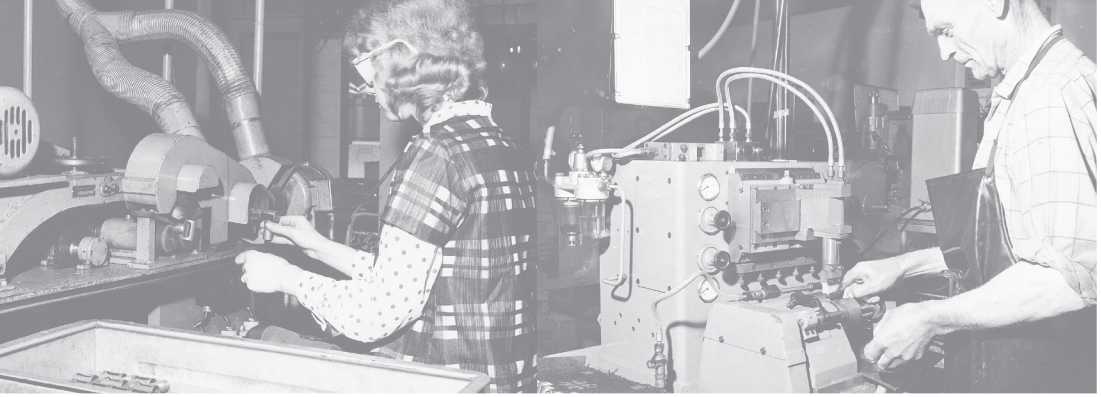
WITH MORE THAN 50 YEARS OF EXPERIENCE IN COMPRESSOR TECHNOLOGY AND HIGHLY COMMITTED EMPLOYEES, OUR FOCUS IS TO DEVELOP AND APPLY THE ADVANCED COMPRESSOR TECHNOLOGIES TO ACHIEVE STANDARD SETTING PERFORMANCE FOR LEADING PRODUCTS AND BUSINESSES AROUND THE WORLD.

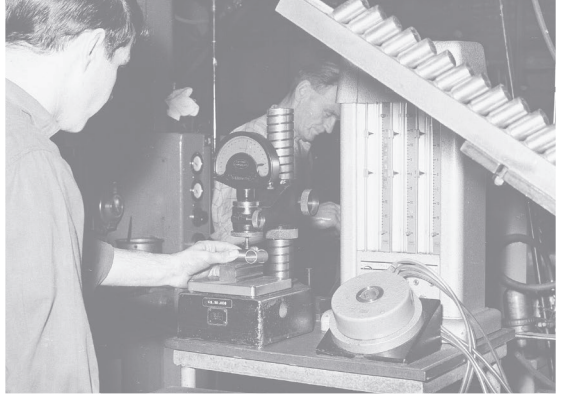
COMPRESSOR BUSINESS
AN INDUSTRIAL HERITAGE

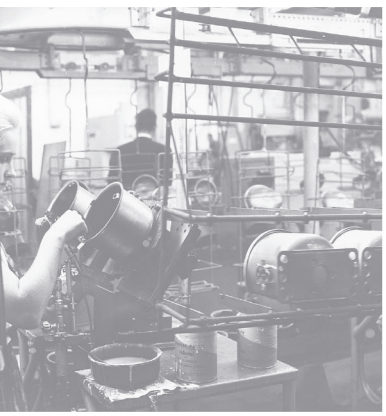
SECOP

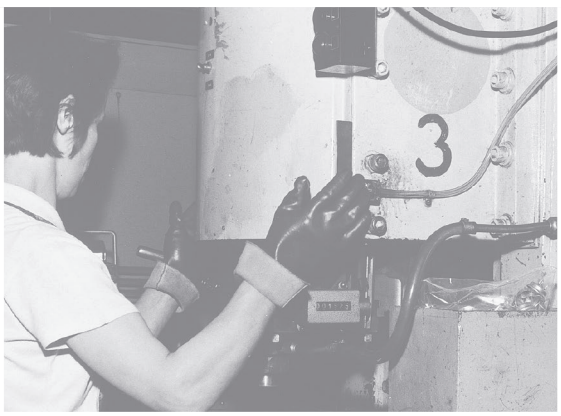
A NEWCOMER WITH 60 YEARS OF EXPERIENCE
Formerly known as Danfoss Compressors, Secop is one of the founding fathers of modern compressor technology with an experience that goes back to the beginning of the 1950's. This book tells Danfoss Compressors' history from 1950-2008.

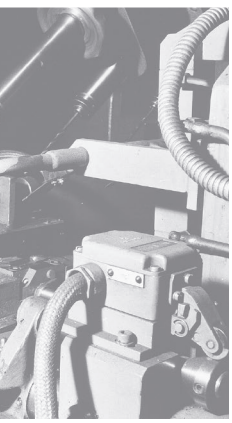
with kind permission of Danfoss

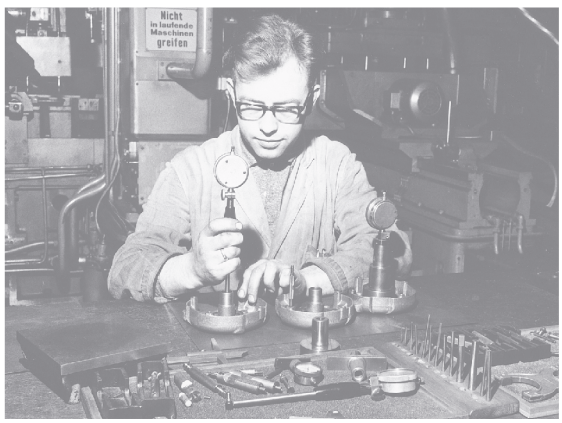


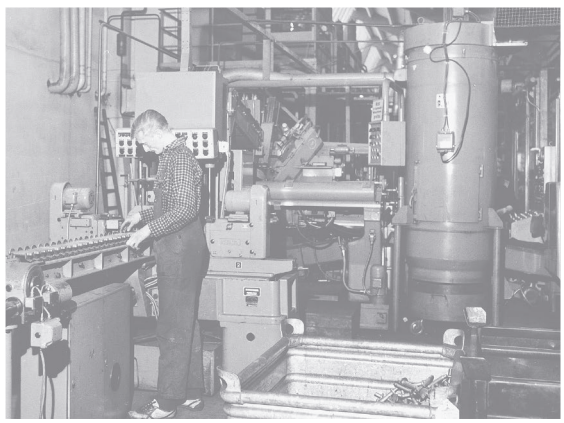


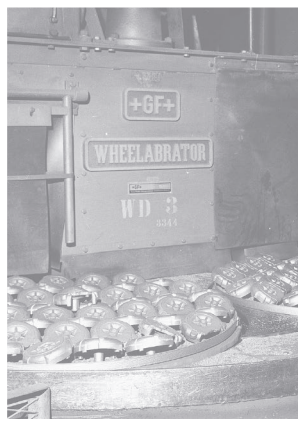


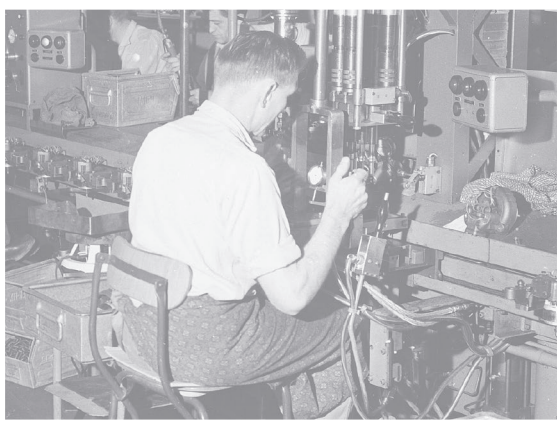

3

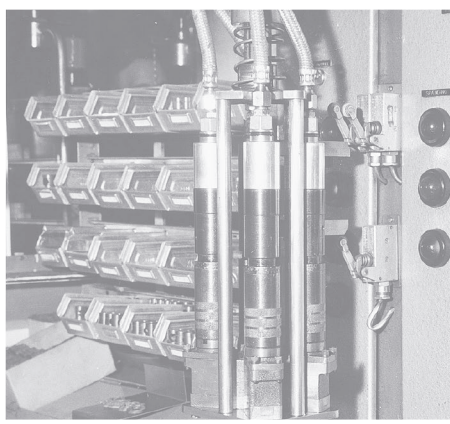


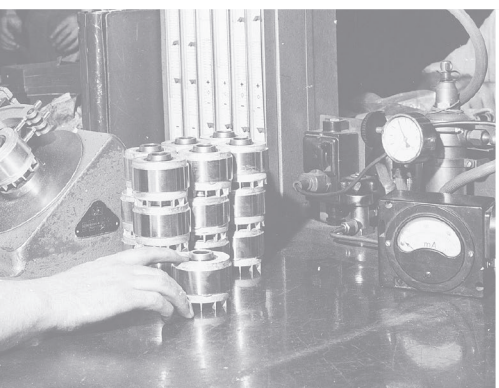

Nicht
in laufende
Maschinen
greifen

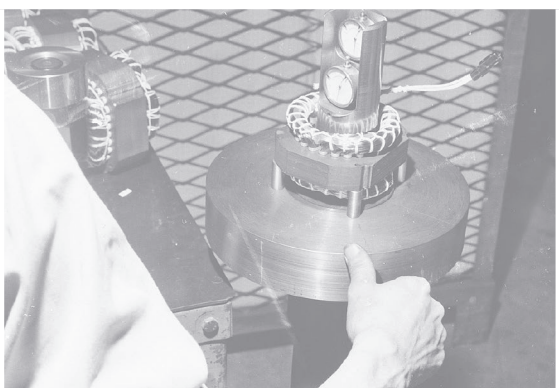


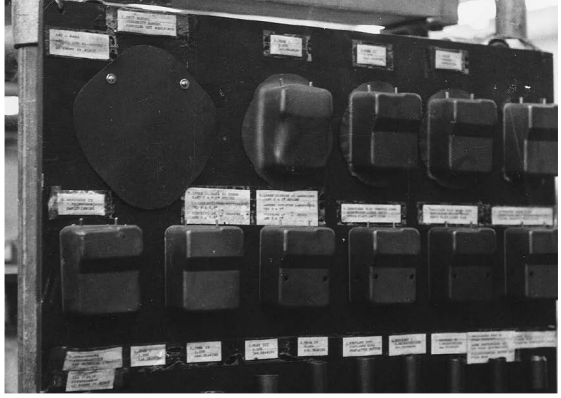
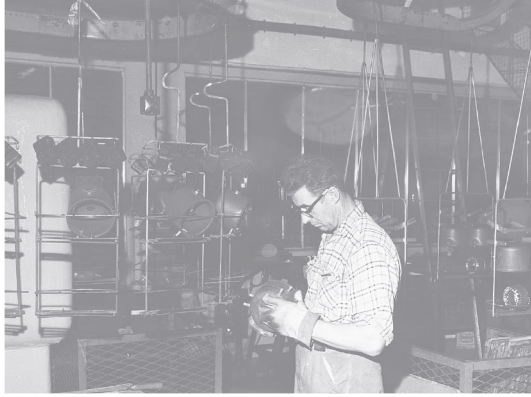
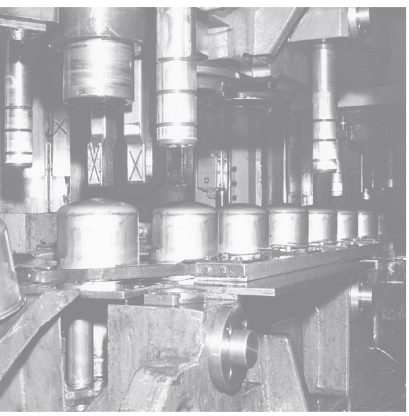
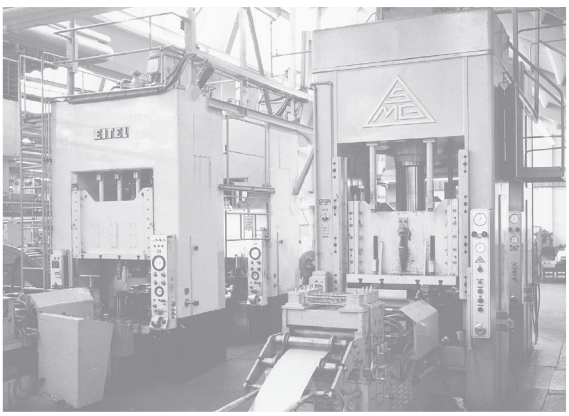
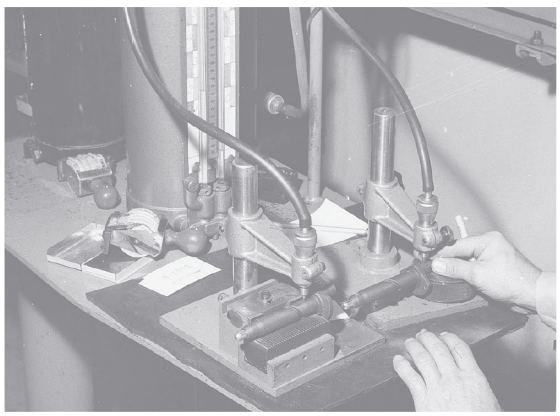

+GF+
WHEELABRATOR

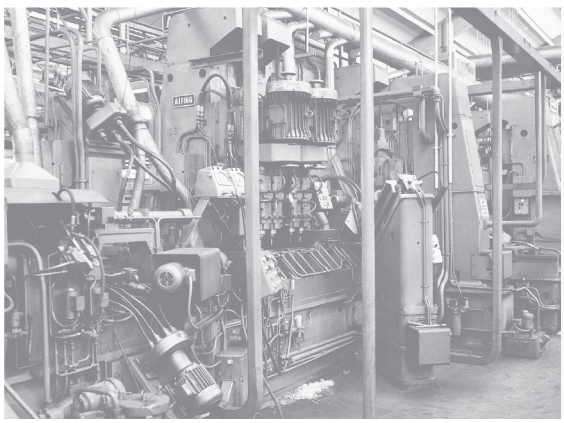
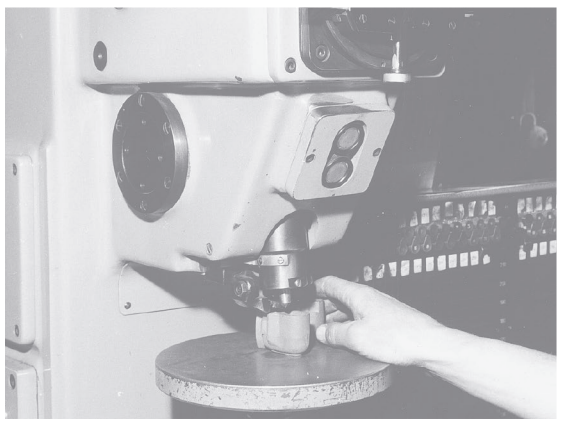
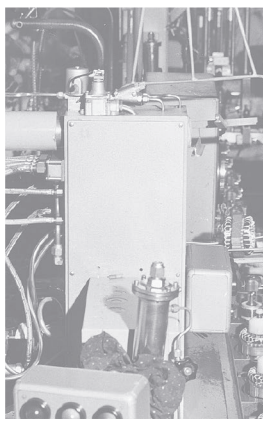


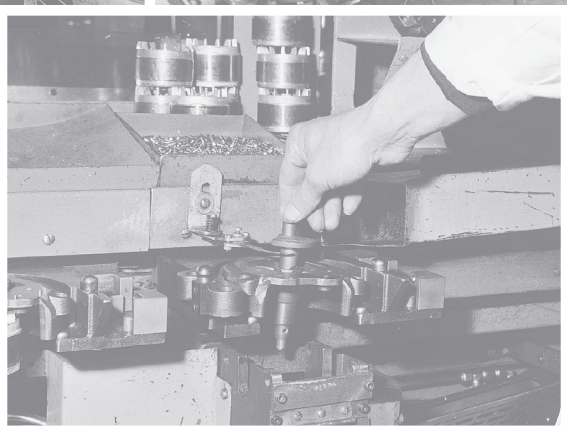




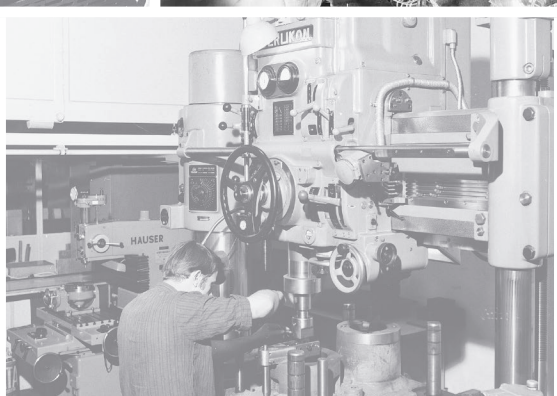
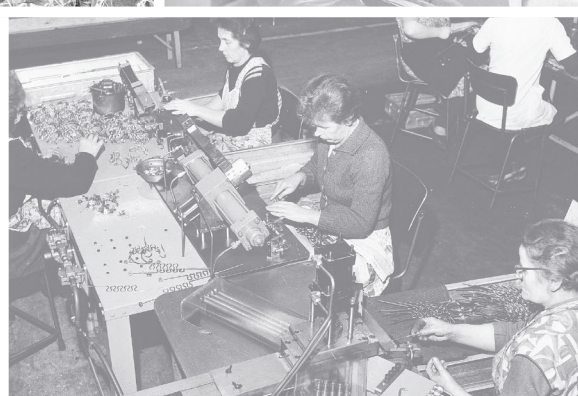


