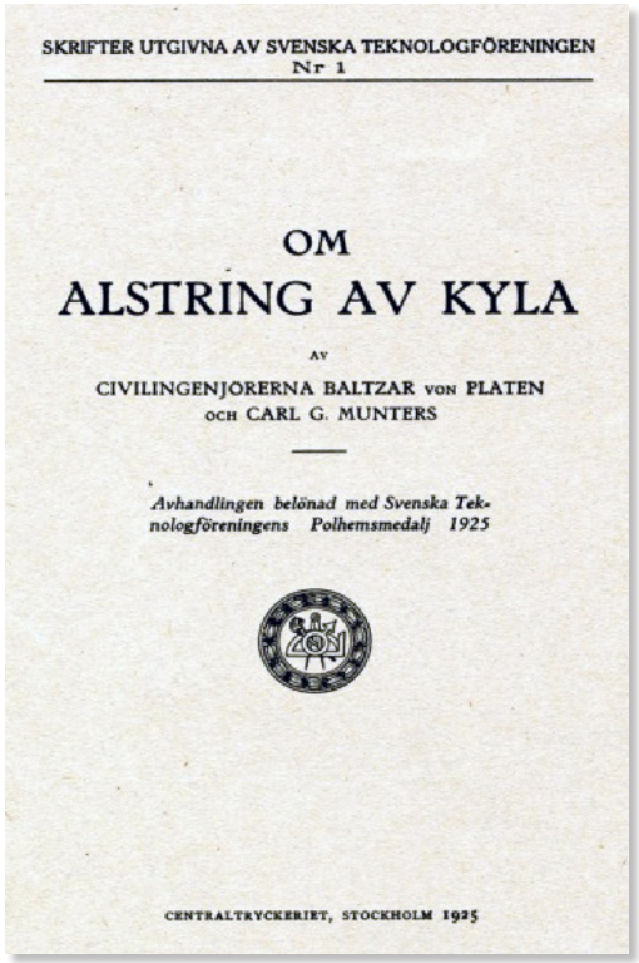


Three images of drawings included in Baltzar von Platen's and Carl Munters' thesis.

The drawing on the left is from von Platen's thesis entitled "The Problem: Refrigerator without moving parts". The drawing illustrates the cycle, including the idea of a thermosiphon pump.

The two drawings on the right are from Munters' thesis which he simply called "Thesis". The drawing in the centre "FIG 2" illustrates the basic idea of using an inert gas (H_2) and corresponds to the cycle in von Platen's drawing on the left. The drawing to the far right "FIG 4" is particularly interesting because it illustrates an entirely different solution to the problem. Here, two refrigerants (NH_3 and propane) are used, with water as the absorption medium for ammonia. This solution was later called the "propane refrigerator". It was patented but never developed to completion.

In 1925 von Platen and Munters arrived at a "marketable design" and presented it at the *Bygge och Bo* (Building and Home) exhibition in Liljevalchs art hall in Stockholm. The presentation had a big impact and made headlines in the daily papers. The inventors also published a detailed account of the principles behind it in a paper entitled *"Om alstring av kyla"* (On producing cold).


SKRIFTER UTGIVNA AV SVENSKA TEKNOLOGFÖRENINGEN
Nr 1

OM
ALSTRING AV KYLA

AV
CIVILINGENJÖRERNA BALTZAR von PLATEN
och CARL G. MUNTERS

Avhandlingen belönad med Svenska Teknologföreningens Polhemsmedalj 1925

CENTRALTRYCKERIET, STOCKHOLM 1925

The two men were awarded a medal for their achievement, Teknologföreningens Polhemsmedalj 1925. In his memoires von Platen says that the attention was very important because it put the two young engineers in a stronger position in negotiations with potential stakeholders.

The negotiations on the rights to the invention became complicated. Their former sponsor Hugo Tillqvist tried unsuccessfully to sign a contract with AB Separator. After several difficult attempts, an agreement was reached in 1925 with Axel Wennergren who was in the process of expanding Electrolux. His company's main focus at that time was manufacturing and selling vacuum cleaners for domestic use, and Wennergren thought that refrigerators could be a natural complement to that business. The two inventors were clearly skilled negotiators and when it came to agreeing

on the terms, they were assisted in the final phase by a well-known inventor called Birger Ljungström. Under the terms of the agreement Munters and von Platen each received SEK 560,000 and royalties of around SEK 0.50 per refrigerator sold.”*Tragically, Tillqvist, the noble gentleman, made so little profit from all of his efforts*”, writes von Platen.


SVENSKA DAGBLADET

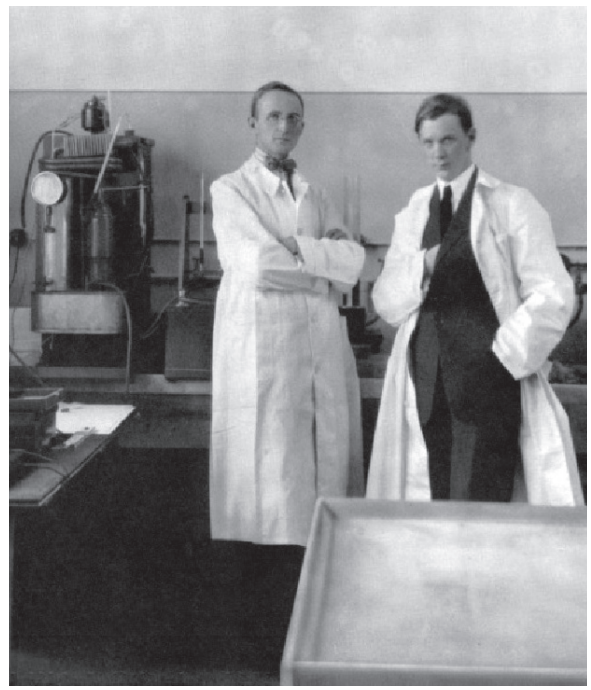
Torsdagen den 26 Februari 1925

INGEN ISBRIST I SOMMAR!
KYLA DIREKT UR VÄRME:
EN IDEALISK KÖLDAPPARAT.

SEKELGAMMALT PROBLEM LÖSES AV TVÅ UNGA STUDERANDE VID TEKNISKA HÖGSKOLAN.

ETT EPOKGÖRANDE EXAMENSARBETE.