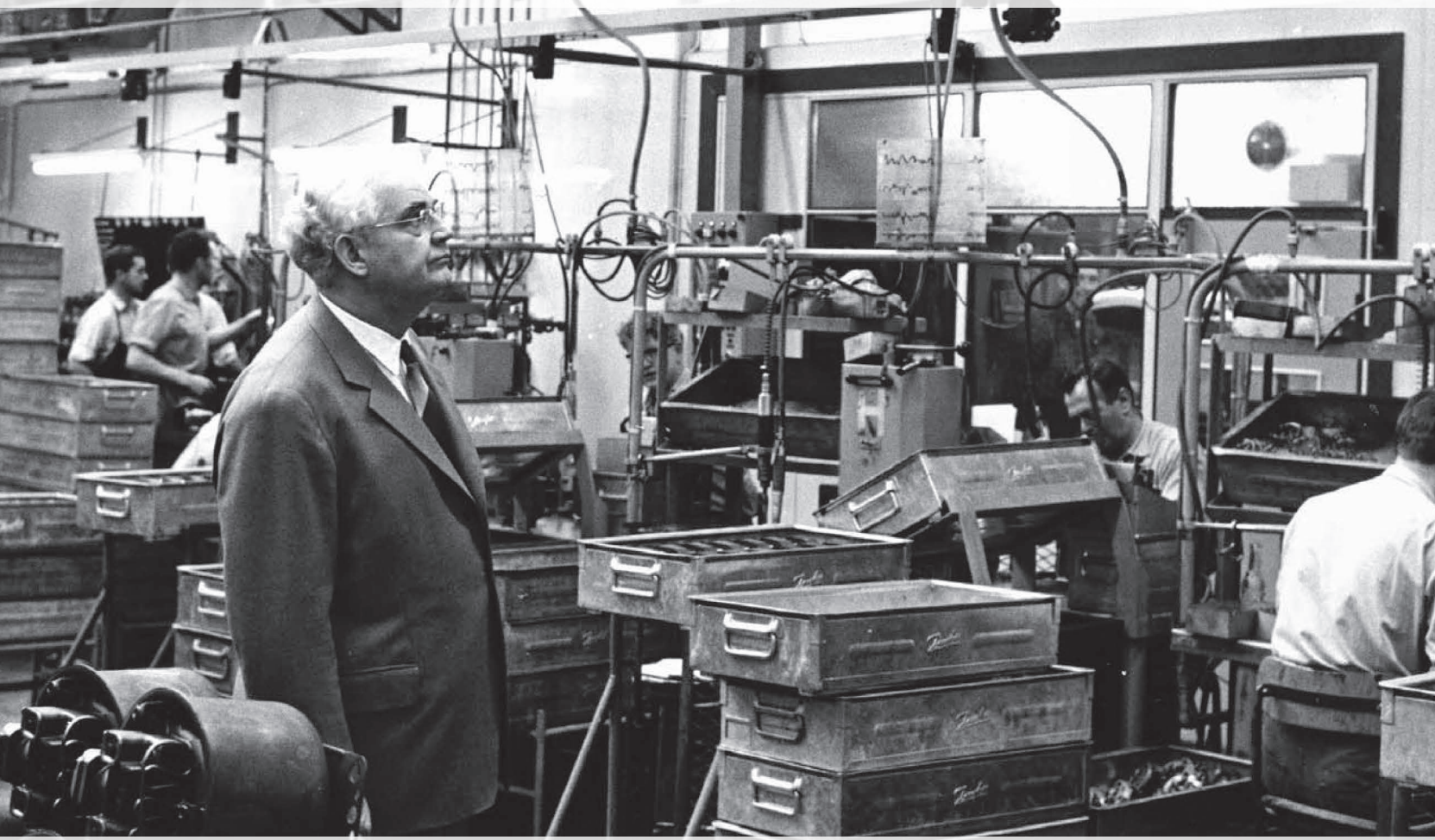





EITEL






Meßbereich
Oberflächenmeß
Perth-O-Meter

HAUSER


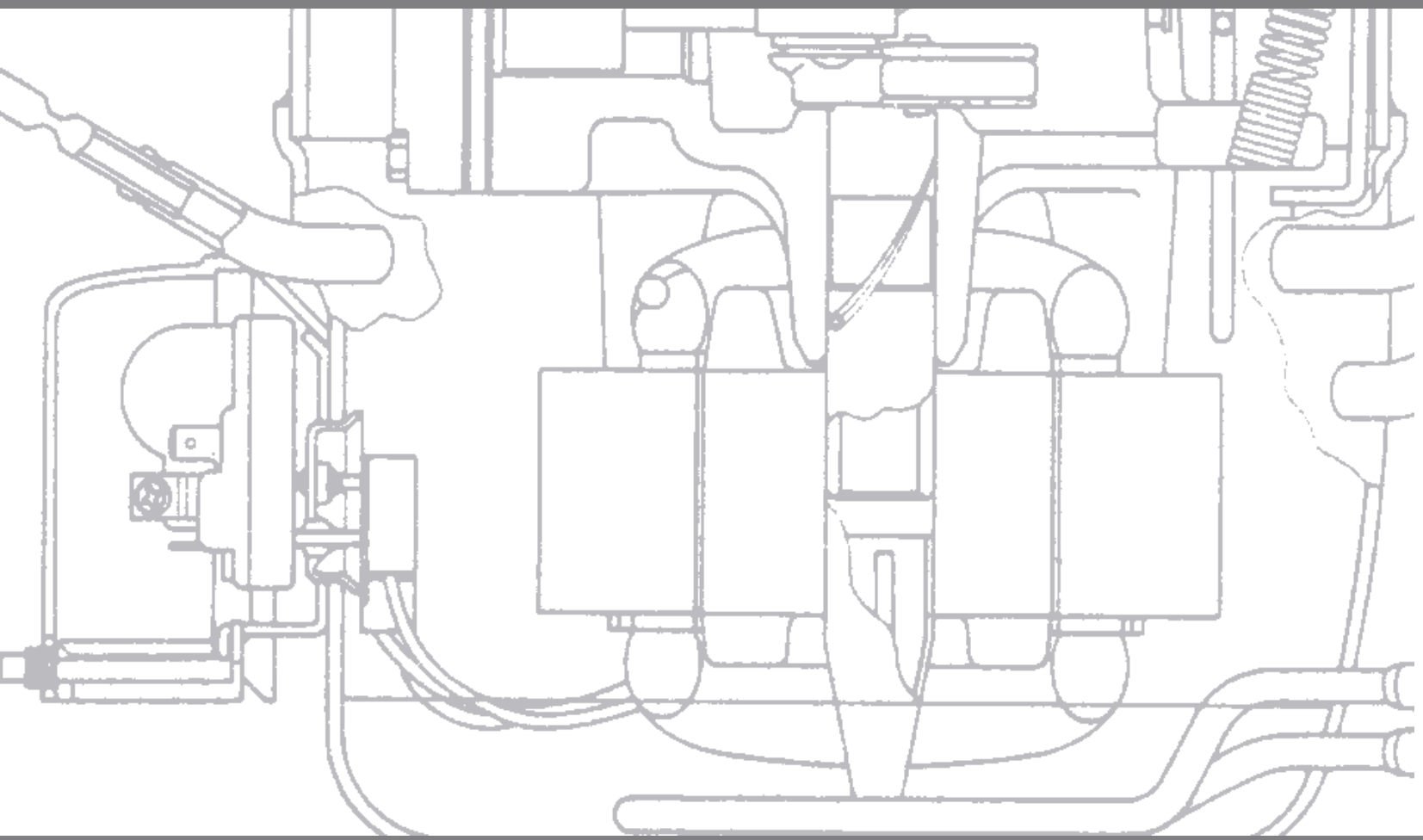


Danfoss Compressor Business

AN INDUSTRIAL HERITAGE

told by former and current employees

DESIGN
Laursen Grafisk A/S, Tonder
The book is set with Myriad Pro

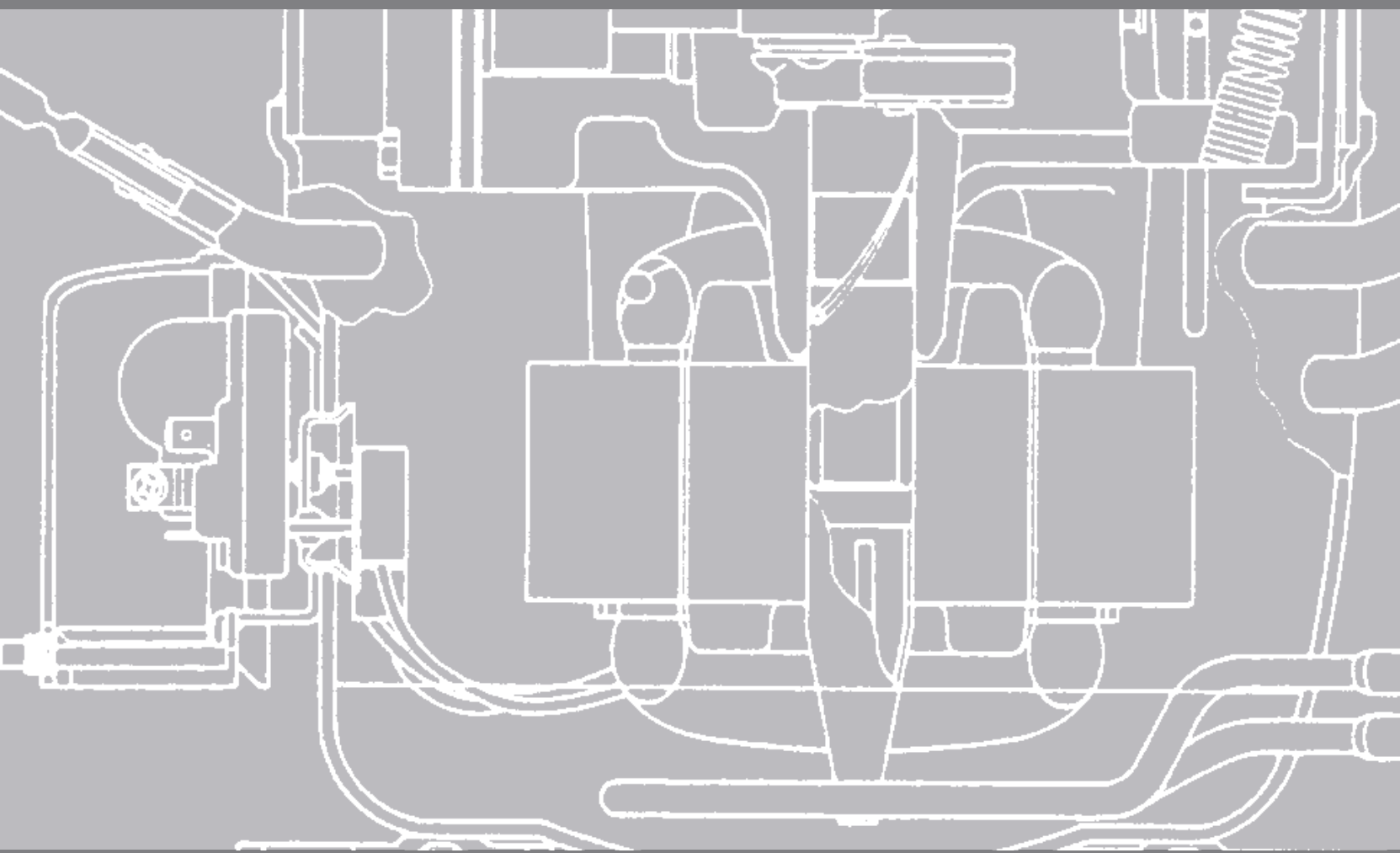


ABOUT THIS BOOK
»Danfoss Compressor Business« is published by Danfoss A/S, Nordborg.
The book tells the story about this business area from the early start in 1950 until present time.

TEXT
The book is written by journalist and CEO Ole Sønnichsen, Storyhouse, and freelance journalist Sune Falther, based on interviews with – and written draft material from – former and current employees at Danfoss. Illustrations: the Danfoss archives.
An editorial group appointed by Danfoss Historical Archive has been responsible for the editorial and graphical work.

The Editorial Office's work ended in October 2008.

TABLE OF CONTENTS



FOREWORD

The pulse of Danfoss

Compressors are historically one of the most productive business areas in Danfoss. The compressor business has generated a huge cash flow. At the same time, the compressor business is also an area that has been highly volatile, and therefore, certainly an important part of the pulse of the entire Danfoss group.

In the same way that a compressor is the heart of a cooling system, the compressor business has been the heart of Danfoss. And since it is important to carry along your heart, we have found it quite appropriate to mark the history of the compressor business with this book.

The compressors were always the most important. We could do everything we wanted with thermostats and valves and we could be in the middle of introducing something new to the management, but if a problem with the compressors came up, we might as well put everything on hold. The compressors always have first priority.

When I, after ten years in the Automatic group, switched to the compressor group, it was a switch to a completely different world. It was a completely different focus, a different pressure.

The compressor business is the only business in Danfoss which was born as a global business, and it has always been facing global competition. The compressors have always been big money, big development, big production, big sales. The compressors have always meant a lot of money. Because of this pressure, many managers at Danfoss have come from a background in the compressor business. They have had a tougher work life in a difficult business area – but this experience is an advantage when they need to succeed in top management.

It is appropriate here to thank all the staff who, over the years, have made the compressor business to what it is today. However, a special thanks goes to those who have contributed with text and input to this book. An additional special thanks must go to "Danfoss Historisk Forening" and the many members who collected and organised the material.

Welcome inside the engine room at Danfoss – and happy reading.

HANS KIRK

Executive advisor, Danfoss A/S

A new market

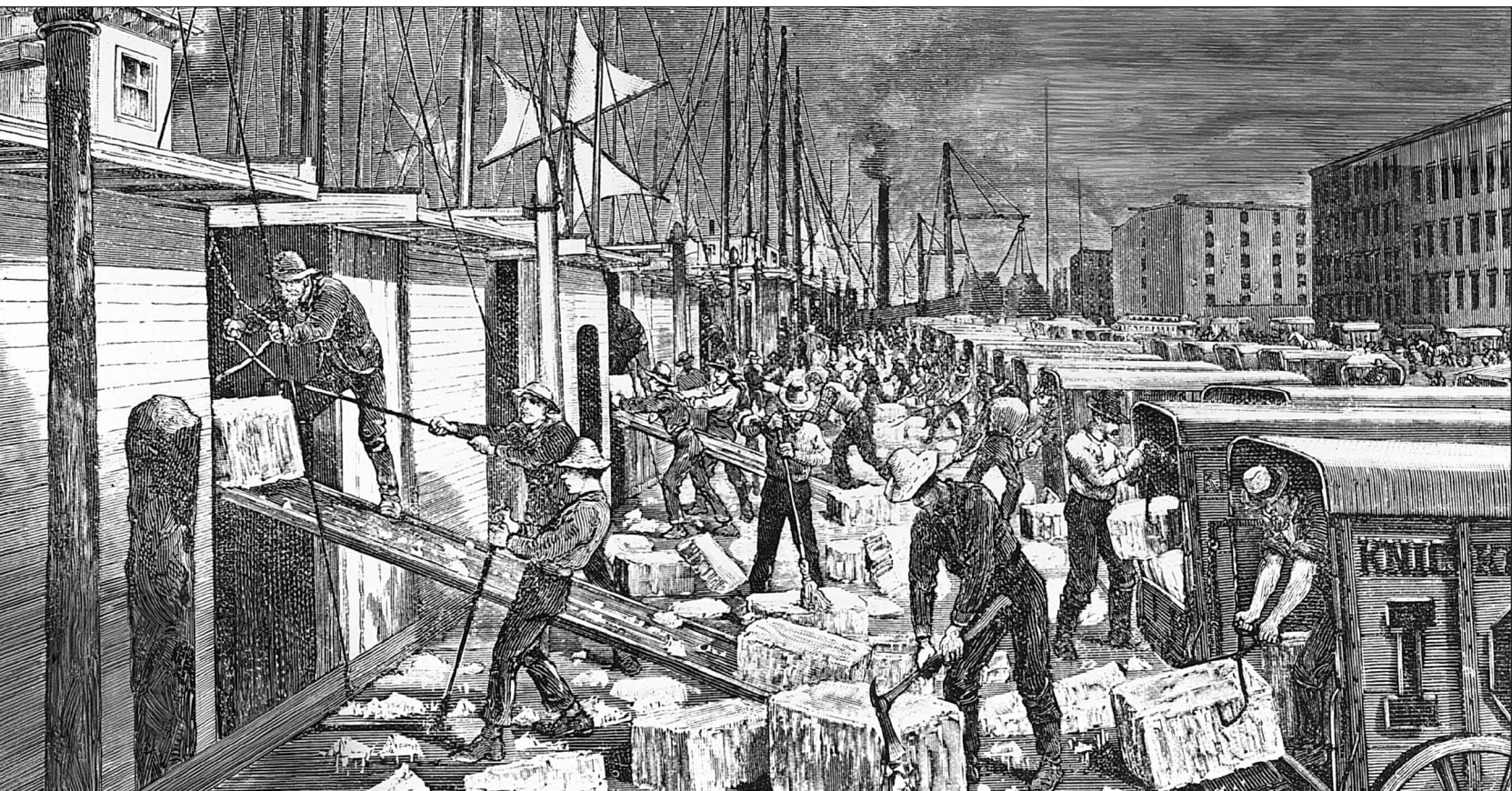
In 1946, much had changed in Europe. War had been the only focus of attention during the previous six years - now peace time had come and the reconstruction of growth and progress. New opportunities

The manufacturer Mads Clausen had many opportunities. On the other hand, he also had his speculations. The expansion valve, which was the main product of the manufacturing company, Danfoss, was not in demand to the extent that it should. In the world that was taking shape in 1946, customers asked for other products.

Until then, the cooling production had largely been reserved for ice houses. For need of something cold in your home, an ice block from the dairy was brought home and placed at the bottom of the ice box, then the ice could cool the food as the ice block melted. Or you would find a common refrigeration system placed in blocks of flats.
New, so-called hermetic compressors in a compact design made it possible for more people to have their own refrigerator at home.

Danfoss' expansion valve was suitable to the cooling production at the dairy or for central cooling units in large apartment buildings – a market that was clearly in decline. Danfoss did not produce hermetic compressors.

Distribution of ice blocks.



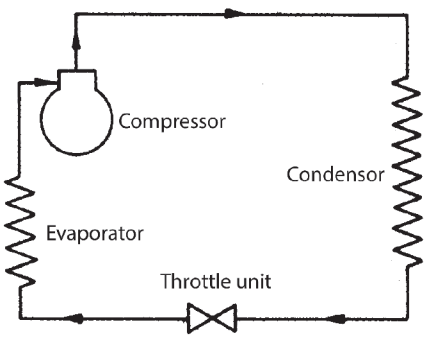
Threat and opportunity

Mads Clausen had knowledge that several Danish companies were working to establish the production of hermetic compressors. He had, among other things, questioned the Danish domestic appliance manufacturers such as Sabroe, Atlas, Gram and Nordic Køleteknik. All stated that they had great confidence in the market for hermetic compressors, and that they considered to start production of these.

From Detroit in the United States, reports stated that Tecumseh Products produced about 20,000 hermetic compressors – every week.

Tecumseh hermetic compressors were small by standards of the day. At least small enough to be seen as practical and useful and as an important part of refrigerators and freezers, which were still only within reach for a minority of people, but which could very well become an everyday commodity for most people, once the cleaning up after the war had finished and the world would be able to think ahead again.

Hermetic compressors and use of capillary tubes were therefore a threat to Danfoss' core business – the expansion valve – but largely also an opportunity to enter a new business area.



THE COOLING HISTORY

Chilling has been known for centuries as a preservative for perishable foods. A preservative, which was only accessible in places, where people could obtain ice during the winter. In practice, ice from lakes and rivers were cut in blocks and stored in heavily insulated rooms or pits from which it was retrieved when needed for cooling. By use of the mechanical refrigeration, cold production became easier, because the ice could now be manufactured artificially. Now ice factories popped up, where blocks of ice were produced in large-scale operations and delivered to dairies, from which the consumer could fetch ice. The ice was placed in an ice box at home in the kitchen in which it melted and cooled the contents. The principle sounds old-fashioned, but the method was actually used up until the mid-1900s.

Gradually it became possible to produce the refrigerator systems so relatively small that they could be moved to where the cold was to be used. This meant, for example, that a refrigerator system could be placed in the basement and from there the refrigerant was circulated to insulated cabinets placed in the apartments.

Danfoss supplied expansion valves to control the temperature in these refrigeration systems. The expansion valve was Danfoss' first, largest, and most important product.

THE HERMETIC COMPRESSOR

The hermetic compressor has Danish pedigree since a Danish engineer named Christian Steenstrup, working at General Electric in the United States, as early as around 1930 had developed a functional hermetic piston compressor for use in refrigerators. During the 1930s, several manufacturers of hermetic compressors evolved in the U.S. such as: Westinghouse, Gibson, Frigidaire and Tecumseh, but in Europe the war stopped all development.

Mads Clausen purchased 200 compressors from Tecumseh and his engineers and technical staff methodically dissected the technology. They analyzed and tested, screwed and disassembled.

The new compressor from the USA was built and tested on five purchased refrigerators. Compared to the previously known, open

THE TECHNIQUE IN A HERMETIC COMPRESSOR AND COOLING SYSTEM

A hermetic compressor and a hermetic cooling system is a system without fittings, flanges or gaskets. Everything is soldered or welded together.
The compressor, which is the heart of the cooling system, consists of a combined pump and electric motor encased in a single housing. In addition, the compressor has an electric start and protection system.
The compressor is without stamp rings, so the seal between the piston and cylinder is established only with a clearance of few thousandths of a millimeter.
There must also be some room for an oil film to ensure wear resistance and long life.
A refrigerator cabinet (refrigerator or freezer) consists of an isolated cabinet in which is placed a cooling element or evaporator.
In a closed circuit, the compressor draws the refrigerant gases from the evaporator and the heat needed for evaporation is taken from the environment, including the food inside the cabinet. In addition to keeping food chilled / frozen, the cooling system must also remove the heat which occurs from the insulation and doorways.
But where does the heat go?
Outside the chilled room, a kind of radiator or condenser is placed, from where heat is transferred to the surrounding air. The refrigerant gases from the evaporator is sucked into the compressor and compressed to a higher pressure and thus a temperature higher than the surrounding area, thereby the transfer of heat can take place.
At this point of the process, the refrigerant condenses and it converts from gas to liquid.
In order to maintain the necessary pressure difference between the evaporator (suction side) and condenser (pressure side), we connect those with a so-called throttling device that can consist of a capillary tube or expansion valve. Both components have the task to inject into the evaporator the necessary volume of refrigerant.
The brain of the refrigerator cabinet is an electronic or mechanical thermostat designed to provide a start and stop to the compressor in dependence of the thermal requirements of the refrigerator cabinet.
In the refrigerated room or on the evaporator, the sensor of the thermostat is placed, whereby a signal to start or stop the compressor in dependence of the need for cooling takes place, since a switch contact is created inside the thermostat that can make or break the power to the compressor.

compressors, they were much more silent and Mads Clausen had a cabinet placed in the attic near his office. It had a control light, so that he could see if the compressor was running.

After a few days a message came, requesting the removal of the cabinet again. It was placed just over Mads's parents' bedroom, and it disturbed their night sleep.

After extensive testing, it was clear to Mads Clausen that Danfoss mastered the necessary production technology to venture into the market. He decided that Danfoss should produce hermetic compressors. Already, he had – with the noisy refrigerator placed above the bedroom - received the first knowledge: that noise and vibration are very important comfort parameters in the design work of hermetic compressors.

License agreement with Tecumseh

In September 1950, Bitten and Mads Clausen travelled to Detroit to visit Tecumseh. The aim was to obtain and bring home a license, so that the first Danish production of compressors could start up in Nordborg – based on the Tecumseh S model.

During their stay, Mads Clausen became aware that Tecumseh was developing a new, smaller model of hermetic compressors. Mads Clausen was known as someone who highly weighted technological conquests and new thinking. Therefore, it was inconceivable for the manufacturer to return home with a license for a product that was already out of date. Danfoss and Tecumseh continued to negotiate, but Mads Clausen looked forward with interest to the news about work on the new Tecumseh model.
During the negotiations, Mads Clausen and the engineers Aage Korsgaard and Magne F.

Schoeler travelled several times to Detroit to follow the developments. Why Danfoss became the player that the Americans choose to negotiate with about a license agreement was a bit of coincidence. There were others, also Danish companies that had seen the potential of producing hermetic compressors as those Tecumseh had built.
They had even seen the potential several years before Mads Clausen.

Pancake – a success

Engineer Aage Korsgaard knew Tecumseh extremely well. He was initially employed in Nordic Køleteknik at S. A. Andersen (who later became a professor of thermodynamics), but had obtained a one-year stay as a trainee at Tecumseh, where he learned a lot about hermetic compressors.
S. A. Andersen had imagined that Korsgaard would return to Nordic Køleteknik where he would then produce the compressors he had learned so much about, but Korsgaard came to Danfoss instead.

In the much the same way, S. A. Andersen and Nordic Køleteknik were left behind, when engineer Arne Enemark, after having studied in Switzerland, also failed to return to Nordic Køleteknik, but, via Brdr. Gram in Vojens, ended at Danfoss where he used his compressor knowledge.
So although S. A. Andersen and Nordic Køleteknik did not have the necessary capital or otherwise had the basis to start a hermetic compressor production, he was disappointed that, despite very timely consideration of a possible compressor production, he never managed to get anything out of it.

In January 1952, Danfoss (which at the time had grown to 800 employees) and Tecumseh signed a deal. The agreement allowed Danfoss to

HIGH DEMANDS TO THE COMPRESSORS

In comparison, a car illustrates rather well the enormous demands that are raised to a hermetic compressor. A compressor is expected to have a lifespan of 15 years – but many compressors last twice as long.
If a car travels approx. 250,000 km with an average speed of 50 km/h, this is equivalent to 5,000 hours of operation. Assuming that the compressor operates for approx. 33 percent of its life, this means five years or 43,800 hours - then, more than eight times as long as the car!
The 43,800 hours of operation provide approximately 7.6 billion engine revolutions and double the number of piston rotations at a 50 Hz network, if the compressor is driven by approx. 2,900 rev./min. While the car has had oil replaced at least 15-20 times, the compressor, during its entire lifetime, runs on the same oil and without the need for any kind of service.

Gram refrigerators from the 1950s.

produce and sell Tecumseh's new compressor, "Tecumseh Hermetic Unit, Model P91", under its own trade name worldwide except in the U.S., Canada, UK and Ireland.
The compressor had, due to its flat shape, the nickname "Pancake". The license fee was $ 1 per. unit.

The Pancake compressor

Danfoss introduced the Tecumseh compressor model P91 on the market as type 101. The compressor with a cooling capacity of approx.75 Watt was designed for the large American refrigerators. On the other hand, in a very popular, European refrigerator of 100 liters, the Pancake compressor took approx. 12 percent of the space, which was too much.
Therefore, it was only natural for Danfoss to examine the possibility of redesigning the compressor to fit the European refrigerators, but it did not succeed. The situation was discussed with Tecumseh, who came with a proposal for a small compressor with a 2-pole motor that provides twice the number of turns as a 4-pole motor.
Several companies started production of compressors for their own production of refrigerators and freezers, and the concept to become an independent compressor supplier, which Danfoss worked on, was new in Europe. For Danfoss, it was also a question of striking the right balance, since the company did not want to be seen as a competitor to the customers purchasing products from Køleautomatik (RC/AC).
Over the past years, many people have wondered why Danfoss did not start a production of refrigerators and freezers, but that would mean competing with own customers and this was not wanted.

Tecumseh did not give Danfoss any kind of exclusive rights to produce and sell the "Pancake". But Danfoss was first, and this was an advantage, Danfoss wanted to maintain its position. Already in February - less than one month after entering the agreement - the first hermetic compressor with the red Danfoss logo reached batch production.

Danfoss' first compressor customers

It soon turned out that the Danish producers, almost everyone, had dropped their plans to design and construct their own compressors. The only one who had done something about it was Atlas. Atlas had developed and also invested in production facilities. However, Atlas had problems with the design and failed to make it work. Atlas became the first customer of Danfoss compressors. In return, Danfoss took over a part of Atlas' production machines.

During 1952, which was the first year with hermetic compressors, Danfoss achieved a production of 5,000 pcs. of Pancake in total. Not a huge number compared to the other Danfoss business areas, where it remained primarily Køleautomatic (RC/AC) – i.e. components for major refrigeration equipment – that delivered the main products. However, hermetic compressors were finding its way to change the everyday life in many people's homes. Thanks to hermetic compressors, the refrigerator was becoming an everyday commodity. And Danfoss had secured its position at a crucial phase in cooling trade development.

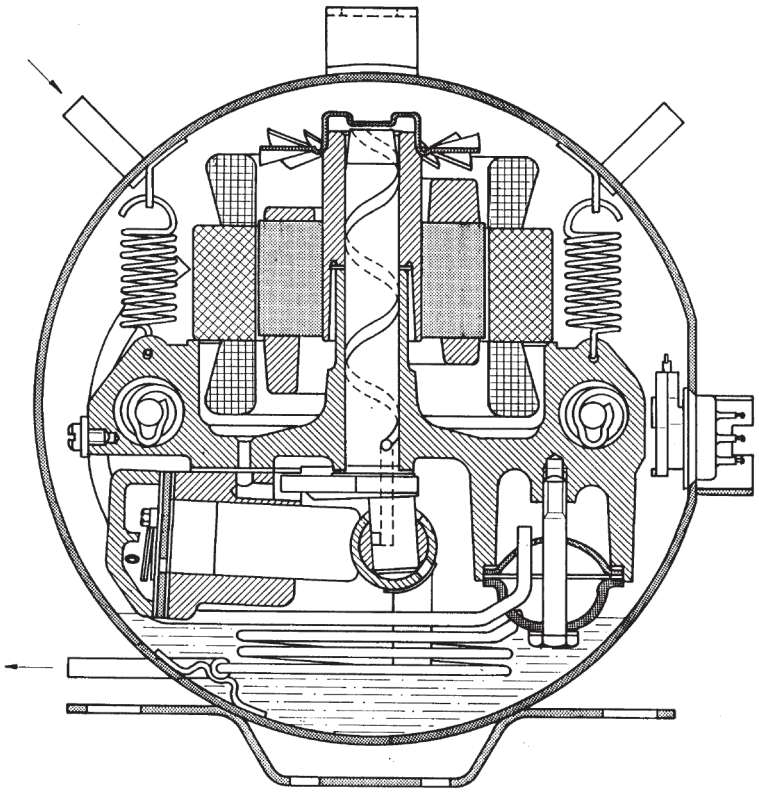
Danfoss moves into the kitchen

Due to the compressors, refrigerators and freezers became more consumer-friendly, in particular to the domestic consumers.With the compressors, Danfoss focused on products used in the individual household consumption. With the strong, economic growth in Europe in the 1950s, it was thus a growing proportion of the population, who acquired Danfoss products in their homes. Now refrigerators were sought after by millions of ordinary consumers and Danfoss started a mass production of compressors to maintain its competitiveness.

The success did not fail. In 1952, sales of Danfoss hermetic Pancake compressors reached almost DKK 3m. The following year, sales had increased to DKK 9m, and in 1954, Danfoss sold for more than DKK 21m. The annual growth ranged between 40 and 50 percent and sales surpassed

DKK100m in 1959 – only ten years after Bitten and Mads Clausen travelled to Detroit for the first time. In 1959, hermetic compressors represented approximately 60-70 percent of the Danfoss business. The compressors were important. The success encouraged other European manufacturers to take part in the growth, for example: Aspera Frigo, AEG, Bosch, Lunite Hermetic, Unidad, Sterne and Necchi.

However, Danfoss soon experienced that the compressor market was highly competitive. During the 1950s, both independent manufacturers and the manufacturers of refrigerators began to manufacture compressors for household refrigerators. This meant that Danfoss from the start was not only in perpetual competition on price with its competitors, but also with its customers, who both purchased the compressors and even produced them themselves.



Cross-section of Pancake compressor.

Pancake-compressor.

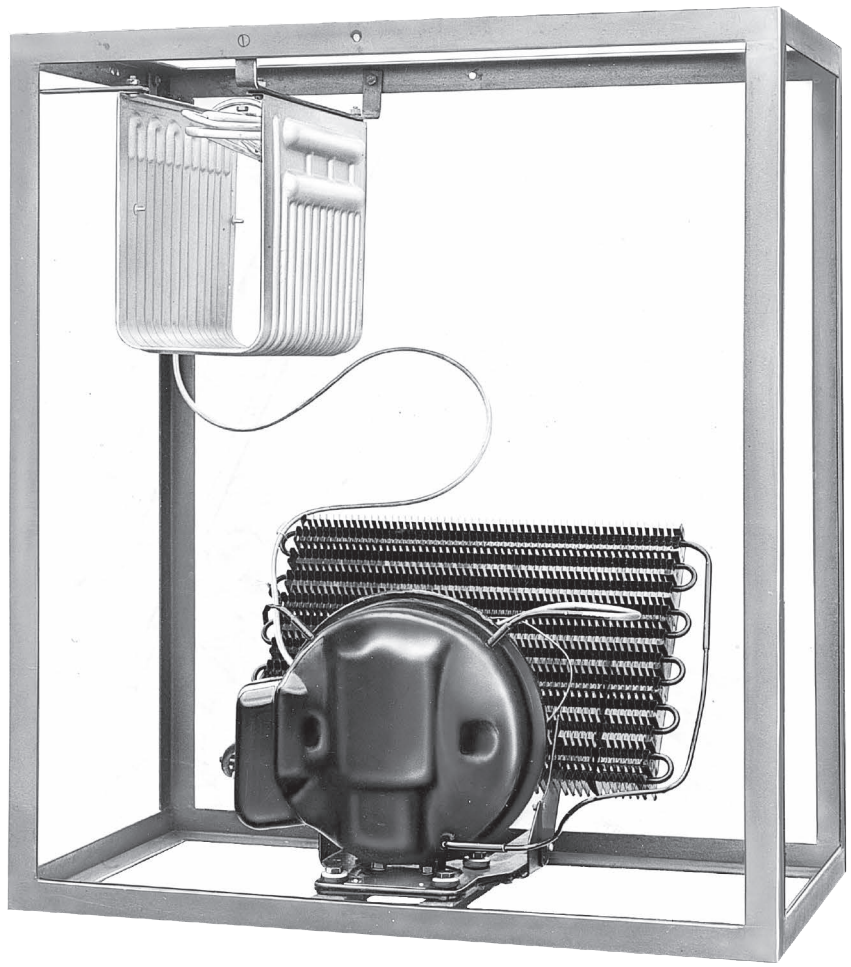
LG – A letdown

During the meetings at Tecumseh in Detroit, Danfoss worked together with a Dane named Jens Touborg. He had emigrated from Denmark in 1926, and he was one of the co-owners of the partially Tecumseh-owned development company TRESCO that delivered the drawings to Tecumseh. The position – and his Danish roots – made him the natural choice and partner for the Danes.

The ownership of Tecumseh was difficult to figure out. Tecumseh Products was responsible for production, while TRESCO handled development. Between the two companies were several other companies with owners, who again were intertwined. The spheres of influence were not always easy to interpret - nor unidirectional.

Jens Touborg's cooperation with his old fellow compatriots had been good.

Complete cooling system with Pancake compressor.



Manufacturing

Compressor components were initially processed on quite traditional machines, which underwent the necessary adjustments to meet the need of the current processing.
If the need for unique machines arose, one usually had to build it himself, and in the compressor assembly a continuous development took place.
Compressor housing and the cover were assembled with electric welding and a protective argon atmosphere around the weld, but this method was relatively slow. This is why an investigation of the possibility of using CO2 shielding gas was initiated. They managed to introduce this faster method of welding, which was much cheaper than the Argon welding.

When the cooperation with the U.S. partners became troubled, Touborg began to correspond with Danfoss again – but this time without Tecumseh.

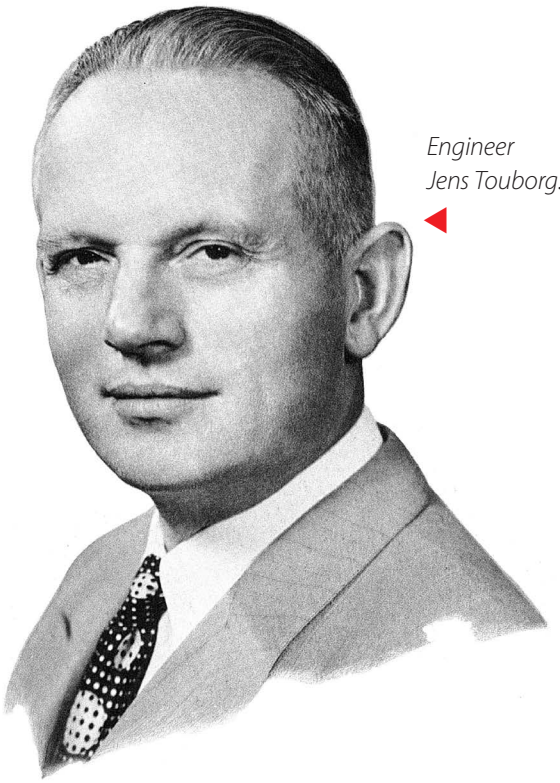
The conversations led to Tecumseh Products ending their cooperation with TRESCO, when they found out that TRESCO had worked with Danfoss without their participation.
The relationship between Tecumseh and Danfoss failed to improve due to this reason.

Nonetheless, Danfoss could now freely cooperate with TRESCO and the confidence in TRESCO's know-how was big.
Combined with the at the time rather limited knowledge of hermetic compressors at Danfoss, it soon led to a production that Danfoss had been better off without.
In 1953, TRESCO delivered drawings for the small, fast-running compressor that Mads Clausen had searched for, both internally at home and during conversations with Touborg.
TRESCO called the small compressor "Little Giant" (LG).
Danfoss was very enthusiastic and rushed quite headlong into the production of it and had a production line running in October 1954.

It had quickly become apparent that the production of LG caused trouble.
Its area of weakness was the lack of bearing stability of cylinder and piston, which, in spite of more accurate production tools and processes, could not be found compensated.
The model quickly began to look like a disaster with a return rate approaching 100.
It was said at Danfoss that the only "Giant" thing about "The Little Giant" were the problems created during its production.