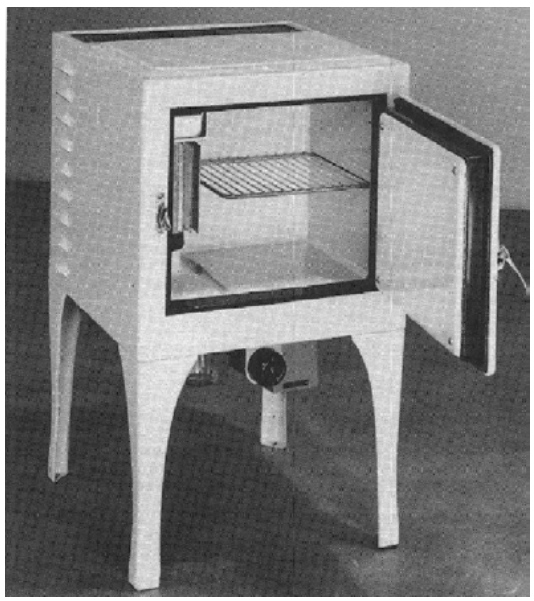
EN BILLIG, OÖM OCH LÄTTSKÖTT KYLMASKIN FÖR HUSHÅLLSBRUK INOM KORT I MARKNADEN.



Headlines in the daily newspapers following the Bygge och Bo exhibition at Liljevalchs art hall, February 1925 (picture from Rydberg et al., 1984). On the far right a recent photo of an early prototype (now at KTH Energy Technology lab)

As early as 1925 Electrolux signed an agreement with Servel, a US company whose head office was in Evansville, Indiana, to launch the refrigerator in the US. The company had

close ties with the gas industry and a gas-fired refrigerator would be a perfect fit. The agreement attracted attention, not least because of its terms: Electrolux received USD 10 million in cash and half of Servel's share capital in addition to production royalties. Axel Wennergren was a skilled negotiator as well...



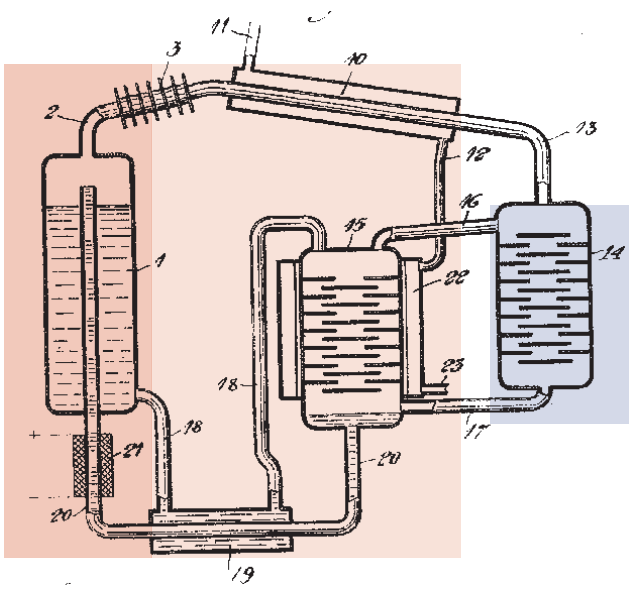
On the left Electrolux's first refrigerator from 1925, a water-cooled version. The first air-cooled refrigerator came in 1931, picture on the right.

How does the Platen-Munters refrigerator work?

In their patents, von Platen and Munters describe several different design solutions. Here is one of them. A brief description of how it worked is included.

The starting point for this design was Carré's absorption process to produce a cooling effect. The groundbreaking aspect here was that the inventors managed to eliminate the need for a liquid pump by introducing an inert gas, which enabled the total pressure to remain constant throughout the cycle. Thanks to the inert gas, the *partial pressure* in the evaporator was low enough for the refrigerant liquid to evaporate at a low temperature and thereby produce the cooling effect.

There are four main components in the refrigerator, the "boiler" (in the red zone of



"The structure of an absorption refrigerator"
Illustration from Swedish patent no. 66951, 11 September 1925.

The colour fields have been added here to illustrate the different temperatures when the apparatus is in operation.

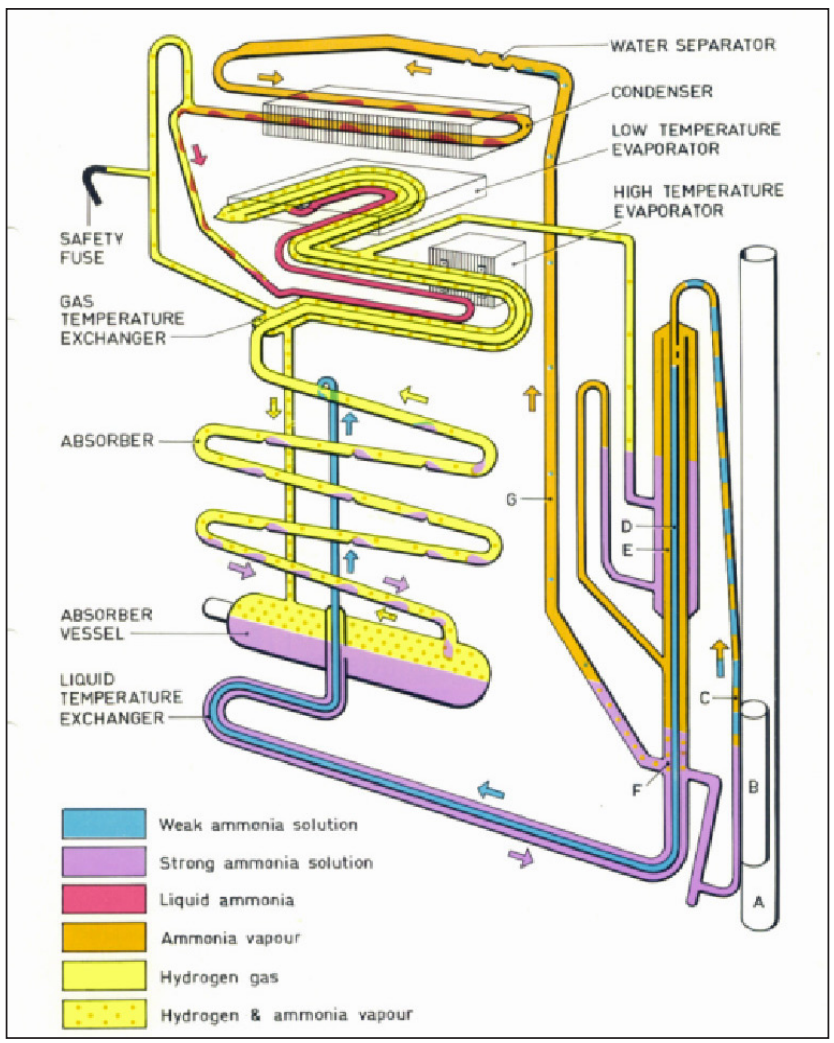
the illustration labelled 21 and 1), the "condenser" (10), the "evaporator" (14, blue in the illustration) where the cooling effect is produced, and the "absorber" (15).

Three substances are used: *ammonia*, *water* and *hydrogen gas*. They pass through three different cycles with the total pressure remaining constant throughout the system:

- ammonia flows through all of the components in a vapour or liquid state,
- water (mixed with ammonia in various concentrations) flows between the boiler and the absorber, and finally
- hydrogen gas flows between the absorber and the evaporator.

When heat is applied to the pipe (21, bottom left in the illustration), ammonia vapour bubbles are formed in the water-ammonia mixture in the pipe (20). The rising bubbles draw liquid with them and a "thermosiphon pump" is created which pumps the water-ammonia mixture through its cycle. The ammonia vapour passes through the pipe (2) to the condenser (10) which is cooled with the water coolant (11). Here the ammonia vapour is condensed and the resulting liquid flows to the evaporator (14) where it meets a stream of hydrogen gas from the pipe (16). When the liquid ammonia is exposed to the hydrogen gas, it will evaporate and this is what produces the cooling effect. The evaporator (14) is placed inside the refrigerator to keep it cold. The temperature will be the lowest at the intake – as low as -40°C and increases until all of the liquid ammonia is evaporated at the bottom. The upper (coldest) section of the evaporator (14) can be positioned inside a freezer compartment in the refrigerator.

The ammonia and hydrogen gas mixture is heavier than pure hydrogen gas and gravity therefore pulls it downwards and into the absorber (15). Here the ammonia vapour is absorbed into liquid form when it meets the watery solution flowing through the pipe (18) and the resulting hydrogen-rich gas flows back to the evaporator. The ammonia-rich water solution gathers at the bottom of the absorber and flows through the pipe (20) via a heat exchanger (19) to the heat source (21).



The illustration on the left shows a more modern presentation of the refrigeration cycle (information from Electrolux, around 1970). The principle is the same as in the previous illustration, even though there is 50 years of development between the two versions to make the process more efficient and to simplify production. On the right is a photo of an Electrolux demonstration model from 1970.

More development in Electrolux's laboratory

As soon as the agreement was signed Electrolux set up a laboratory to develop the refrigerator. Here Baltzar von Platen and Carl Munters worked together and were clearly very productive. In various patent databases we can find at least 47 patents for which they are jointly responsible. They mainly worked on improving multiple details, but they also considered alternative cycles and mediums.

Several prominent individuals worked at the Electrolux laboratory, including John Tandberg, who subsequently received the title of professor, and Matts Bäckström, later a professor in Refrigeration Technology at KTH. Tandberg was a chemist and brought important expertise to the team. He discovered an anti-corrosion agent which made it possible to use simple materials. Bäckström was the one who analysed the cooling cycle and developed the theoretical comprehension which was essential to optimising the design of the heat transfer and diffusion processes. A summary was published many years later (Bäckström, 1956).

Absorption refrigerators of this type are only suited for small cooling demands, in the region of 25–100 W. The thermodynamic efficiency is, despite refinements made over many years, still relatively low. The ratio between the cooling power and required power input is around 0.2 to 0.35; in certain cases 0.5 is possible (Bäckström, 1970).

The patent portfolio gave Electrolux strong protection for its refrigerator throughout the world, well into the 1950s. But later on the protection weakened and several competitors launched production operations around the world. Many years later Electrolux transferred all of the rights and production operations to a subsidiary, Dometic, a company focusing on mobile applications. Absorption refrigerators were still being manufactured in Motala in Sweden up until 2010 when Dometic moved its production to the USA. Some contract manufacturing was carried out in Motala until 2012 by a company called Arktic.

von Platen goes his own way as an inventor

Baltzar von Platen decided to resign from Electrolux in 1927. Axel Wennergren was sorry about his decision and gave von Platen free rein to use of the laboratory. von Platen was financially independent thanks to his substantial royalty income.

Baltzar von Platen found himself at a crossroads. He had multiple interests aside from technology and he writes in his memoires that at this time he should naturally have travelled to Italy. *"I should have taken singing lessons there and recorded gramophone records..."*. He was very interested in music and although he did take singing lessons, he could not abandon his work as an inventor altogether. The notion of a perpetuum mobile of the second kind[1] was always on his mind. He writes: *"It became clear to me on the morning of Christmas Eve 1914"*. His memoires indicate that he pondered this idea his entire life. However, he also presented a number of practical ideas which did become reality, and which will be described only briefly here.

[1]An example of a perpetuum mobile of the second kind is a heat pump that "pumps" heat from a low temperature to a higher without any operating power input. This violates the second law of thermodynamics which, in short, states that heat cannot by itself be transferred from a cold to a warm body.

High voltage direct current

Back in 1927 von Platen had applied for the first in a series of patents for a rotating mechanical device to rectify alternating current. His partners in this work included Professor Johan Emil Alm at KTH and the two men applied for several joint patents for systems of this type. They invented the *Glesum* system consisting of a switching unit driven by a synchronous engine.

Although the Glesum system never really caught on, the basic idea of rectifying alternating current for long-distance power transmission was a sound one. It would take around 20 years before a competitive technology was developed. Dr Uno Lamm at ASEA was behind the development of the so-called HVDC technology using thyristors which made it possible to realise the system in practice. In 1950 energy company Vattenfall built a direct current transmission system between the Swedish mainland and the island of Gotland under a partnership with ASEA. But it would still take until 1961 for the cable to be operational (Fridlund, 1999). Today this is one of ABB's core business areas.

Wood gas engine development

Around 1940 von Platen designed a "wood gas regulator" to create the correct ratio of wood gas to air and a homogeneous mixture at the inlet to an engine's cylinders. He had installed one in his own car. With assistance from aircraft captain Carl Gustaf von Rosen, the rights were sold to Svenska Gengas AB. He writes that he used the extra income from this deal to purchase:

"...a very old boat, a yawl built in 1881. After some restoration work she was very nice. She was originally called "Venus from Callmar". I renamed her Agneta after my eldest daughter..."