Success with its own design

In the spring of 1955, the plant manager



Engineer Jens Touborg.

COMPLETE DANFOSS COOLING SYSTEMS

Apart from larger companies, sales of Danfoss compressors , also went to many smaller businesses. Several of these were producers of kitchen items and units, who had a desire to deliver refrigerators along with their units.
The companies had very limited or no knowledge of refrigeration engineering, thus, Danfoss often supplied the complete system (soldered cooling system filled with refrigerant and oil in the compressor), just ready for installation in the refrigerator.
Before delivery from Danfoss took place, each cooling system was tested on a system line, to ensure that the proper refrigerant charge was present, the compressor would operate satisfactorily, and that the system was sealed.
Prior to delivery of complete cooling systems, Danfoss usually received a refrigerator to be able to ensure through testing that the cooling system was precisely adjusted to the current refrigerator and its application.
From the very beginning, Danfoss had seen the need of having the necessary testing facilities at their disposal for the different types of refrigerators.
Through these tests, a lot of valuable knowledge was gained, which benefitted both customers and Danfoss.

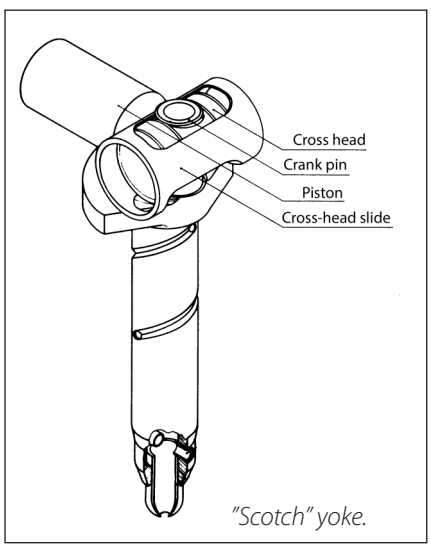
DEMONSTRATION MODEL WAS HIDDEN IN THE CLOAKROOM

Danfoss was planning to let Knud Roelsgaard and Gunnar Sorensen present the new own-designed PW compressor to Tecumseh during a visit in the spring of 1956. Since only Mads Clausen could give permission to show the PW compressor – and he was away at the time – the permission was never given. In order to avoid the trouble of carrying the demonstration compressor back home, it was agreed to leave it where it was, namely in the hotel cloakroom in Dearborn. Perhaps it is still there, but the cloakroom label is gone!

Carsten Kidde-Hansen called for a meeting to announce that the LG had to come to a stop. At that time, a 5 kroner banknote was attached to each compressor that left the factory. At the meeting, it was decided to reconstruct the LG compressor with principles known from the Pancake compressor, including the "Scotch yoke". This was a technique that Danfoss had come to know quite well. That's what it took.

Compressors are important

With the Tecumseh license on the Pancake, Danfoss had gained access to a very competitive product of its time. The Pancake had opened a market to Danfoss.
However, Mads Clausen was not satisfied by letting others hold up as technological pioneers.
He wanted independent further development to avoid falling behind. Also, for the long term, he desired to be independent of the Americans and the constraints that the license agreement caused Danfoss on the large markets, such as North America and the UK.
It was obvious that the compressor market was a market of utmost importance for Danfoss. Also, it was too important to let the development of new products be handled by others.



"Scotch" yoke.

The later Executive Vice President at Danfoss, Hans Kirk began his career in Nordborg in 1970. Here, he experienced many examples that compressors were of the utmost importance for Danfoss:
It actually did not matter what other product you were in the process of presenting to the management. If there were problems with the compressors, then all the managers disappeared. The compressors were always a first priority, even at a time when other product were more successful.
So, it could be a quite annoying – or you became jealous – when you worked in other departments.
But this is how it was, says Hans Kirk:

The status of the compressor business also became apparent in the appointment of managers. There are no managers at Danfoss from a certain departmental level and upwards who have not crossed the compressor business. This was where competition was the toughest. This was where they were under the most pressure - this was where most was at stake. So it has always been the place where employees were tested before they were promoted to more demanding tasks, at a higher level, says Hans Kirk.

The PW maintains the lead

The PW was the first hermetic compressor produced by Danfoss themselves.
It was smaller than the Pancake model, but it had a higher performance. It made less noise – and soon got nicknamed PeeWee , meaning "tiny" in the U.S. It also means chamber pot, given the shape. The production of PW was launched in 1956 while the production of the Pancake continued.
The PW became the solution to the problems with the LG model. It also was proof that Danfoss could manage on its own. It gave the construction department at Danfoss

confidence to continue, and it whetted their appetite.
Both facts could be used to gain an advance compared to the competitors.
In 1958, more PW compressors than Pancake models were produced, and Danfoss was now the leader in the European market for hermetic compressors. This position, however, was under pressure.

Germany's growing importance

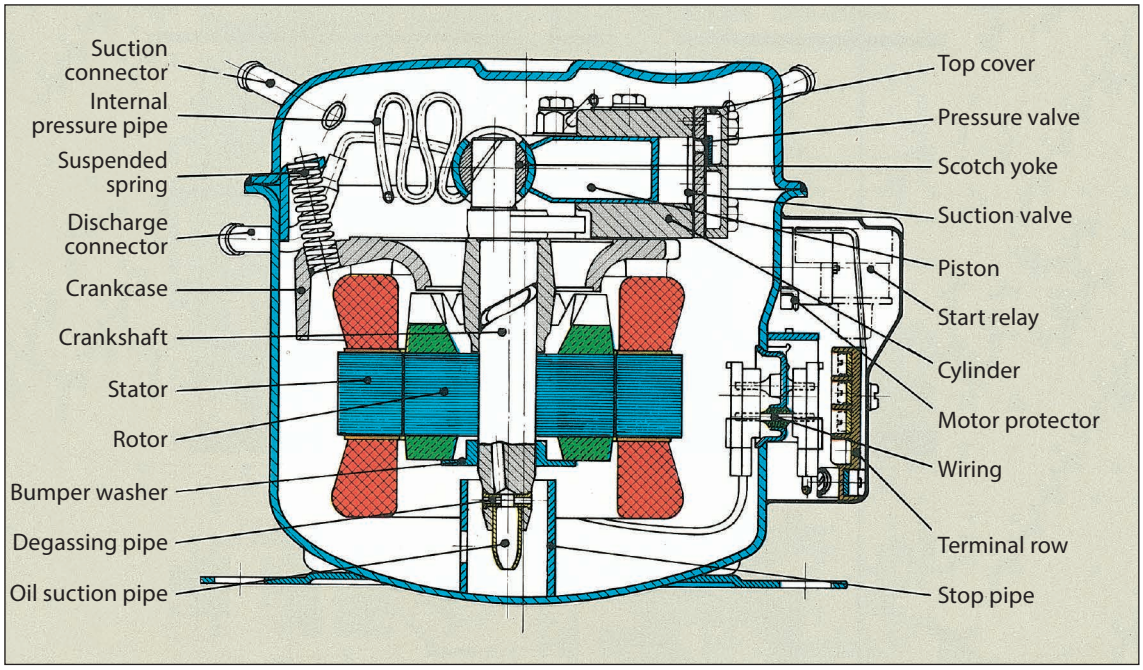
Sales of hermetic compressors largely followed the economic trends in society.
The increasing prosperity made customers demand the practical solution of having their own refrigerators. It was estimated that the proportion of Danish families with a private refrigerator in the period 1951-1960 increased from less than 10 percent to about 20 percent.

During the 1950s, Danfoss managed to become subsupplier of compressors, not only to the great Danish manufacturers of refrigerators and freezers, but also to most of the major European manufacturers. These were typically long-term contracts of several million Danish kroner.

PW compressor.

Already in 1953, more than 80 percent of the Danfoss-produced compressors were exported.

In the mid-1950s, sales had expanded to 30 countries, including Italy, Brazil and Germany, who together received about two-thirds of the export. Sweden, Norway and Finland received between 10 and 15 percent.



Cross-section of PW compressor.

Production line in Danfoss Nordborg for complete cooling systems.

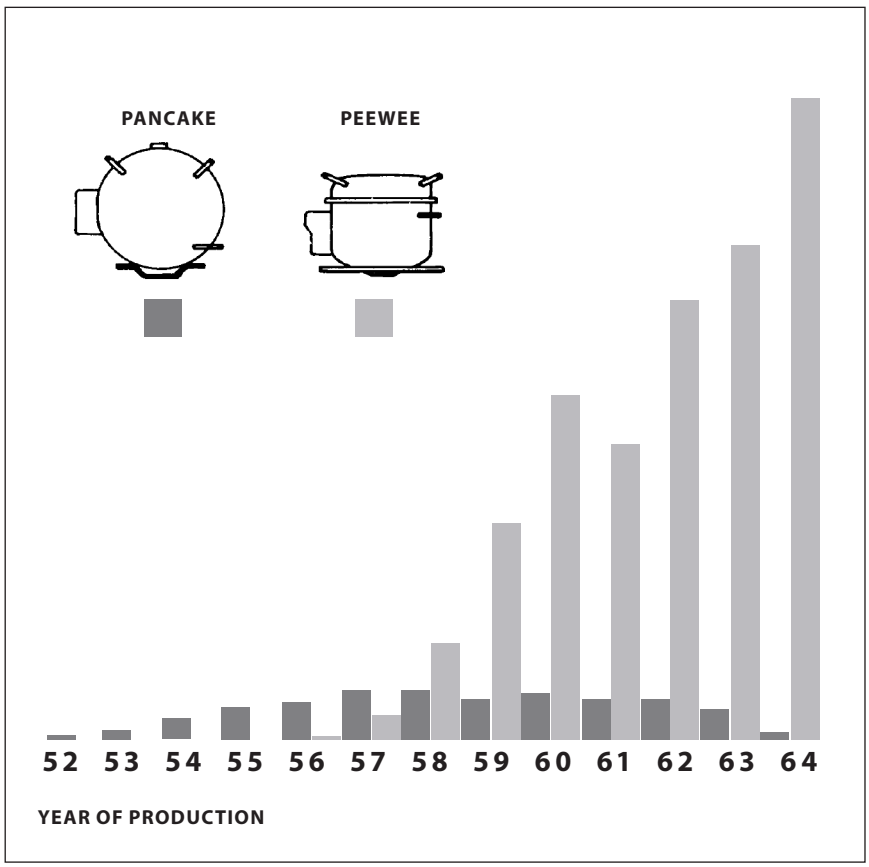
Especially sales in Germany rose by leaps and bounds. The German "Wirtschaftswunder" seen after the war, where the Marshall Plan helped the bombed country to re-build, had its effects, and therefore the German economy grew.
The impact could be measured in Nordborg. Germany accounted for 4 percent of the Danfoss compressor exports in 1954 – three years later it was 30 percent.

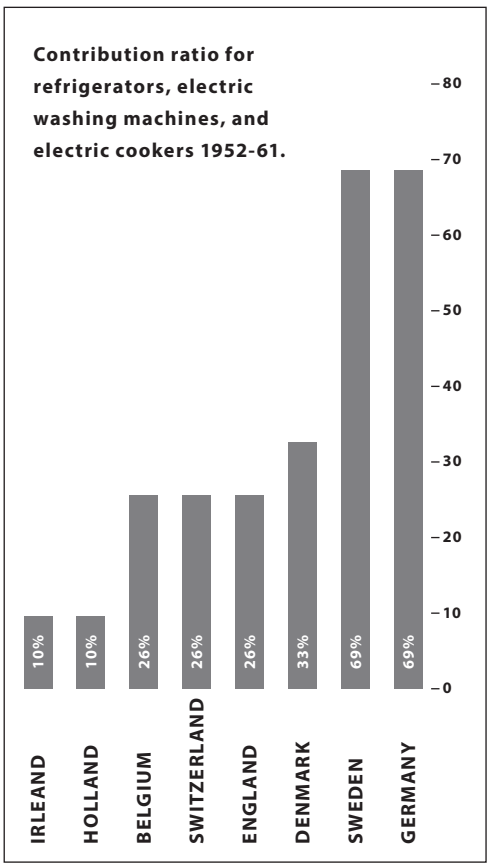
Danfoss did its best to follow up and, in 1957, Pancake compressor number 500,000 was assembled.

Bacon in the machinery

That same year, the Danish bacon production did, however, provide Danfoss with a challenge. Based on the Coal and Steel Community, which was formed in 1952, the EC was created in 1957. Out of consideration for the agricultural exports, Denmark chose to position itself on the same markets as England. Denmark still saw itself as being an agricultural country, and the consideration for the bacon exports carried great weight.
Denmark was thus on "the other side" of the tariff wall, which the six EEC countries (France, Italy, Germany, Belgium, Netherlands and Luxembourg) agreed to establish against the non-member countries, while they themselves worked on full economic integration through decomposition of the inter-tariff barriers.

Sales development for Pancake and PW compressors.





As a counterbalance, EFTA was established in 1960 as a framework for a free trade cooperation between the seven countries, Great Britain, Denmark, Norway, Sweden, Portugal, Switzerland and Austria.

Tariff wall sets limitations

Yet EFTA was no solution for Danfoss.
In 1956-57, two-thirds of the compressor exports went to countries that were included in the EC. In comparison, the corresponding EFTA share was approx. 15 percent.

Germany was rapidly on its way to becoming the most important market for Danfoss.

The creation of the markets would in other words cause trouble for Danfoss if they could not get a foothold on the other side of the EC's common tariff wall. The tariff wall was indeed a wall to climb. Within the wall the six countries – France, Germany, Italy and the Benelux countries – could mutually trade without customs charges, while all countries outside of the wall, who wanted to sell goods were already behind in competitiveness due to extra costs. In reality, it meant that Danfoss' German, French and Italian competitors were able to achieve large-scale sales in markets, where Danfoss was effectively precluded, and in which Danfoss could not compete.

Danfoss had to set up production in a EC country.

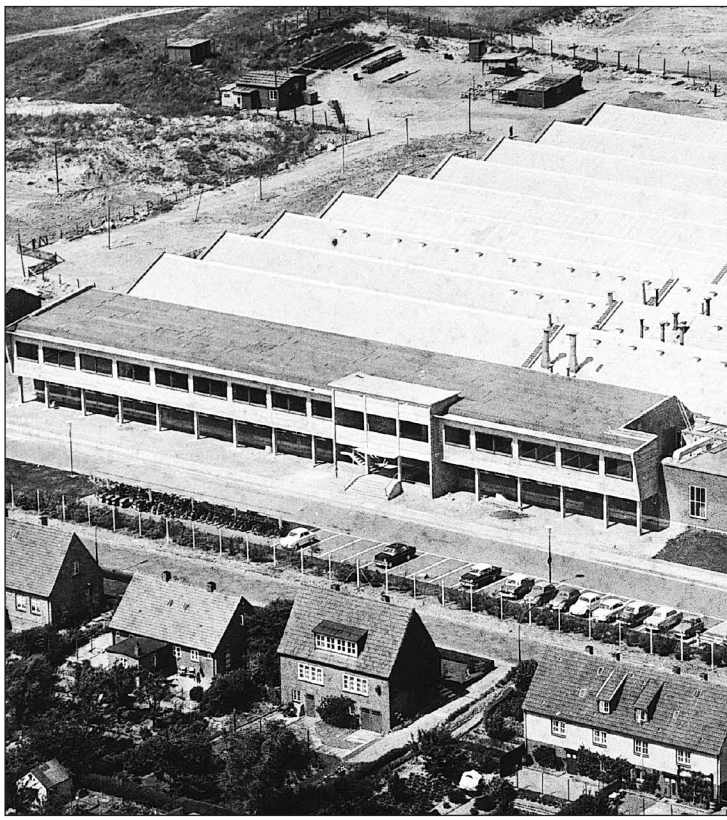
Danfoss enters the Community

From the spring of 1955, Mads Clausen investigated the opportunities of startting a production in Germany.
Danfoss bought an undeveloped plot of 9.6 ha at Klues, north of Flensburg; 40 km from Nordborg, as the crow flies. The area had ample available labour and wage levels were lower than in Denmark.

In 1956, the final decision was taken to establish production south of the border.

The plan was to produce the PW model in Germany. However, the license agreement with Tecumseh prevented Danfoss from doing so. Danfoss could not be released from the agreement without having to pay a huge amount of money, regardless of whether it was the Pancake or the PW.

With the Tecumseh license under control, the independent limited company "Danfoss Flensburg Automatische Schalt-und Regel-apparate" was established in the autumn of 1956. At same time, the process of building a factory on the Klues site (located on the outskirts of the northern German port city) was started. The financing was facilitated by low-priced



Danfoss Werk Flensburg.

government loans – the Germans were very happy for the creation of new jobs in the area.

The factory is ready the walls are missing

The work on the new plant would consist of assembling compressor parts since the actual production of its components was done in Nordborg. Danfoss hired Frank M. Scholtz and Erwin Brix as plant manager and production manager respectively, in Flensburg. It was characteristic of both of them that they would not dream of asking for a postponement, no matter what the trouble was.

– The deadline for starting production in the new factory was set to 1 September 1958, Erwin Brix recalls.

– It was just a year after the decision to start building had been made. But a deadline is a deadline. So we began production on 1 September, he said.

The factory was missing several of its walls, but this was no obstacle to the 75 employees. Brix had on-site huts put up instead, and then, the production began. It was thought at the beginning that Danfoss produced either skips or building materials because that was what

License agreement with Tecumseh

After the unveiling and introduction of the PW compressor in July 1956, along with the formation of Danfoss Flensburg GmbH on 22 September, 1956, the situation with Tecumseh was resolved by a new license agreement, signed on 17 November, 1956. Among other things, the contract contained the agreement that Danfoss Flensburg GmbH would receive the necessary basic specification from Tecumseh, to start production of any compressor model which was in continuous production at Tecumseh in the United States. Furthermore, it stated that specifications for compressors equal to or less than 1/8 HP, prepared on an "experimental basis" in Tecumseh and delivered to Danfoss before the contract is signed were contained in the agreement (such as Tecumseh LG / PW). In return for paying a royalty, Danfoss Flensburg GmbH was allowed to produce in Germany and sell anywhere in the world, except in the U.S. and Canada.

On the other hand, during the validity period of the agreement (ten years), Tecumseh would refrain from manufacturing on its own and from giving others a license to a production in Germany. The royalty was agreed to 50 cents per manufactured compressor.

Mads Clausen inspects the construction site in Flensburg.

was seen by the neighbourhood to the factory. Walls were not the only thing that was missing. Complete basic necessities were also a priority, but it was solved with a practical approach, even then this was typical of Danfoss, says the plant's quality manager, Hans Uwe Nissen.

– The toilets were also not finished when we started production. If you had to go to the toilet, you had to do it in nature – in the woods behind the factory. Potentially embarrassing scenes were contemplated by the Executive Board, which was why signs were hung on tree trunks, so that the ladies made sure to go left and the gentlemen to go right, says Hans Uwe Nissen.

Dust-tight spaces and wet shoes

During the first season, they encountered a roof leak. Occasionally, employees had to tolerate rain, inside the building. On particularly bad days, the water would rise on the floor in the production hall. The staff who sat here (construction on the office wing was also incomplete) had to regularly chock their desks up on stones, so the rain water on the floor would not cause damage to the furniture. Considering the priority at Danfoss, the compressors were never affected by such problems.
They were scheduled to be mounted in dust-tight rooms. The fact that the employees sat there with wet shoes was secondary. Most importantly, the production took place as scheduled.

The start-up deadline was not the only thing that was important. Production figures were also observed. In 1958, 1,000 compressors were required per week. In the event of failure, the management would show up at the production line on Saturday and Sunday and assemble the compressors in order to achieve the weekly quota.
Seeing a manager take a car to visit customers to deliver the compressors was also not unusual. They would even take a plane if customers were in dire need.
The persistence led to success. Already in the factory's second year, it was necessary to introduce two shifts. As of January 1959, the production brought 8,000 compressors a week, and soon the Flensburg plant's status as assembler expanded to include several independent production operations.

Visits by the manufacturer himself

The first overseas production at Danfoss, naturally, had full attention from the boss.
To set up a production in the area where the demand for the products was to be found was not completely common in the 1950s. The 50 years of experience that Danfoss now has in 2008 with relocating production facilities can, among other things, be attributed to the "feel for timely care" that Mads Clausen possesses – even though this slogan belonged to another business giant of that time.
Mads Clausen often had his thoughts in Flensburg and he also liked to be there himself. He generally came unannounced. He would sneak in through the back door and straight into the production. It was not always a good thing if the machinery stood still for one reason or another. The big pot press often did. One day, when the machine had stopped, Erwin Brix noticed the boss at the door.

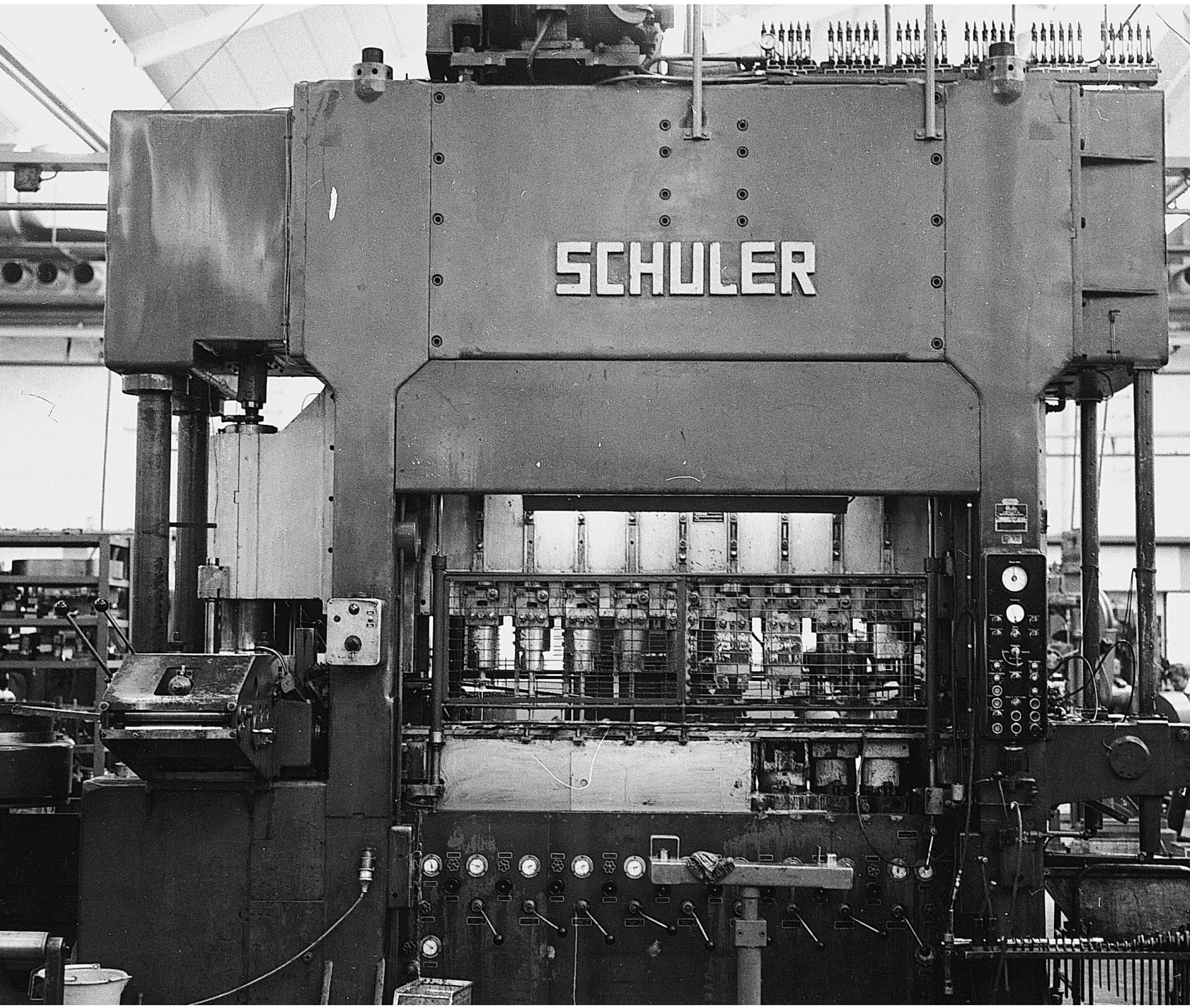
– " I immediately went to him and regretted that I did not have the time to show Mads Clausen around", says Erwin Brix.

Mads Clausen replied, "It does not matter, as long as everybody is busy with getting this machine back up and running" he recalls.

The pot press machine was a frequent problem. There was never any doubt whether it was running or not. Because when it was, it caused vibrations throughout the entire factory. Plant manager Frank M. Scholtz once took advantage of this.
One day, when Mads Clausen was visiting again unannounced – and the pot press machine again stood still – the plant manager succeeded in pulling Mads Clausen into his office. Scholtz discreetly placed a pencil upright on his desk and kept on talking with Mads Clausen.

Expansion of Danfoss in Flensburg.

The pot press-machine for the manufacturing of compressor pots.



When the pot press machine started again, the vibration made the pencil fall over.
– "And now, Mr. Clausen, I think we should take a closer look at the production", said Scholtz

Consolidation poses new challenges

In the summer of 1959, a price war on the refrigeration market in Germany started. Mail-order companies and chain stores were selling cheap refrigerators, which caused significant irritation for the major manufacturers of refrigerators: Bosch, Bauknecht and Linde. The price of semi-manufactured goods for refrigerators, especially the hermetic compressors, thus came into the spotlight.
Therefore, in August 1959, the family company G. Bauknecht, chose to buy one of the German producers, the company "Stempel-Hermetik" in Offenbach, who was founded in 1952 and had 1,200 employees.
The ownership was short-lived. In mid-December, it became official that Danfoss had taken over "Stempel-Hermetik".
To Mads Clausen, who was making great investments in Flensburg, and who from the end 1958 had seen a certain increase in the stocks of compressors, it was important to avoid price reductions.
Danfoss had experienced increasing competition, because competitors copied the PW model.

In September 1959, it also caused anxiety that Bauknecht, through an expansion of "Stempel-Hermetik", could become self-sufficient with compressors. The situation was challenging, because Danfoss could hardly tolerate to lose a customer as big and important as Bauknecht.
Already one month after Bauknechts acquisition of "Stempel-Hermetik", Danfoss reached an understanding with the newly fledged owners and Danfoss took over "Stempel-Hermetik", even though the factory was both old and outdated.

In this way, an important piece fell into place for Danfoss to penetrate the large German market. The purchase of "Stempel-Hermetic" strengthened the position Danfoss held on the German market and Mads Clausen was able to satisfactorily prove that Danfoss had managed to participate in the structural rationalisation of the German refrigerator factories.

The purchase of "Stempel-Hermetik" also helped to strengthen Danfoss' position on the European market for compressors.

Danfoss was thus financially well-founded in the late 1950s and at the beginning of the 1960. But when it came to liquidity, some warning signs flashed. Major investments had been carried out – and the market was declining.

The party that never appeared

In the early 1960s, the relatively newly created industry, the production of refrigerators for private homes, had taken shape. However, it was already in the process of being changed.

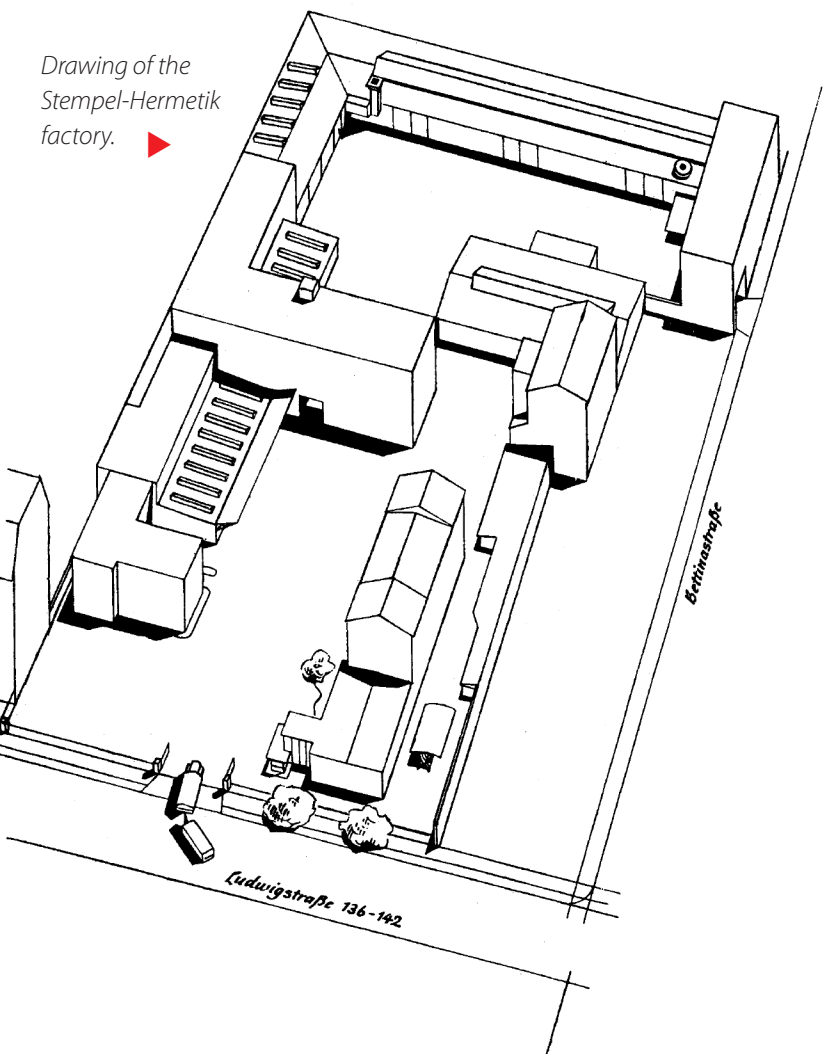
While the 1950s had shown that there was a market for the refrigerator industry, the end of the decade clearly demonstrated to the white goods manufacturers that the markets had enormous growth potential when looking beyond its own borders. At the beginning of the 1960s, the domestic white goods manufacturers focused on growth beyond its borders.
So, as a manufacturer of compressors and thus as a subcontractor to white goods manufacturers, you would need to bring yourself up to speed to participate in this growth. Danfoss wanted to participate and the 1960s should determine Danfoss' position as a regional business rather than a national business.

Danfoss was ready for the 1960s and more so than ever.

Danfoss had its own compressor, the PW. It had sold well during the 1950s and technologically the PW was still superior compared to the other competitors in the market.
At the same time, Danfoss had prevented the loss of important customers by setting up more thoroughly in the German market with the acquisition of the factory "Stempel-Hermetik" from the Bauknecht family.
"Stempel-Hermetik" produced 2,500 compressors daily, and in June 1960, the compressor no. 3,000,000 left the factory.

Also, in 1959, Danfoss had decided to begin a highly needed expansion of the production area in Nordborg with the construction of four new production halls in "Lunden" (name of production area in Nordborg), each approx. 15,000 square meters, and already in 1961, the compressor factory L2 was running. L5 was among the first buildings in "Lunden", and it came to house the process laboratory for the compressor production.

In the "Lunden" area, a new building was built in the mid-1960s, L21, and it held construction and development departments in one area and



Drawing of the Stempel-Hermetik factory.

laboratories and test rooms in the other area of the building. In addition, a separate building was constructed for noise measurement. At the same time, large amounts were invested in transfer lines and machines that could replace turret lathes and many special machines.
By use of the transfer lines a lower error rate was obtained, since now the items could be machined in a single setup. Of course, this meant a much better working process and a substantial reduction of production costs and an improved compressor quality .
In 1956, only five percent of all new machines were automatic – in 1962, 80 percent of all machines were automatic.
The Danfoss compressor business was, in short, a large, "well-oiled" factory.

The market turns

However, just as the investments were to be followed by consolidation, the market reversed. The party did not materialise, and thus, the position that Danfoss had in the market changed. From having been a solidly driven player in a growing market, and prepared for growth , Danfoss was suddenly a giant with major investments tied up in a market that failed.

In the late 1960s, Danfoss, faced the failing German market for the first time.
So far, all reports of sales for 1961 had been positive – large sales were expected and therefore also a need for many compressors. Things turned out differently.

Especially in the spring of 1961, the sale of refrigerators plummeted. Some thought that it was due to a very cold spring; others that it was competition from the sale of televisions.
It may seem a rather strange priority today, but it was revealed that a large number of consumers in 1961 preferred to acquire a television instead of a refrigerator. Both products were far from being an everyday commodity, but as direct competition the television, a technical novelty, was apparently more interesting than refrigerators.

Sales were affected; however, it did not help either that the Germans revalued the Deutschmark in March 1961.

Meanwhile, the competition within the industry increased, so the price came even more into focus. Refrigerator manufacturers still produced compressors on their own, but they also began to buy more and more from the independent producers. Danfoss was therefore in competition with both competitors and

Expansion of the production area in Nordborg.

ACTIVE ROLE AS INNOVATOR

Through the 1960s, Danfoss gained a more active role as innovator and developer in the compressors business.

The shift from being a compressor manufacturer that produced based on Tecumseh's know-how to being an innovative and independent producer gradually completes, as Danfoss develops and improves its own models – and thus sets the standard for other manufacturers.

For example, the reduced size of the PW compressor – compared to the Pancake – created a higher temperature level at which the PW could work.

This led to Danfoss, in 1960, being the first one to introduce a plastic insulation (polyester film) in the motors, which was more heat-resistant than the previously used cellulose-based insulation, which was known to contain some moisture, and even in very small quantities, this was pure poison to a cooling system. The thread lacquer had also been gradually improved, and combined with better lubricating oils, the compressors were now able to work at a higher temperature level, resulting in greater reliability and longer life of the compressors.

Danfoss also changed the name of the compressors. Over the past many years, it had been customary to name hermetic compressors according to associated motor horsepower name (HP). This often led to misunderstandings and wrong choice of compressor sizes since the HP indication does not characterise the utility or capacity of a compressor. Since there were quite large differences between compressor models supplied from the different manufacturers with the same HP designation, Danfoss changed its compressor designations in 1963.

With the new designations from the summer of 1963, a much better European benchmark for customers and more informative compressor designations were created.

Setting standards in the industry did not stop with the changed HP designation, and again it was Danfoss that added pressure. The need for standardised measurement conditions was put on the agenda, requested by Danfoss in CECOMAF context.

CECOMAF was the European association of manufacturers of refrigeration equipment, whose task it was to remove barriers to trade within the EU.

The focus was different technical specifications for testing and the description of products.

Danfoss came to play a significant role with chief engineer Arne Enemark as initiator.

Chief engineer Knud Roelsgaard took over Enemark's seat in CECOMAF and later he extended Danfoss' representation internationally with an active membership of DIN (Deutsche Industrie Norm, Fachnormenausschuss Kälte) and IEC (International Electrotechnical Committee).

The first results from CECOMAF were specifications indicating at which loads hermetic compressors' cooling capacity and energy consumption should be specified.

Thus Danfoss influenced the development of standardised measurement conditions in the 1960s.

customers, while the requirements of the compressor properties continued to increase. Refrigerator manufacturers requested lower noise levels, better materials and isolation, energy optimisation and new refrigerants. This prompted the manufacturers to buy even more from outside, once again intensifying the requirements when it came to technical development and price .

Liquidity is under pressure

At Danfoss, optimism ruled. The general opinion was that a rapid increase in sales would occur when the summer weather set in. However, even in early spring the stocks of compressors at Danfoss were so high that it became necessary to revise the production programs. In May, it became necessary to proceed with the first layoffs in the compressor section.

The sales did not increase when summer came. On a yearly basis, the sale of compressors on the German market decreased by 45 percent. For a company like Danfoss, who had placed more than half of its sales of compressors in Germany, it had to cause serious problems.

The decline in sales came at a very inconvenient time for Danfoss. They had already made – and were still in the process – large investments and had expected to use part of the income for financing. It did not help either that "Stempel-Hermetik" had produced and sold a large quantity of compressors, which proved to be faulty. The compressors had been sold with a warranty for which Danfoss was now liable, and this had a further negative impact on the accounts.

The crisis created liquidity problems. In 1961, Danfoss was certainly a healthy company, but the period was characterised by large investments and inventories that grew. Both were potentially problematic for the liquidity,

and both problems did unfold when the compressor sales during the late 1960s failed.

The situation became critical in early spring of 1961. Together with "Handelsbanken" (later "Danske Bank"), a solution was found, however, and Danfoss was guided through the imminent crisis. With the rapidly improving markets, sales rose again from the end of 1961. Soon a liquidity reserve was built and that made Danfoss far less vulnerable in the following years.

Production is strengthened in Flensburg

Work areas were expanded and changed. The factory in Flensburg was originally a purely assembly company. The compressors' individual components were delivered from Nordborg in so-called "Lunchboxes" – they were molded plastic boxes containing parts for the compressor. Electric motors, housings, and covers were also provided externally. However, already in 1960, Danfoss began to produce housings and covers in Flensburg. In 1961, the first machined castings parts were made, and the production of electrical equipment slowly began towards the end of 1961.