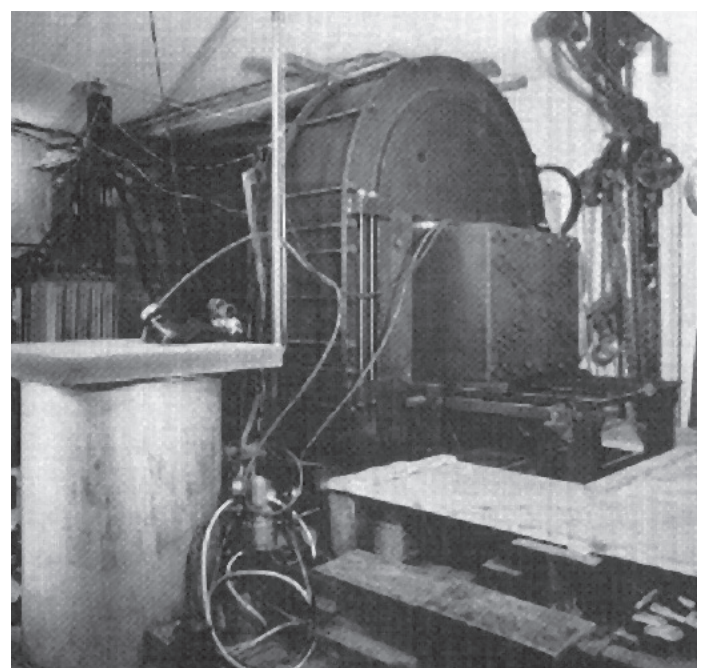
Diamonds

Another of von Platen's endeavours was attempting to manufacture diamonds. He became interested in it back in the 1930s. It was believed that a pressure of 25,000 bars was needed and von Platen decided to design a device that could achieve at least this amount of pressure and in relatively large volumes. To this end he developed a high-pressure press consisting of a regular polygon where each surface was held in place and the pressure at the core was altered by a punch using hydrostatic pressure. von Platen's design could apply forces of around 14,000 tonnes. He used an old technique whereby the structure was held together by flat piano wire wrapped around it several times. The press was named *Quintus*. The name came about when a good friend, Folke Hedrén, noted that this was his fifth major invention and thus the name was adopted (Platen, 1975).

At the beginning of the 1940s, by a strange coincidence, two of the world's leading electrical engineering companies, ASEA in Sweden and General Electric in the USA became interested in the artificial production of diamonds. They were entirely independent of each other and knew nothing about each other's activities. In both cases they were successful, but only after working on the process for more than ten years. Why they invested in this endeavour is unclear since at the beginning there was little commercial interest in

it. Perhaps it was due to the dedication of the individuals who inspired the projects: In the case of GE that person was evidently PW Bridgman, a Harvard professor who had for many years been interested in high-pressure physics (for which he was awarded the Nobel Prize in Physics in 1946) who inspired GE management. At ASEA it was von Platen who in 1941 approached the company about a partnership to finance his experiments. An agreement was signed in 1942 and eventually a laboratory was installed in the Ebba Brahe Palace at Götgatan 16 in Stockholm. Lundblad (1988) writes as follows:

> *"von platen arranged for two floors of the old palace to be converted into a laboratory and a flat. Half of the outdoor 'dry privy' was converted to house the high-pressure equipment (while the other half was used for its original purpose)."*

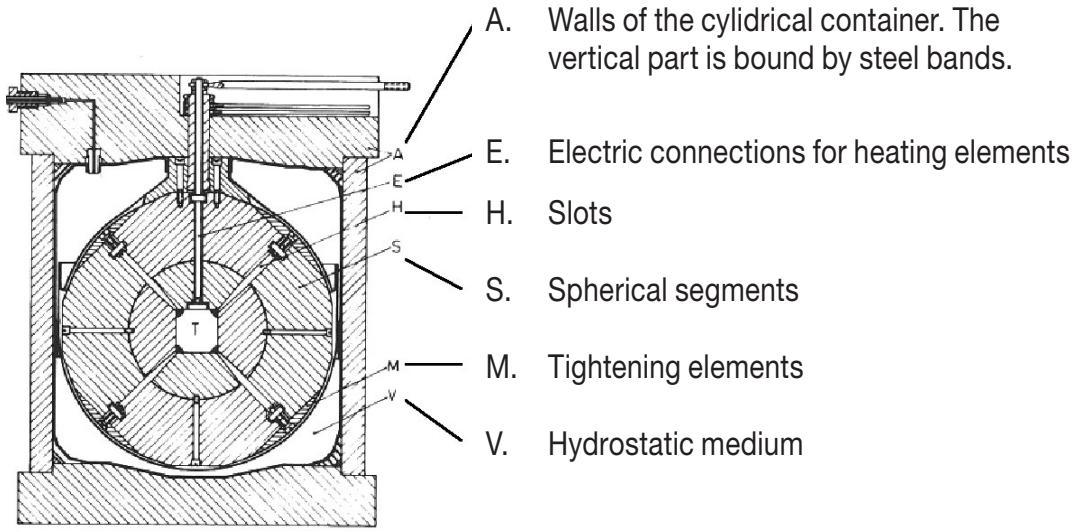


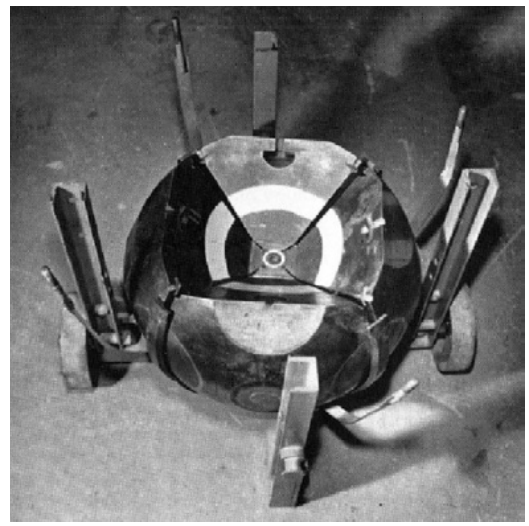
The interior of the high-pressure laboratory, Götgatan 16. The photo shows the press and high-pressure cylinder. Photo: E. Lundblad, 1953 (from Lundblad, 1988)

Progress was slow for diamond manufacturing and von Platen was simultaneously involved in other projects. ASEA's level of interest and investment fluctuated over time as well. But at the end of 1949 the company decided to make a fresh attempt and employed a chemist called Erik Lundblad. ASEA took possession of all of the equipment and von Platen stayed on as a consultant. On his collaboration with von Platen, Erik Lundblad writes somewhat cynically (Lundblad, 1988):

> *"His good reputation as an inventor endured and he rarely had difficulties securing financing for his many invention projects. The projects often fuelled the imagination and gave hope of great wealth to those who went in as investors from the start. Unfortunately, reality was von Platen's worst enemy. It was almost always impossible for the projects to come to fruition. They were instead cut short prematurely or became shrouded in silence, and the investors were wiser for the experience. von Platen was, however, involved in the diamond project to some degree until as late as 1954."*

ASEA decided to continue working on defining the conditions necessary for manufacturing diamonds. A new Quintus lab was set up in new premises. Systematic attempts were now being made to establish stable pressure and temperature conditions to produce diamonds. Success was achieved in an experiment conducted on 16 February 1953 when small crystals were found in the iron-graphite that had been under pressure in the press and analysis showed that these were small diamonds.





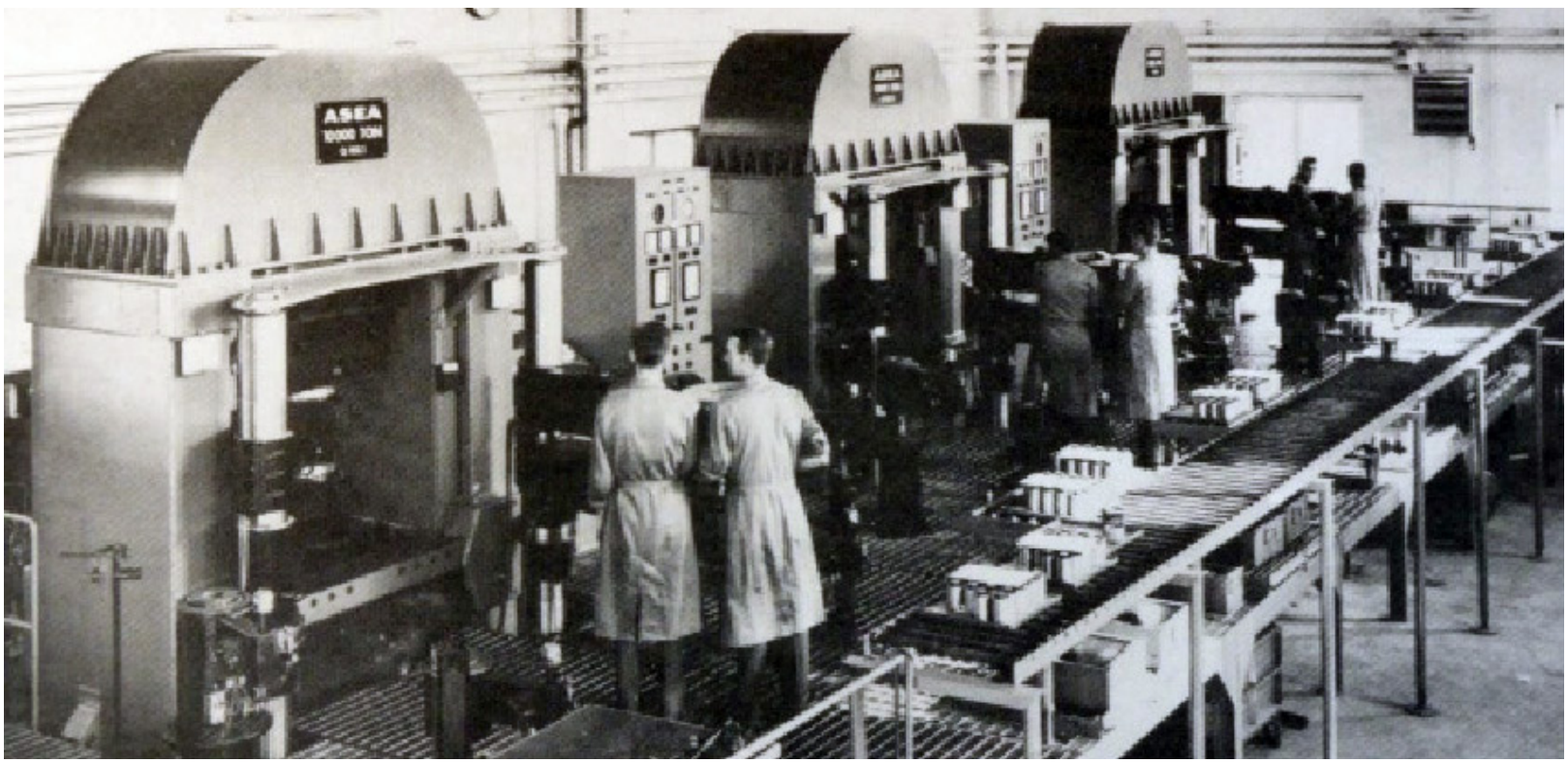
Images illustrating the principle of the Quintus press, Lundblad (1988).

The results were confirmed by more tests in 1953 and ASEA's board of directors was informed. The board, however, decided to delay publication of the findings as well as the patent application until they had an even stronger foundation. This proved to be a very unfortunate move because two years later, on 15 February 1955, General Electric announced the big news that it had succeeded in producing synthetic diamonds. Soon the magazine Nature published an article on 9 June 1955 under the heading "Man-Made Diamonds". Since ASEA had not published its results, a long, complicated and costly patent dispute ensued and continued until the end of the 1960s.

At the beginning of the 1960s ASEA's diamond production took place in the town of Robertsfors. A new division was formed and assumed the Quintus name. Industrial diamond production subsequently picked up speed in Robertsfors.

Industrial diamonds had a revolutionary impact on drilling and processing in the form of “diamond tools”. Methods were developed which enabled concrete to be drilled and sawed almost as easily as wood with conventional methods (Lundblad, 1989).

The industrial diamonds were small, but von Platen also dreamt of producing diamonds that were at least the size of the Koh-i-Noor Diamond. von Platen and the Swedish Government founded a company in Ystad in 1969, Carbox AB, where a gigantic press



The only photograph ever to be released of the press hall in Robertsfors. It is from 1964 and shows three 10,000-tonne Quintus presses with high-pressure equipment for diamond production. In the photo we see that two operators have been intentionally positioned in front of each of the presses to hide the actual high-pressure equipment.

capable of 80,000 tonnes of pressure was constructed. Unfortunately the venture was not a success and von Platen later recounts in his memoires that he felt excluded from the work conducted there.

Non-drip valves and thermostats

Baltzar von Platen was also involved in more commonplace problems. He developed various solutions for thermostats, to control electrical connectors and for valve actuators. In cooperation with AGA, he presented a thermostat for room radiators. The first patent in this category dates back to autumn 1959. The temperature sensor in the thermostat consists of an enclosed plastic mass. The room temperature affects the density of the mass, and his device was therefore able to produce forces strong enough to actuate the radiator valve.