It was time to expand, and it required more workers than were available in the local area. The large amount of free and relatively cheap labour, which had once been one of the attractions for Mads Clausen when he chose Flensburg as a location, had found work elsewhere, which is why Danfoss began to hire people in other parts of the world. Through the 1960s, Danfoss Flensburg had many different nationalities employed – Greeks, Spaniards, Turks, Tunisians, Algerians and Yugoslavs - and the personnel office used a foreigners department to arrange the integration. Later, increasingly more of the tasks handled in Nordborg came to Flensburg, such as the installation of radiator valves, cooling thermostats and other tasks that required professionals and specialists.

King Frederik IX visits Danfoss in Nordborg.

The expanded production area in Flensburg.

Those specialists were not easily found in Flensburg and the surrounding area, so Danfoss built three semi-detached houses (1961) and a tall block of flats (1962), so that lack of adequate housing would not keep anyone away from applying for work at Danfoss.

Danfoss crosses the Atlantic

Danfoss had a very good brand and a firm hold on its local markets, as the 1950s changed to the 1960s. Admittedly, it was not everywhere that the business was as successful as in the South of Jutland. Here the traders reported that customers demanded a refrigerator with "a Danfoss compressor" when they purchased a refrigerator. The type of refrigerator seemed less relevant.

Danfoss' reputation was known and ready for expansion. At the end of 1961, Danfoss was ready also to signal its international status with the choice of legal company structure
On 20 October 1961, the management sent a press release and announced that the one-man company owned by Mads Clausen per 19 October 1961 was now registered as a limited company – with a fully paid up share capital of DKK 40 million.
The Danish A/S was not the only signal from Danfoss of being an active player in the world.

In February 1961, Danfoss Inc. was founded, a four-man department, which would be the spearhead into the lucrative US market.

The compressors were the driving force – the PW's from PW3 to PW11 were shown at the first major trade show with Danfoss' participation in the US, ASHRAE Congress, and the exhibition in Chicago that year. Danfoss demonstrated on that occasion the ingenuity on other fronts than those solely technical. They had hired a "Grand Danois" to illustrate Danfoss as a "Great Dane" (a "Grand Danois" is named Great Dane in English-speaking countries) and the dog sat on the stand during the four days the show lasted, with sadness in its eyes.

It was without much sublimity that Danfoss entered North America. They started very modestly, and Danfoss Inc.'s office in the city of Lodi, New Jersey, was far from flashy. A posted employee at Danfoss remembered that he had to settle down with furniture purchased from the Salvation Army (second-hand).

However, it was a start, and in August 1961, Bitten and Mads Clausen visited the United States. Among others, they met with the American manager at Danfoss Inc., Tom Ford, to talk about strategies for development, about

Press release of Danfoss' transition to become a limited company.

To all directors and heads of departments

As would be known to you, certainly, the management of the company has decided to convert the company into a limited company.

Since registration at the Register of Companies has now happened, and the company's legal existence is thus a reality, the following message has been sent to the daily press simultaneously:

DANFOSS becomes a limited company

The country's second largest industrial company DANFOSS, which hitherto has been a sole proprietorship owned by the manufacturer Mads Clausen, has on 19 October 1961 under registration no. 31744 been registered as a limited company with a fully paid up share capital of DKK 40,000,000.00

The shares are not freely transferable.

The founders of the new limited company is manufacturer Mads Clausen, manufacturer Clausen's wife, Mrs. Dorthea Clausen and DANFOSS' chief commercial director Andreas Jepsen, who also form the Board of Directors.

The company's management consists of manufacturer Mads Clausen, who holds the post of Director-General for DANFOSS, while Andreas Jepsen is chief commercial director, and Carsten Kidde-Hansen, managing director of manufacturing.

DANFOSS' headquarters are as before located in Havnbjerg, Nordborg / Als.

DANFOSS, 20 October, 1961
The MANAGEMENT

plans and prospects for the US market. On the wall a large map of the United States was put up where the participants placed needles to indicate potential customers, locations of potential branch offices, and more. However, it all took place without the participation of Mads Clausen.

His only contribution was the words "Do you have a screwdriver?" and as it was obtained he started to disassemble an American mixing fitting, accompanied by expressions such as "hmhm" and "it's neat".Tom Ford was visibly disconcerted to see the manufacturer's lack of interest in strategic discussions.

Despite Mads Clausen apparent lack of interest, Danfoss paid much attention to the North American market. They perceived it to be essential for the future compressor business. This is illustrated by a somewhat exceptional delivery service:
Friday, 20 September 1964, at 9.00 am, a customer requested from Danfoss Canada

Tom Ford with a Grand Danois.

that it was of vital importance, not later than 23 September, that they received 500 PW compressors in a special design. Could it be done?

Danfoss Nordborg accepted the challenge, and the compressors were produced during the night in Nordborg and prepared Saturday morning. In the afternoon, the compressors were shipped by flight from Sonderborg to Kastrup/Copenhagen for further air transport to New York. Sunday 12:00 noon, the compressors arrived in New York, where they were transferred to another airplane – and four hours later the compressors arrived at Toronto airport, for customs clearance.

Monday, 23 September at 7:30 am, the

compressors were delivered to the customer, and engineer Gunnar Sorensen from Danfoss Nordborg could inspect them before they went into production at 8:00 am.

The rumour of that kind of service spread quickly. And Danfoss' interest in North America was repaid by the American manufacturers of white goods.

The break with Tecumseh

One company had paid special attention to the intrusion by Danfoss on its own markets. Tecumseh, who had once sold Danfoss those compressors that Mads Clausen had used for decoding the technical knowledge fount in the machinery, could now see that the Danish apprentice had grown
big and strong.

Tecumseh and Danfoss had both benefitted greatly from their mutual cooperation, which had also, however, contained elements of mutual observance of each other's moves.

Air shipment of Danfoss compressors.

So now it was time for the two companies to seperate, and it was done in connection with the previously mentioned trade show in Chicago, where Danfoss marked the introduction of the products from South Jutland on the US market.

A divided Europe was divided once more

The first half of the 1960s was a period of inflation in the western world, but the price increases were very different from product to product. Within the area where Danfoss produced, the competition was very hard and the productivity increase so fast that prices were falling. It was certainly the picture until 1963 when prices found a more stable level, which continued the following years. From then on, it was only through continued rationalisation that it became possible to maintain competitiveness.

In the 1960s, the European market formation continued to play a significant role to Danish industry and its opportunities. After the formation of EFTA in 1960, the customs rate between the seven original EFTA countries gradually decreased, and particularly in the British and Swedish markets, this was a clear advantage to Danfoss.

One might expect that the Danish industry the following years would be hit by the gradual formation of a common tariff wall, without the six. The recipe for Danfoss was to create a parallel production of all the main products in Denmark and Germany. In Denmark, it should take place in Nordborg, and in Germany, at the new factory in Flensburg using the production facilities that had been acquired through the acquisition of "Stempel-Hermetik" in 1959. The idea was to centralise the automatic production in Flensburg and the compressor production at "Stempel-Hermetik", in a new building in Spredlingen, south of Frankfurt.

When de Gaulle said no

However, as Britain and Denmark had applied for full membership of the EC in July 1961, Danfoss revised its plans for the production in Germany. Now Danfoss would be on the right side of the tariff wall, and it was decided to abandon the planned compressor production in Sprendlingen.
Instead, the main factory in Germany should be placed in Flensburg. Significant amounts of money could be saved by abandoning the plans for a the new building in Sprendlingen, and with the strained liquidity that could still be felt despite the growing sales, it was decided to quickly leave Sprendlingen and move the purchased equipment to Flensburg.

However, in January 1963, President de Gaulle rejected a full British membership. Danish industry was facing a period, where exports to the six EC countries would encounter increased discrimination.

Danfoss did not have to wait very long to feel the effects of de Gaulle's "non". The project in Sprendlingen was largely settled and the capacity at the old plant in Offenbach was rather limited. Danfoss had to produce where possible – this meant that most of the Danfoss products were subject to an added customs rate of 12-18 percent of product value when sold on Community markets.

The compressors are too noisy

During the 1960s, it was still the PW compressor, which was the dominant product in the refrigerator area. It had been introduced to the market in 1957 and had not since been substantially changed. Around 1966, it was understood that it did not fully meet the requirements from the market anymore.
It was clear to the management that product development was needed, and therefore they worked diligently to develop new types during this period.

Particularly the customers' demand for smaller noisy compressors became apparent, and in mid-1960s it was decided to construct new buildings for the compressor department in "Lunden". This also included an up-to-date sound laboratory. The refrigerator had now found a place in people's homes, and thus the requirement for noise reduction was reinforced. Danfoss did a lot to reduce the noise level, but at the customers the PW compressors still caused many noise problems.
In the compressors, both rotating components as well as forward and backward components are present, generating a certain level of vibration, which can easily be transferred to the capacitor or cabinet, and which is amplified by a high level of noise as a result.
Furthermore, the piston causes pulsations in the gas pressure. Often, the noise nuisance did not originate from the compressor. The vibration of the compressor was the cause. When the refrigerator manufacturer had installed the compressor in the fridge, the noise occurred – for example, as a result of inappropriate conditions during the mounting of the compressor, or because of the connections to the cooling system. When problems occurred, the customers usually believed that the noise originated from defects in the compressor, but the problems could often be attributed to other conditions.

One example is the so-called "white noise generator", which was created for one of the attempts to reduce noise. As a result of the experiments, Danfoss filed patent applications in several countries. U.S. Patent 3,187,995 from 8 June, 1965, is thus Danfoss' patent for noise reduction in hermetic compressors.

Mads Clausen dies

The liquidity crisis in 1961 was limited to – exactly – a liquidity problem. Even though the Danfoss group was sound and solid, Mads Clausen knew that it was serious.
During the crisis in 1961, there was a meeting in Bitten and Mads Clausen's home, where Mads Clausen, Bitten Clausen, Andreas Jepsen and Magne F. Schøler were present to discuss the crisis. It was Andreas Jepsen, who reached an agreement with the bank. He also continued the leadership of the company after Mads Clausen.

Andreas Jepsen was Mads Clausen's highly trusted employee. He was very conscious of what the liquidity crisis had meant to his appointment as CEO.
True to Mads Clausen and his concerns, Andreas Jepsen made sure that a sufficient amount of money was raised in the following year, to prevent a situation of liquidity problems, as in 1961. On 27 August 1966, Mads Clausen dies, 60 years old.

Bitten Clausen took over her husband's post as Chairman of the Board.

In the early morning hours on Saturday, 27 August, 1966, my husband, Mads Clausen, passed away quietly in his sleep, barely 61 years old. A heart attack abruptly stopped the life of the man who was my best friend, and with whom I was allowed to take part in building the company that became his life's work.

With these lines I want to start this special edition of the Danfoss Journal, because it gives me the opportunity to express something that, in recent years, absorbed my husband very much, and which, also on the last evening of his life, was still in his thoughts. It concerned the future of Danfoss.

Throughout his life, my husband was a warm supporter of the concept of teamwork, and it was also on this basis that he built Danfoss, a world-wide organisation. Ever since its start in 1933, he deliberately allocated tasks and responsibilities to many different people. He knew that capable and responsible employees are the key to progress and success - and he never forgot it.

Therefore, he also leaves a company that is more vigorous and dynamic as ever - a close-knit unit, spanning from Japan in the east to Canada in the west and from Australia in the south to the factories here in Nordborg.

Those men who, through the years, were his nearest employees in Danfoss' management and board of directors now stand at the helm - and they stand well prepared. They all share knowledge of the development plans and general guidelines, which my husband had already prepared for the company several years ago, and through teamwork they will in his spirit lead Danfoss into the future - a future of continued development, new products and new markets, and now, as before, Danfoss will be present at the forefront of the world market.

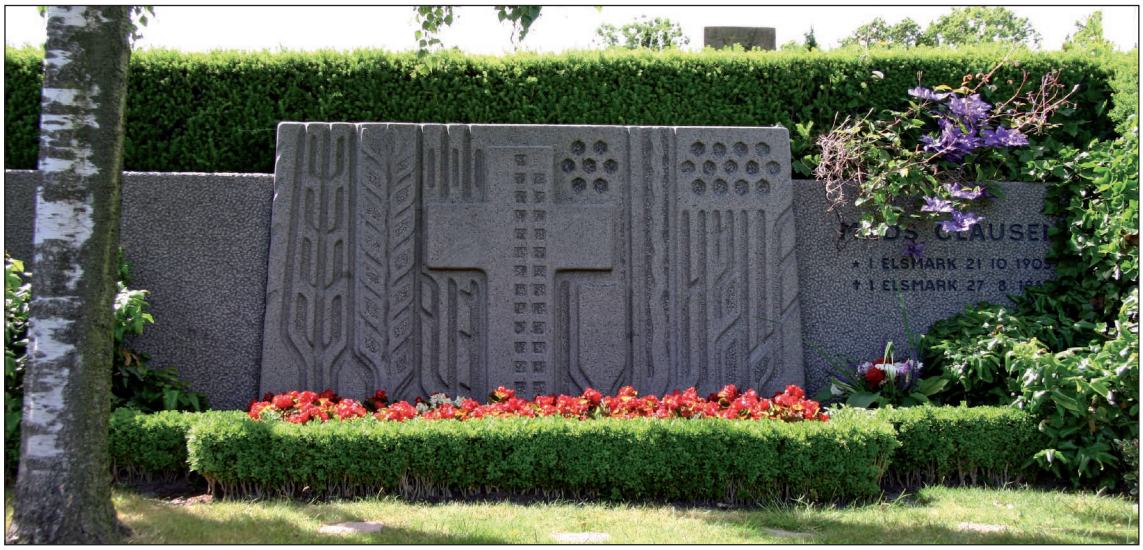
On the next pages, in a photographic cavalcade you will meet my husband in many of the great moments in his life. I, too, will join in - and remember. And then I can hear him say to me: You do not dwell in the past. It is the future, it is all about.

This is how he was – and such is Danfoss.

Bitten Clausen

The very last farewell greeting to Mads Clausen from empoyees and Nordborg residents.

Mads Clausen's funeral at Havnbjerg Kirke (church).



Mads Clausen's burial place in Havnbjerg cemetery.

The ear behind the tie

A German customer complained about the noise level of the PW compressor, and many attempts to improve the situation were carried out. When an acceptable level had been obtained, an engineer from the customer came to visit Nordborg to approve the improvements.
The measurements took place in a noise measurement room, where the compressor was running under different loads.
When the engineer had to listen, he leaned over the compressor and pushed his tie to one side to free the area in front of a microphone, which was attached to a hearing aid, placed under his tie.
Later it was discovered that the hearing aid was not even able to detect the frequencies with the disturbing noise level.

Confidence grows

The noise issue – and the attempts to solve it – was not the only example of Danfoss' focus on other issues, and it went further than technological issues and engineer art. Customer satisfaction and service loomed more and more in Danfoss' consciousness. The noise problem had also shown that the Danfoss compressors were sometimes deemed guilty of problems that they could not be blamed for. These problems had to be dealt with, and gradually, they created a new department. The creation of the application department, designed to extend the service. Such an offer from Danfoss to the customers became a reality around 1960 with engineer Gunner Sorensen as chief.

The forerunner of the department was a technical department that had covered all product lines, from which all counselling and handling of technical problems at the customers had to be addressed.

However, it was not satisfactory for the Danfoss compressor customers since this area required a more specialised knowledge.

Thorough testing

Coinciding with the start of the production of the Pancake hermetic compressors, Danfoss quickly realised that it was absolutely necessary to have at their disposal some test rooms for the testing of various refrigerators. Danfoss, as a subcontractor, had to be able to carry out tests of their compressors in the same model of refrigerators in which the customers would install them.
More testing rooms for refrigerators were arranged, in which the refrigerators were being prepared for tests and connected with the necessary measuring instruments.
In order to gain a foothold at a customer, it was usually a part of the agreement that Danfoss tested the customer's refrigerator, and in a final report demonstrated improvement proposals along with a possible comparative testing of a competing product.

These tests were really thorough: cooling capacity, cool-down time, time for the ice freezing, running time percentages, reliability, condensing temperature, winding temperature and determination of downtime periods due to the pressure equalisation through the cooling system capillaries. All was tested and recorded.

It surprised Danfoss that up to 30 percent of the returned compressors received at their factory were flawless. By confronting some refrigeration engineers, it turned out that the installers mainly chose to just exchange the compressor during the investigation of a complaint at a customer. The customer would then more easily accept a bill, if he could see that something had happened, more so than if only a minor error had been corrected.

How far are the competitors?

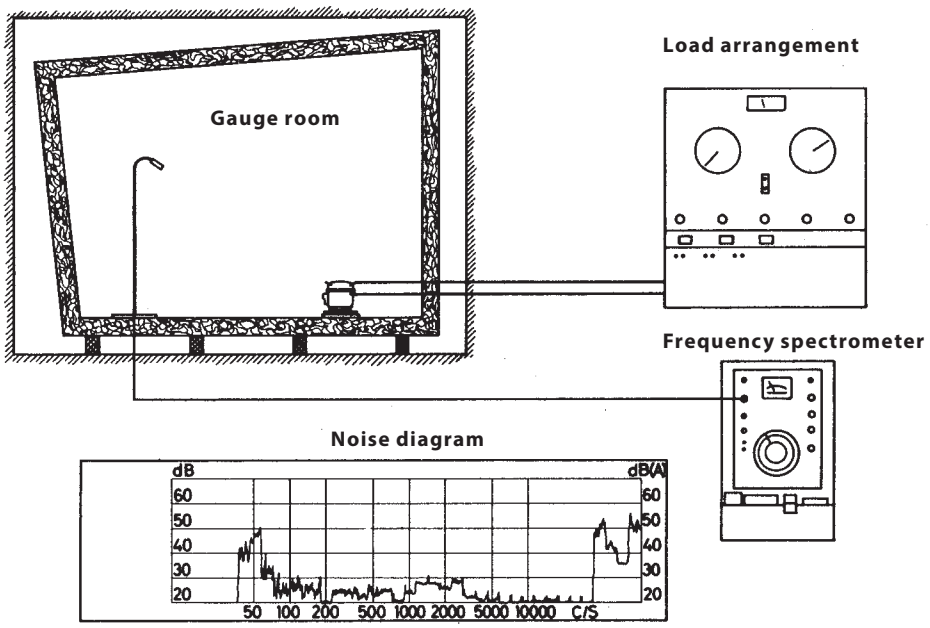
It was not only Danfoss' compressors, mounted in the refrigerators supplied by the refrigerator manufacturers, which were tested.
If Danfoss had to dismantle the existing compressor from a refrigerator anyway, received from a manufacturer to whom they wanted to become a subcontractor, they used the opportunity to take stock of the competitors' products and see how it was designed.

The refrigerators and freezers always held a competing product. After testing the compressor in the refrigerator, it was tested on a colorimeter and other test stations. Finally, in a report, the competitor's compressor was compared with a Danfoss compressor.