Perpetuum mobile of the second kind

As mentioned above, von Platen also had the notion almost his whole life that it should, under certain circumstances, be possible to circumvent the second law of thermodynamics. He believed that in a very strong gravitational field it should be possible to use the effect of diffusion in a liquid to produce useful work without the need for an external energy source, and in 1973 he filed a patent application. The following year he was awarded IVA's Great Gold Medal and he realised that he needed to publish his ideas before the patent application became public in autumn 1975. He therefore told the daily newspaper

Svenska Dagbladet about his invention and the paper featured it as a top news story on 25 March 1975. This led to more headlines. However, independent analysis later showed that von Platen had neglected some steps in his cycle and this would eliminate the anticipated effect (debate, Teknisk Tidskrift magazine, 1975). His patent application in Sweden was rejected. One high point for him, however, was that he was invited to present his idea at the Swedish Physicist Days on 12 June 1975 in Gothenburg.

A MAN OF MANY INTERESTS

Baltzar von Platen had a passion for art, music and singing. He took singing lessons both in Sweden and Italy, and recorded a number of gramophone records (probably mostly for private use). von Platen lived for long periods in Italy and writes in his memoires that he *"for a couple of weeks was a pupil of one of the world's most famous baritones, and he tried to persuade me to extend my stay in Florence and study singing under him ... His name was Mario Ancona..."*. von Platen had many friends, both in Italy and Sweden, who shared his interest in music.

Carl Munters stayed on at Electrolux, but eventually started his own business

Carl Munters is indicated as the sole inventor on numerous patents filed after von Platen left Electrolux. His work mainly involved improving parts of the absorption apparatus and the refrigerator's insulation. Munters developed ideas on "multi-layer insulation" for refrigerators, which he later would return to in his own business. He also worked with vacuum insulation or insulation that used low heat conduction heavy gases. Although in most cases he was the sole inventor, he applied for a few joint patents with colleagues as well. One example was the following:

Carl Munters and John Tandberg are the inventors of a material that is extensively used to-

No. 2023204

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas CARL GEORG MUNTERS and JOHN GUDBRAND TANDBERG, of Stockholm, Sweden; said TANDBERG assignor to said MUNTERS,

PRESENTED TO THE Commissioner of Patents A PETITION PRAYING FOR THE GRANT OF LETTERS PATENT FOR AN ALLEGED NEW AND USEFUL IMPROVEMENT IN

HEAT INSULATIONS,

A DESCRIPTION OF WHICH INVENTION IS CONTAINED IN THE SPECIFICATION OF WHICH A COPY IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND COMPLIED WITH THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED, AND

Whereas UPON DUE EXAMINATION MADE THE SAID CLAIMANT S ARE ADJUDGED TO BE JUSTLY ENTITLED TO A PATENT UNDER THE LAW.

NOW THEREFORE THESE Letters Patent ARE TO GRANT UNTO THE SAID

Carl Georg Munters, his heirs OR ASSIGNS

FOR THE TERM OF SEVENTEEN YEARS FROM THE DATE OF THIS GRANT

THE EXCLUSIVE RIGHT TO MAKE, USE AND VEND THE SAID INVENTION THROUGHOUT THE UNITED STATES AND THE TERRITORIES THEREOF.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington this third day of December, in the year of our Lord one thousand nine hundred and thirty-five, and of the Independence of the United States of America the one hundred and sixtieth.

Attest:

Image from Rydberg et al., 1984

day in multiple applications. The patent describes the production of what is now called foam plastic and the priority date for the patent in Sweden was 3 March 1931. There is a description of how to achieve "hermetically sealed insulation filled with, for example, halogen gas".

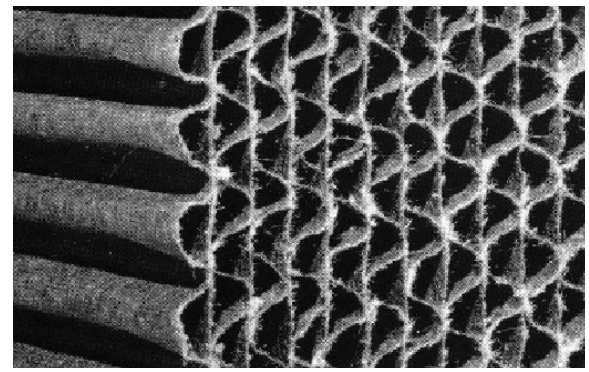
This patent probably came too early. Electrolux did not find an investor until the end of the 1930s. The US chemical company Dow acquired the rights but rather than as insulation material, it was first used in life jackets and life rafts. This material would later be used in a vast number of products.

Business owner

In the mid-1930s Carl Munters felt that he was at a crossroads: He considered continuing to work as a physics researcher and made some contacts in that area. But in the end it was his calling as a more practical designer and inventor that took precedence and he decided to start his own business. In 1936 he resigned from Electrolux. His company, Munters Industri AB, was formed in 1938 for the purpose "of exploiting his inventions and as a manufacturing and sales business".

The company acquired premises in Ulvsunda close to Bromma Airport and Carl's brother Birger was appointed as Managing Director. The company first started manufacturing corrugated cardboard for packaging, but the real purpose was no doubt to use it for various types of insulation. In 1941 Munters presented an insulating material called *Wellit* which was multi-layer insulation consisting of corrugated layers of asphalt-impregnated

paper. The structure proved to have many beneficial attributes; it had "superior insulation properties, moisture resistance, was highly economical, very stable and strong, and lightweight".



Close-up of Wellit insulation.

While working on his insulation material Carl Munters contacted a couple of competitors, who were mainly using cork for heat insulation. A company was formed in 1946 under the name WMB from the founders' initials (Wicander, Munters and Berner). The company's product range included various materials including cork, Wellit, powder and fibre. One of the company's assets was its patent portfolio in which Munters was responsible for 26 patents. Later on Wellit insulation was replaced by various types of mineral wool and foam plastic. In 1967 WMB was sold to Metallverken in Västerås and the company continued operating for a while under the name Gullfiber.

Laboratory on the grounds

In 1940 Carl Munters purchased an impressive home with large grounds in Stocksund north of Stockholm. It would later be known as *"Munterska villan"*. On the grounds by the water he set up a small laboratory in a structure of around 200 m^2 which was ready for use in 1947. Before long some interesting new and entirely different products were developed here.

This new époque originated from an idea that Carl Munters came up with for an air conditioning system in 1948. He imagined an open system where the air to be cooled

Munterska villan

would first be dried to resemble dry hot desert air, then cooled with a heat exchanger and cooled further by allowing water to evaporate in the dry air. The process thus required three components: an *air drying* device, an efficient *heat exchanger* and an *air humidifier.*

The system developed by Munters would be given the working name the *Lizzy System.* The project was much more comprehensive, expensive and demanding than anticipated. This field is now called desiccant cooling and is often a topic at international conferences on cooling technology, or may even have whole conferences dedicated to it.