At appropriate intervals, the different competitors' compressors were reviewed at a meeting where, for example, the technical level, application, weaknesses and strengths were examined. Particular emphasis was placed on noise and vibration levels along with the capacity in relation to the absorbed power.

In this way, Danfoss kept abreast of competitors – and also the sales staff got the best possible hand of cards, when they had to argue for the Danfoss products compared to those of the competitors.

In the early 1960s, a major change in the insulation of a refrigerator occurred. Since the previously used insulation materials, such as Rockwool and glass wool, were replaced by polyurethane, the insulation capability of which was about twice as good. Now the insulation thickness could be halved and a higher effective volume in the same refrigeration appliance was obtained.
With the production of the major PW compressors Danfoss got the opportunity to enter the commercial market, for example, commercial coolers and freezers, ice machines and dehumidifiers.



Drawing of principle for noise measuring.

While the original market was refrigerators and freezers for household use, the public had also now taken an interest in other commercial furniture, such as refrigerated cabinets, display cases, retail display cabinets and cabinets with glass doors or covers.

Larger Danfoss compressor

There was a growing need for compressors with a larger capacity than the PW compressors. In the latter part of the 1960s, Danfoss worked on an entirely new and revolutionary design, the SC model, which was introduced to individual clients in 1969-70.

With their new sizes, the SC compressors enabled a doubling of the current capacity range, making access to the commercial market possible.

The first SC compressor.

The SC compressor represented a considerable expansion of Danfoss' current product range, and Danfoss could now offer capacities up to about 400 watts. The production of SC compressor was started in Nordborg.

A logical explanation!

The factory in Flensburg was extended in several rounds during the late 1960s, and it reached about 29,000 square metres in 1970. The number of employees increased from about 900 in 1966 to nearly 2,000 in 1971. Danfoss had become Flensburg's biggest company.

Throughout the 1960s, the compressor business thus cemented its position as one of the most important to Danfoss. Moreover, this was also the opinion among the employees.

It can be illustrated by a good example, which involves the chief of the compressor department, engineer Arne F. Enemark: Enemark pronounced that his staff was absolutely the best in the factory. The department was the most important one and his staff was the best. Other departments were a little envious of the popularity and status the compressor department received, whereby it

The SC compressor

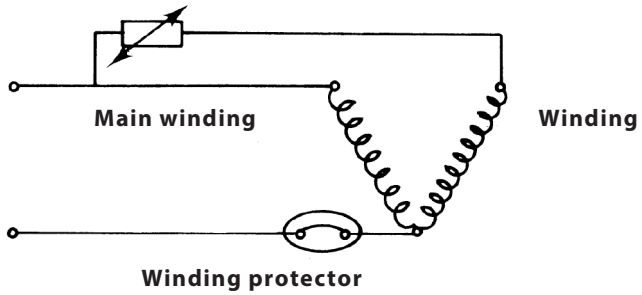
The SC compressor was the first in the world with an ignition system with ceramic resistance with positive temperature coefficient (PTC). It replaced the starter relay with moving parts.

The PTC starting device also provided an automatic protection of the starter winding of the motor. Furthermore, the compressor got its motor protector mounted directly on the motor windings, which creates a significant increase in protection (better than a motor protector located on the outside of the compressor).

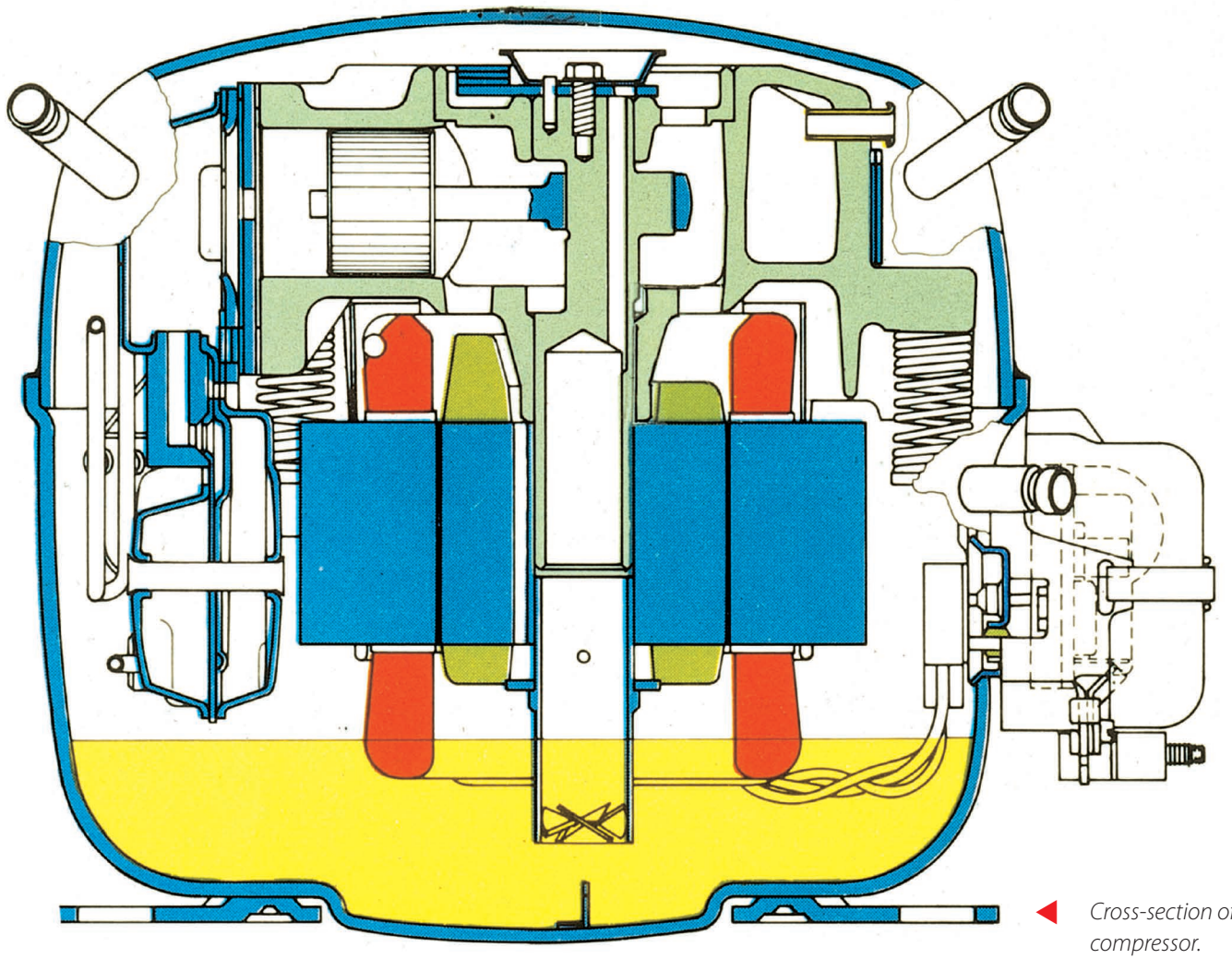
happened that some of the senior executives protested that Enemarks' employees were paid a little better than their employees. To this Enemark only replied:

– If my people are not the best, they are not allowed to stay with me.

■



Wiring diagram with PTC and winding protector. ▲



◀ *Cross-section of SC compressor.*

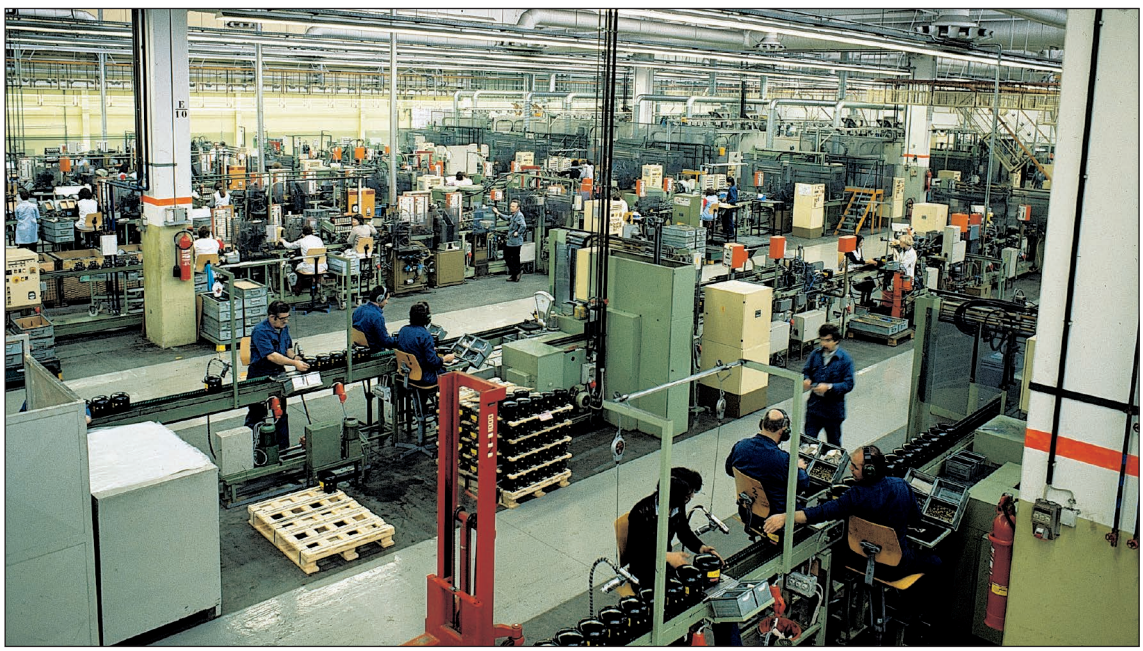
A world of rapid economic change

Danfoss has successfully spread to more and more international markets through the 1950s and 1960s. However, not until the 1970s did Danfoss really begin to see itself as an international company – and at the same time begins to organise and arrange itself as such. Rationalisation experts were hired.

At its introduction in 1956, the PW had been so advanced that it still in the early 1970 accounted for 90 percent of the Danfoss compressor sales. It had become such a great success that Danfoss, thanks to this model in the early 1970s, was the biggest compressor manufacturer in Western Europe.

However, Western Europe's largest compressor manufacturer was not master in its own house. When Danfoss entered 1970, it came with an organisational change, which caused more and more headaches - both for the compressor business and for many of Danfoss' other business areas.

Since 1956, Danfoss had divided its organisation into functions. This subdivision was inappropriate, because each business area had grown into both large and specialised businesses, and they needed to act as independent units.



Assembly line in the compressor production.

Already in the late 1960s, it became clear that the functional form of organisation had to be changed if the business were to develop optimally in the future. Instead, they chose an organisational form that departed from the separation of functions (production, sales, finance, etc.), and they chose one in which each of Danfoss' main product areas were assigned a significant technical and economic empowerment through the creation of so-called product groups.

The main structure of the new organisation that was finally introduced in 1971 was the creation of three product areas:

1 Compressors
2 Automatics (cooling, heating and industrial automation)
3 Hydraulic and burner components

The three areas each received their own independent development, sales and finance departments, which made them highly independent from each other. Directly under the Executive Board, a number of functions were placed, partly to support long-term planning, and to act as common service functions for the three product groups.
It would not be an advantage to allocate these functions to the three product groups individually.

However, Danfoss was generally divided into three areas - and the compressors had become independent. In connection with the restructuring, Danfoss Flensburg was assigned to the Compressor Group. From 1971, Harald Agerley was responsible for the large compressor group. The organisational led to a management style that was suited to sustain the ongoing development of the company. This now became the focus.

Hit by the oil crisis

In the early 1970s, the whole of the Western world could look back on a unique period in history, more than ten years of lasting economic growth.
Most of the Danish families had acquired a fridge - and many of them with compressors and thermostats from Danfoss.

Families no longer shopped at the local grocery store, but rather in self-service stores with large refrigerated cabinets and freezers. These also had Danfoss components.
The trend of having your own fridge and shopping in supermarkets had more or less become the same in all Western European countries, which together accounted for the most important markets for Danfoss.

In October 1973, the fourth war between Israel and its neighbouring Arab states began, and in the middle of the month, the oil-producing countries in the Middle East began to cut down their export of crude oil to the West. Oil prices tripled during over the following few months. This started a stagnation in the world economy, which had a huge impact.

Heat pump compressor.

WHEN EUROPE WAS LESS ENVIRONMENTALLY CONSCIOUS THAN THE US

The US is often blamed for being the major culprit in the climate debate, especially from the European side. Reality was different during the period between the mid-1970s to the early 1980s.
In Europe, the legislation on energy consumption at that time lagged behind the Americans.
The requirements for modest energy consumption were not defined by law, and therefore it was in reality the end users in their private homes, who decided whether or not they wanted to pay for an energy-optimised compressor.
Therefore, sales of the energy-optimised types were more than modest, but obviously contributed to a certain profile of the business. Also some northern European refrigeration manufacturers launched a few highly optimised refrigerators - with a focus on the relatively few end users, who at this time were willing to pay extra for the sake of the environment.

HEAT PUMPS BECOME INTERESTING

As a result of the energy crisis in 1973, many companies began to take an interest in heat pump systems. Danfoss did too.
In principle, a cooling system and a heat pump system are identical. The cooling system harnesses the cooling effect through the evaporator while the heat pump must get as much heat as possible recovered from the condenser.
The heat pump draws its heat from the air, water or earth at a relatively low temperature and discharges it by use of the compressor and through the condenser to a higher temperature level. Danfoss manufactured special FR and SC compressors for use in heat pump systems.
The smallest types were used for warming up water and the larger ones were used as space heaters.
With this new market area, Danfoss faced many problems. Companies, which were established in the heating industry, began to manufacture heat pump systems, resulting in a lot of errors.
The consequences were new tasks such as increased efforts in the information and service area.

Denmark had largely based its economy on cheap oil, and the governments failed to make effective, economical interventions that could adjust the Danish economy to meet the changing circumstances., Therefore, already in 1974, the result was a significant decline in industrial production.

Similar situations existed in Germany and the UK - and especially Germany was an important market for Danfoss. The recession lasted very long, and although the industrial production stabilised in 1975, it remained at a significantly lower level than around 1970.
The energy crisis in the mid-1970s only had limited influence on the energy consumption, requested by Danfoss' customers.

The rest of Danfoss joins the Community

The reality at Danfoss in the early 1970 was also marked by the fact that it was no longer necessary to recognise tariff barriers in the closest European markets. In 1973, Denmark, United Kingdom and Ireland joined the EC, and during a transitional period custom duty was gradually removed between the old and new EC members.

Now the "entire" Danfoss had joined the good company, not just the compressor factory, which had been built in Flensburg to compensate for the non-membership of the common market.
In 1972, the Danfoss management did not doubt that the Danish membership would be an advantage for the company.

At that time, the sale of components to the refrigeration industry was extremely important for Danfoss. If looked at in isolation, sales of these components represented almost 50 percent of Danfoss' total sales during the first part of 1970s.

Compressor type FR. ▲

Danfoss' production abroad continued to be concentrated in northern Germany. The Flensburg factory, which around 1970 had evolved to become the city's largest employer, found itself in a situation of manpower shortages. Already in the 1970s, it was clear to Danfoss' management that the wage bill was and would become an obstacle in the long term. Already at this time, the investments were therefore dominated by the investments in the automation of the production facility. However, the lack of operating staff was still present.

It was therefore decided to build a smaller plant in Schleswig, and the production started in September 1974. Shortly after, a smaller department in Kiel opened in rented premises. However, this was already closed in 1979. A third factory in Flensburg was added in 1976-77 and 34,500 square feet was now available in the Flensburg factory.

The PW shows its age

In the early 1970s, the small and large compressors of the PW series highly dominated the production. The PW amounted to more than 90 percent of the Danfoss compressor sales. The new SC compressor for larger refrigerators, which had been introduced in 1970, had yet a limited sale.
The PW series had been the foundation for Danfoss' position as the largest compressor manufacturer in Western Europe, but the age gradually started to weigh down the PW, and thus weaken its competitiveness. Competitors were also not idle in terms of product development.
In order to regain the position as largest compressor manufacturer in Western Europe, it became necessary to phase out and replace the PW with newly developed models that met the more stringent performance requirements.

Since the introduction of the PW compressors, new demands for less noise had been raised – and with the first oil crisis in 1973 – and slowly also the desire for less energy consumption.
In 1973, the product range was extended with the FR type, which was intended for use in larger refrigerators and household freezers. The FR delivered the same refrigeration capacity and efficiency than the largest models of the PW compressors, but had improved comfort through reduced noise and vibration. It was also less expensive to manufacture than the largest models of the PW compressor.
The FR series was ready to enter production in the middle of the major energy crisis and

PRODUCTION OF OWN MOTORS IN NORDBORG

At the turn of 1970-71, Danfoss decided to establish an independent motor production in Nordborg. So far, Danfoss had purchased motors, specially designed for compressors.
At this point in time, they wished to handle a future production themselves in order to build the know-how, which was necessary to optimise operation as well as the manufacturing processes. The motor production began in Nordborg in 1972 and in Flensburg in 1973.

this timing inhibited its start. However, when it was put into mass production in April 1975, it quickly reached high sales.

In 1977, the TL type was launched as a contemporary replacement for the smaller PW. Both models were equipped with the new start and protection system that had proven successful in the SC type.
With the success of the TL compressors, Danfoss regained its position as leader in Western Europe in quality and sales. The success of the TL was so convincing that a couple of Danfoss' large customers stopped their own production of compressors and instead they bought from Danfoss.
Another addition to the compressor product group was the BD type, which was introduced in 1978 for use at 12 and 24 volts DC.
This meant that it was suitable for use in caravans, buses, trucks and yachts, and it expanded the Danfoss product range.

Danfoss creates its own competitor

Already in the 1960s, the possibility of establishing a compressor plant in Brazil had been investigated. However, finding a reliable and profitable basis for such a facility was unsuccessful. Instead, in June 1971, a contract for a license production of the PW was signed by the company Embraco. Yet it did not start production until the spring of 1975.

In the beginning, the agreement with Embraco did not evolve quite as intended.
The quality was too poor compared to the standards of Danfoss, which was why the quality manager of compressors, Hans Kirk, was sent to Brazil for three months:
– We had to rectify the quality and we did, but it was a balancing act between teaching them how to make proper quality without disclosing everything. We did not want to give them too much advice, says Hans Kirk, who later worked his way to the very top as a board member in Danfoss.

Compressor type BD for DC current.

Energy optimisation leads to license agreement

The energy crises in the mid-1970s, as mentioned earlier, only had limited influence on the expectations from the market, concerning the energy consumption from a compressor.
In contrast, , the stringent regulations on the North American market in 1983 had quite a different influence.
These also involved the requirement for an energy marking on all refrigerators. It became the starting point for energy optimisation, also in Europe.

This tightening caused a serious activity level at Danfoss – and the competitors – to ensure market shares in the US / Canada. Of course, the knowledge that was obtained for this market could also be used to develop models for the 220 V 50 Hz market in Europe.