The project suffered a serious set-back when the laboratory in Stocksund was devastated by fire in 1963 during prototype testing. The entire lab building went up in flames.

Carl Munters and his colleagues 1963. Carl Munters is the man in the dark suit and tie in the middle.

The laboratory in Stocksund on fire in 1963.

At the end of the 1960s the work on Munters' Lizzy project was abandoned, but the company continued developing the components.

New company and new products

Over the years Carl Munters formed several different companies to commercialise ideas with various partners. Carl Munters & Co AB was formed in 1955 with SEK 3.3 million in share capital and Carl Munters and Marcus Wallenberg each owned 38% of the shares. The remaining shares were held by Munters' partners in WMB, Carl Gustaf Wicander and Erling Berner.

In 1969 the company moved to new premises in Sollentuna and a new laboratory was set up. Discussions with, among others, Sven Brohult Chairman of the Royal Swedish Academy of Engineering Sciences (IVA) at the time and Marcus Wallenberg led to Carl Munters & Co AB being included in the newly launched Incentive AB. More recently Munters AB has been both listed and then delisted from the Stockholm Stock Exchange.

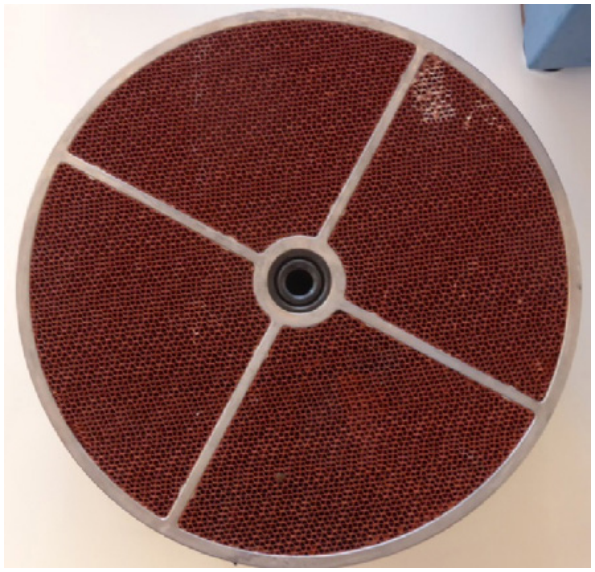
Since 2010 Munters AB is owned by Nordic Capital Fund VII. It now is a large international group of companies represented in some 30 countries with close to 3,000 employees and annual net sales of around SEK 4 billion.

The work to develop the Lizzy air conditioning system provided a breeding ground for the development of new products. All of these products have a corrugated structure through which air can flow at a relatively low speed and often with a laminar flow. Thanks to the small dimensions of the channels (as small as around 1.5 mm) the heat exchange performance is good even in the case of a laminar flow. Since the speeds are kept at a low level, the drop in pressure is not a problem. The introduction of laminar structures made the heat exchangers and air dehumidifiers more efficient and compact and at the same time cheaper to produce. The traditional technology for air drying at the time was rendered obsolete.

Munters and his colleagues thus were remarkably productive and their work resulted in three separate, stand-alone industrial applications, namely:

- The air dehumidifier. This is a product with multiple applications. One specific version which is required to maintain extremely low humidity is used in pharmaceutical manufacturing. Dehumidifiers are used in the food industry as well as in animal stables. Atmospheric corrosion is also avoided by dehumidifying air. Munters AB, the company, has delivered more than 10,000 dehumidifiers to the Swedish armed forces alone, and the technology is used throughout the world to protect defence ma-

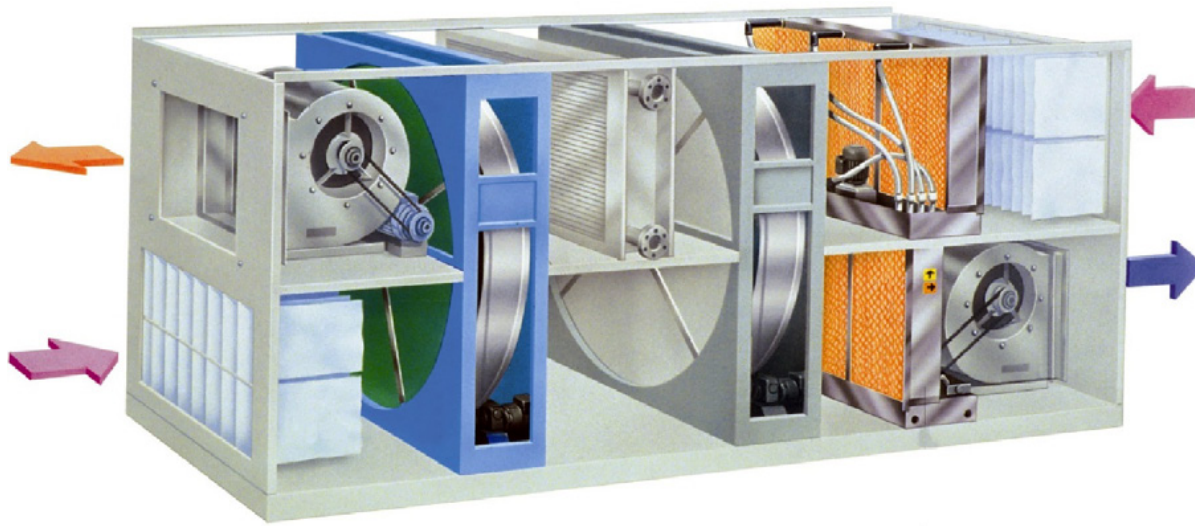
terials. Dehumidifiers are used to protect steel bridges as well as turbines when they are shut down. An emergency drying service after flooding accidents in buildings was another important division within the company up until 2010 when it was sold.



A version of the Munters desiccant rotor for drying air that is used today. The same type of structure (but with other materials) is used in regenerative heat exchangers for ventilation air in buildings.

- REGENERATIVE HEAT EXCHANGERS for air in building ventilation etc. It could be seen as an alternative design and application for "Ljungström's air preheater", with entirely different materials and dimensions. Here the corrugated structure in the form of rotors proved to be perfect for the purpose. One interesting property of the heat exchanger is that it can be used to transfer moisture if necessary. It is manufactured in various sizes with rotors measuring from a few decimetres to several metres.

- THE COOLING TOWER and AIR HUMIDIFIER with a new type of filler material for water evaporation coolers or air humidifiers. One application for the latter is cooling greenhouses in hot climates. The so-called cross structure is also used in scrubber systems, for flue gas cleaning, waste water purification and in the chemicals industry.



The Desi-Cool *system uses low-grade thermal energy to cool and condition air in large buildings* (UNT Uppland, 1994). *It is combined with heat recycling in the winter. Thus Carl Munters' idea from more than 50 years earlier in 1948 was realised (illustration from a brochure, 2013).*

The active development work on the Lizzy project was, as mentioned, ended at the end of the 1960. About 30 years later it was rejuvenated and the system has been installed in buildings for air conditioning since the end of the 1990s. It now goes by the name *Desi-Cool* and was almost 50 years in the making!

Carl Munters continued to come up with new applications. One of his last patents has the heading *"On the osmosis effect to generate energy from sea water"* with a priority date of 13 June 1975. It describes the principle using membranes to create a significant difference in pressure between fresh water and sea water (at the mouth of a river). The idea was to use the pressure difference to generate power – in other words it was an advanced hydroelectric power generator.

Carl Munters and Lennart Lindqvist, who was Managing Director for Carl Munters & Co AB for 19 years, studying the "cross structure" in an evaporation cooler. The structure is rinsed intermittently with water while air flows horizontally through it. The design allows for good contact between air and the water surface.

In the background we can see the rotor of a large regenerative heat exchanger. Munters' dehumidifier looks the same but the corrugated structure is made of different materials.

The photograph is probably from the mid-1970s (from Rydberg et al., 1984).

Conclusion

Baltzar von Platen and Carl Munters are above all known for their remarkable invention of the refrigerator without moving parts which they made as technology students at the beginning of the 1920s. Together they succeeded in realising and commercialising their idea into an important industrial product which is still being manufactured today – albeit no longer in Sweden. Their collaboration as young men was like a shot in the arm – success breeds success – and they continued, individually, to develop products and push the boundaries of technology in other directions as well. Their efforts resulted in products that still have broad applications today.

Carl Munters and Baltzar von Platen are among the last representatives of the group of inventors who created the great Swedish industrial tradition at the beginning of the last century. Both had unique qualities, not only in terms of their brilliance, but also their determination and ability to pursue their ideas to create innovations and finished products.

Biographical data

Baltzar Carl von Platen was born on 24 February 1898 in Malmö and was married 1925–1928 to Brita Catharina née Vitus, (born 1898, died 1985) and had a second marriage, 1930–1942, to Doris Signe Maria née Kofoed Fernström (born 1906, died 1998). There was one daughter in the first marriage, and a son and a daughter in the second (the son, however, died at an early age). von Platen died on 29 April 1984 in Italy and is buried in Ystad (in the same grave as his son Baltzar Philip Casimir who was born 1931 and died at the age of six). A memorial stone was erected in 2012 in Ystad in memory of Baltzar von Platen.

Carl Georg Munters was born on 22 March 1897 in Dala-Järna in Vansbro municipality. In 1925 he married Anna Eugenia Geralf (born 1896, died 1951). He later married Marianne Warkander (born 1924, died 1983). In 1940 he acquired an impressive property, Villa Stocksberg (or "Munterska villan") in Stocksund. The property was sold in 1967 and in 1970 the family moved to Switzerland where Carl died on 29 March 1989. He is buried in Järna cemetery in Dalarna. His first marriage was childless, but he had a son and a daughter in his second one. Today the surviving family members no longer have any financial stake in the Munters companies.

Distinctions

Carl Munters and Baltzar von Platen were honoured with a number of distinctions, including:

Teknologföreningens Polhemspris 1925. For their invention which is described in a paper entitled "Om alstring av kyla" (On producing cold).

The John Price Wetherill Medal 1932. "For their Pioneer Work and Ingenuity on the Evolution of an Absorption Type of Apparatus for Refrigeration (...)". Awarded by the Franklin Institute, Pennsylvania, USA.

IVA's Great Gold Medal 1974. In recognition of "their more than fifty years of work as inventors and innovators of industrial products".

Stora Energipriset 1984. Established by Dagens Industri and Theorells Ingenjörsbyrå; was awarded to Carl Munters.

References

Berglund, R., *Ny produkt från ABB och Munters: Freonfri kyla ska ge Uppland jobb,* Newspaper article in UNT Uppland, 2 September 1994

Bäckström, Matts, *Einfache Theorie der Gaszirkulation in Sorptionskälteapparaten nach v. Platen und Munters,* Royal Institute of Technology Documents, no. 101, Stockholm 1956

Bäckström, Matts, *Kylteknikern,* Stockholm 1970

Debate, *Därför har von Platen fel… nonsens svarar han.,* Teknisk Tidskrift, no. 13, 1975

Electrolux/Servel, Information materials, late 1920s

Fridlund, Mats, *Den gemensamma utvecklingen: staten, storföretaget och samarbetet kring den svenska elkrafttekniken,* Doctor's dissertation, History of Technology, KTH, 1999

Geppert, H., *Verfahren zur erzeugung von Kälte mittelst einer kontinuirlich wirkenden Absorption-skältemaschine,* Kaiserliches Patentamt Patentschrift no. 122 949. Priority date 9 May 1899

Munters, Carl G., *Examensarbete* (om kylmaskin utan rörliga delar), Degree project, spring term 1922, Combustion engine technology, KTH

Munters, Carl G., *Igångsättningsvev för explosionsmotorer,* Swedish patent no. 49 482

Munters Carl G., *Om osmoseffekt för att alstra energi,* Swedish Patent no. 403 820

Lundblad, Erik, *Om konsten att göra diamanter,* Daedalus – Tekniska Museets Årsbok 1988

Lundblad, Erik, *Diamanter. Utvecklingen vid ASEA 1953 – 1965,* Daedalus – Tekniska Museets Årsbok 1989

Rydberg, Sven K.W. and Gullers, Peter, *Möte med Munters,* Gullers Pictorial AB, Stockholm and AB Carl Munters, 1983

Svenska Kyltekniska Föreningen, *Den svenska kylteknikens historia,* Anniversary book, Stockholm 1992

von Platen, Baltzar C., *Problemet: Kylmaskin utan rörliga delar,* Degree project, spring term, 1922, Combustion engine technology, KTH

von Platen, Baltzar C., Memoarer. *Andar och perpetuum mobile,* Bjurströms förlag, Ystad, 1975

Royal Swedish Academy of Engineering Sciences

IVA-M 447 • ISSN 1102-8254 • ISBN 978-91-7082-881-2