Based on the Whirlpool Group's plans to shut down their compressor production in the US, negotiations with Embraco took place in 1981:

- Danfoss had to deliver technology (= an energy-optimised FR program to the North American market and a tropical/commercial program to Middle/South America).
- Whirlpool would supply capital (to Embraco) and buy the energy models.
- Embraco should build up a production.

The negotiations led to intense activity within the FR area of engineering, application, quality and production, and in 1983 it resulted in a full license agreement between Embraco and Danfoss for the FR compressor. Particularly during the first three years of the agreement, a very intense transfer of know-how to Joinville in Brazil took place.

Production start in Joinville – and expiry of the agreement

By July 1983, the investment had come so far that a pilot production could commence with supervision and support from Danfoss staff.

To be fair it should be added to this story that a large proportion of the relatively young organisation at Embraco was German-speaking. Brazil had received many German immigrants around 1870, and many employees at Embraco were from purely German families. This led to a very effective exchange of information, and thus many personal contacts were established.

The products of the license agreement:

In the first half of 1983, energy improvement of the Danfoss FR compressor was completed.
The optimised pump contained the following elements

- "Improved Leakages": A reduction of gas leaks through a new method of grouping for the piston-cylinder clearance.
- "Improved Valve": A new valve system, where the most significant fact was the reduction of the top dead volume.
- "Direct Intake": A new intake system, which increased the volumetric efficiency.

In terms of development, an increase in the EER value had been achieved (Energy Efficiency Ratio) from 3.62 to 4.45 BTU/Wh at FFE 115 V 60Hz program, an energy improvement of 23 percent – and in 1983 this program series represented the world market's lowest energy level for reciprocating compressors.
At the same time, a complete FF program for tropical/commercial use was developed within the voltage areas 115 V 60 Hz, 220 V 50 Hz, and 220 V 60 Hz – all in a Klixon relay design.

"They were very capable of learning and we were good teachers. Too good, you might say, because when you give away a license, you also automatically launch a competitor. It was the first complete license that we sold and today we would probably have handled it differently", says Hans Kirk.

As Embraco grew in size (and know-how), the contacts weakened. Since the expiry of the license agreement in 1991, Danfoss and Embraco have been competitors. Danfoss knew it was a potential risk as it entered the cooperation, as it was exactly the same thing that happened when Danfoss entered a license agreement with Tecumseh about 30 years earlier.

Hans Kirk believes the license to Embraco was a mistake: "It is a mistake to have taught our greatest competitor everything they know! Ernesto Heinzelmann, who later became chief at Embraco, is trained by Danfoss engineering manager Knud Roelsgaard, and unfortunately it meant that he became proficient. However, the biggest mistake was that we did not buy them, when we had the possibility. We had the opportunity several times, and we could have owned them fully today", says Hans Kirk.

Bitten Clausen and CEO Andreas Jepsen sign an agreement of license production at Embraco, Brazil.

Another factor related to licenses, which is often forgotten, is that a license agreement also provides the licensor with an incentive not to rest on one's laurels, but to exert oneself to succeed.

There was a statue created by a Brazilian artist in Hans Kirk's office. It represents a gilded compressor; a "gift" from Embraco to celebrate the successful sales of compressors, which Danfoss taught them to produce.
Bitten Clausen is believed to have received a similar statue….?

Danfoss under pressure in North America

Danfoss chose to launch a 115 V program in North America with a slightly lower motor efficiency than Embraco, and they also launched a 220 V program.
Sales of both programs were achieved, and General Electric became the largest customer with a total volume of approx. 1.4 million compressors over the years 1983-1987. A fine volume considering that the sales were periodically interrupted by the introduction of GE's own Rotary compressor.
The fluctuating dollar rates meant favourable and less favourable prices measured in DKK.
GE had many specific requirements, which demanded the support of many Danfoss employees.
Generally throughout the 1980s, this meant that Danfoss did not seriously manage to compete on the North American energy market. Instead, particularly Embraco created a firm position very quickly, and also Japanese manufacturers of rotary compressors managed to obtain a strong foothold.


2004

Noise abatement becomes a focus area

A compressor, by itself, does not create noise. However, a compressor can be an indirect source of a lot of noise, and this was what happened with the PW. Throughout the 1960s and 1970s, the PW was Danfoss' best-selling product. Nonetheless, the customers often complained that PW compressors created noise problems.

In the compressors, both rotating components and forward and backward components are present, causing a certain level of vibration, which is easily transferred to the capacitor or cabinet.
Here they are amplified, with a high noise level as a result.
Furthermore, the compressed gas transfers the pulsation, caused by the piston.
When problems arose, the customers usually thought that the noise came from defects in the compressor. However, the problems could almost always be attributed to other factors. It was primarily due to the fact that the customer had inappropriately mounted the compressor or connected it to the cooling system in such a way that the vibrations resulted in noise.

Shipment preparation.

Model designations and capacity specifications

With the Pancake compressors, Danfoss ended up with some model designations which created many problems since the compressor sizes were specified in horsepower (hp).
An international standard that clearly defined compressor capacity in relation to horse power did not exist.

This caused a lot of confusion when customers compared two different compressors with the same horsepower name, finding vastly different capacities.
Some factories stated lower horsepower sizes than what was justifiably correct, to pay less duty.
Therefore, it became necessary to prepare a comparison guide for use of the sales engineers, so different manufacturers and their products could be positioned relative to each other and compared at the same conditions.

In 1965, the PW compressors received a new model designation that provided a better basis for comparison. The nominal displacement in ccm of the compressor was included in the description.
The old description, for example 1/6 hp, LBP / LST, was in the description changed to PW5.5K11, consisting of model, displacement in ccm, starting torque and motor breakdown torque.
For the SC compressor the model designation, e.g. SC15BX, was developed further, where A, B or C indicates the evaporating temperature and refrigerant. X means high starting torque.
Over time, this system has expanded to also include information on energy optimisation, tropical operation, new refrigerants, and the like.
When a compressor is to be marketed, it is necessary to know its capacity or performance under certain test conditions. The capacity is determined with a calorimeter.
During the development work, it was necessary to collect many calorimeter measurements to determine the influence of updates or changes. These measurements were also the basis for the capacity indications in the first data sheets and brochures, for a new compressor type.

From the production, a certain number of compressors were continuously sampled for calorimeter measurement, to be able to document the scattering of the different measurement results.
Depending on how the compressor was used, different evaporation temperatures were used because they have great influence on the capacity.

When customers compared capacities, they often forgot to compare under the same conditions, and a wrong image of the facts was created.
Danfoss used -25 °C evaporating temperature and many competitors used -23.3 °C, which

COOLING IN FREEZING WEATHER

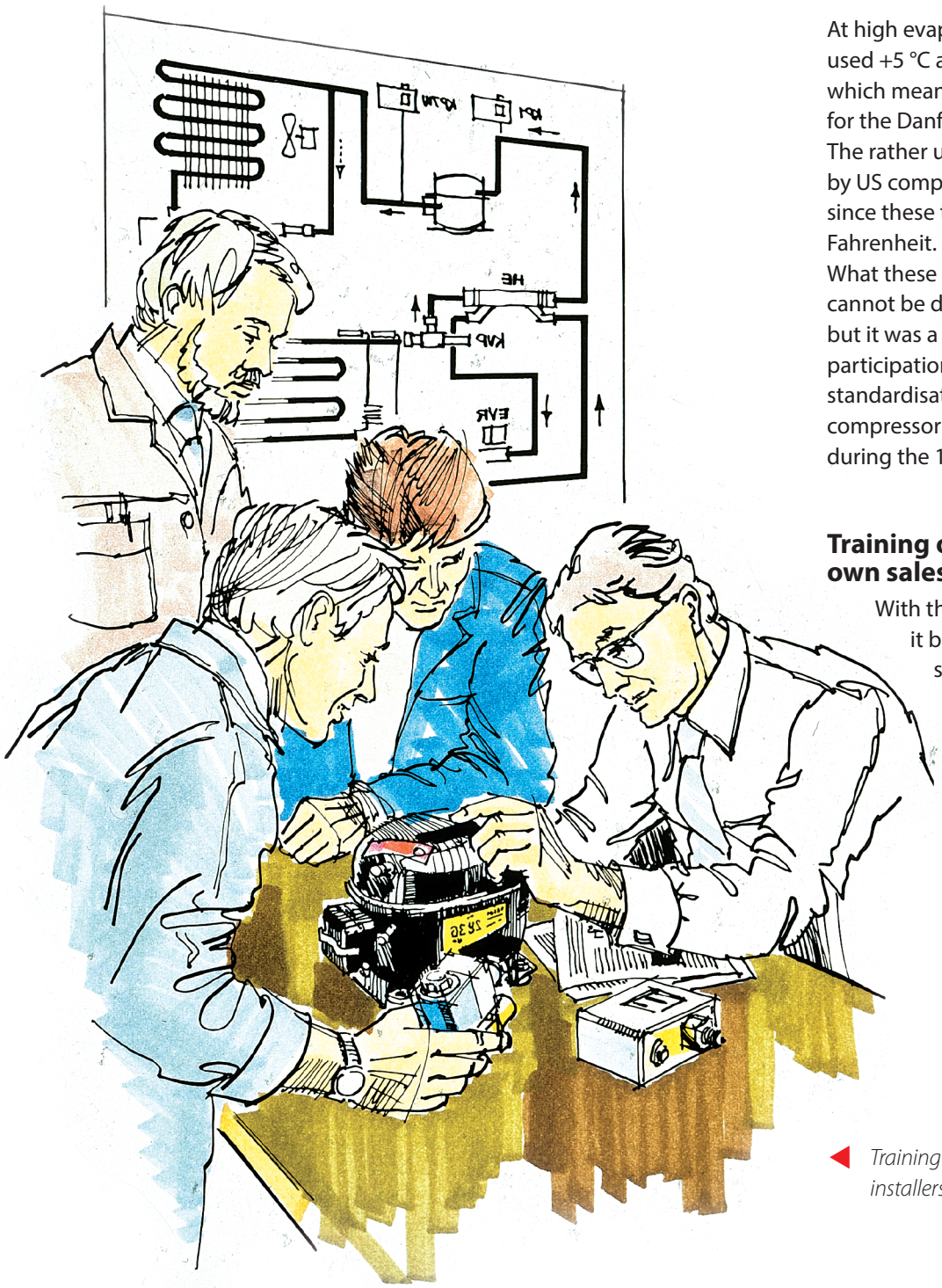
– In Arvika in Sweden, we had a customer with noise problems in a freezer, which had a PW11K22 compressor with oil cooling installed, says Paul Bachmann.
– Oil cooling meant two extra pipe connections that could transfer noise from the compressor to the cabinet, but after one week's work at the customer, we managed to achieve an acceptable noise level.
– The noise measurements were made in the Director's basement with the noise measuring equipment that we had brought with us. Before each measurement, it was necessary to shut down the oil burner in the house to achieve a sufficiently low background noise, so the measurement results would not be affected. However, it was important that the measurements did not take very long, because then it would become too cold in the house, as it was a very cold winter, Poul Bachmann recalls.

meant that the Danfoss compressor showed a lower capacity of approx. 10 percent when compared under these conditions.

At high evaporation temperatures, Danfoss used +5 °C and the competitors used +7.2 °C, which meant less capacity of approx. 8 percent for the Danfoss compressor.
The rather unprecise temperatures were used by US companies or companies with US licenses since these temperatures were converted from Fahrenheit.
What these differences meant for Danfoss cannot be determined in terms of lost sales, but it was a nuisance. Through Danfoss' participation in the European and international standardisation work, the standards for compressors' test conditions were created during the 1980s.

Training of refrigeration fitters and own sales engineers

With the widespread use of refrigerators, it became necessary to perform skilled service work, and the Authorised Refrigeration Manufacturers' Association therefore organised training sessions for the refrigeration engineers, who had primarily carried out service on large commercial refrigeration systems.



Training of refrigeration installers.

The training took place in Copenhagen. Engineers Gustav Johansson and Poul Bachmann from the Danfoss Application department were invited to each course to teach in hermetic cooling systems, compressors, and their application.

Later, the course was discussed at Danfoss. Poul Bachmann described it as ineffective, and the responsible person at the Ministry understood the complaints.
This resulted in Danfoss being given the task to make a proposal for a new course regarding service of hermetic refrigeration.
The proposal was reviewed and approved by the organisations in Copenhagen. It was also decided that Johansson and Bachmann should teach the first course, primarily with the people who would later become in charge of the training in Aarhus and Copenhagen.
From fear of criticism from the competitors, Danfoss had its concerns of doing this kind of work. However, Max Bruun, Chief Executive of the industry association said: Considering the dominance of Danfoss in the market, the fitters might as well start to learn about the Danfoss products.
Thanks to his support, there were no further concerns to initiate this work.
For many years to come, Bachmann was either in Aarhus or Copenhagen, a day at each course, to answer questions from students and teachers.
Almost at the same time, the Jutland Technical College in Hadsten was preparing a similar course. Also here, Bachmann, for many years, helped with both teaching and providing learning materials.
All learning materials came from Danfoss or came with the Danfoss name, and in this way the company was able to spread the knowledge about their products and their proper use.

At The Engineering School in Copenhagen, Johansson and Bachmann also educated many sales engineers from Danfoss' worldwide sales organisation.
The training was both theoretical and practical. The students both had to find the faults in the refrigerators and then correct them. They also learned how to replace a compressor along with procedures related to performing a qualified repair.

Anxiety of closure creates innovative approaches

After the split into divisions in 1971, a strategy project, carried out by McKinsey consultants, followed. The McKinsey consultants are not "just anyone". They are specialists in analysing companies, the markets, products and ideas, with special focus on strategies.

These company doctors, together with a selected "Compressor Team", were to provide the new division business strategies, including of course the product strategies.
Since the profitability of small compressors (at Danfoss the small PW's) was strained, consultants from McKinsey suggested an exit from this business area, during a phasing-out period of ten years.

This proposal was obviously not greeted with joy by the recipients of this information. The newly appointed Group CEO Harald Agerley and his development manager, George Stannow, therefore discussed the future and its consequences. Approx. 1,500 jobs would have to be terminated. In response to the question whether or not the decision could be changed, a list of conditions was presented: Significantly lower production costs, low noise level, patentable innovations, and more.
Finally, it should be demonstrated within 24

months that the goal had been reached. Then the investments could start and the production could be established within a further 24 months with a wide product introduction.

The project was called HICOM, the High Innovation COMpressor, because it was implicitly evident that something different than a single-cylinder piston compressor had to be developed.
Danfoss had used this principle in the PW compressors, the compressors that had done well for 20 years, but was now considered obsolete.

The development group had its own budget and a staff of five people during the first phase. Within six months, they had to provide three possible product concepts that would meet the target. The process began on 1 October 1972.

The framework for the creative process

In order to create an innovative think thank that would not be disturbed by the usual daily work, the development team moved into an empty flat outside the factory area in Havnbjerg.
Here they began a systematic development procedure, which should lead to the two or three best new concepts.
In parallel with this, the group completed the development of a single-cylinder compressor as a benchmark in a creative value analysis project against which the current known compressor principle was analysed and optimised.

CASUAL GROUP WORK

– They were allowed to look after themselves in the flat in Havnbjerg. Sometimes, one would just pass by and see "how things were up there", as one would say.
We were all curious to find out what they were doing. So, we went up there – and found them sitting with their feet up on the table, drinking beer! But it seemed to work, says Hans Kirk.

Compressor type TL.

– We, who worked in Havnbjerg, had requested – and achieved – a quite different working environment than what was normal at the time for employees in a development department, says Jørgen Stannow, Development and Project Manager in the Compressor Division 1970-78.

– If the systematic or innovative approacheds did not move forward as expected, we sought inspiration using unusual methods. We walked, played, went on trips, attended workshops or discussions, which, of course, led to some misconceptions by some people in the mother organisation at the factory, who were accustomed to other standards of work efficiency, says Jørgen Stannow.

The strike helps

After five months – one month ahead of the agreed time – the development team from Havnbjerg had reached the three most

promising concepts, which now had to be detailed, developed, and tested. A systematic analysis and a process of creativity had taken place, both duly documented in reports. At this stage, the process could not be taken any further in the flat in Havnbjerg. The group moved back to the development departments in February 1973 and began the construction work on the first prototypes of all three concepts.

The benchmark compressor got a lucky kick-start during the general strike in April 1973. All workshops were vacant, and the group found available materials, which could be processed by the workshop staff and engineers. For instance, the compressor block was machined from a discarded vise, which had the correct quality castings.

The finished compressor was tested. Its operating characteristics, low noise and material content, created positive surprise and became difficult to match by the two other approaches that were abandoned in the autumn. They were more complex and not as promising with regard to measuring up to the benchmark project.

The TL compressor was thus born, and after another 18 months of development, including three test model generations, it was decided to go into production in the summer of 1974. The necessary experimental work had been carried out, and it showed that the target from the presentation had been reached.

Production maturation to reach the required accuracy

The special, material-saving design of the TL compressor was not so easy to make. Therefore the future of the compressor depended on whether or not it was possible develop a production and assembly method that would be 100 percent accurate coupled with flawless results.

The entire development period and the first years of production were needed to master the exceptionally difficult alignment of the stator and rotor in the unsymmetrical, two-legged compressor block. The number of "repeaters" at first assembly fell from close to 100 percent for the first prototype series to a temporarily acceptable level of a few percent at the start of production.

It was all surrounded by great secrecy:
– Production maturation took place in the compressor factory in L2, and the production

A compressor must survive rough treatment.

"WE ARE BETTER THAN FLENSBURG"

Engineer Peter Mortensen remembers that the TL – in spite of its many excellences – was no dream production to venture into for production manager Gunnar Krohn.

Although being a bit troublesome during the start-up phase, it was apparently possible to resolve the issues by the classic rivalry between the two compressor plants in Nordborg and Flensburg, says Peter Mortensen.

– In the late 1970s, the novel era compressor type TL was ready for production, and it was thoroughly presented by the construction department to production manager Gunnar Krohn and his staff at the Nordborg plant, says Peter Mortensen.

– In the production area, the manufacturing of smaller series had been carried out. It had created some difficulties, especially due to significant differences compared to the previous types. Krohn claimed that it could not be produced at all: "It was typical to see that it was a group of theorists, who had come up with this product, which had no realistic chance of being realised", the production manager thundered.

When it was reported later that the Flensburg factory did not find any difficulties in producing the TL, Krohn said: "It can easily be produced by us - and better than the factory in Flensburg"

During the prototype period they made approx. 2,000 TL compressors.

They were tested in an extensive quality assurance program. They were taken apart and analysed and then they were stored in a scrap heap in the basement.

– Nothing was allowed to reach "Josiah" , as the product handler was called, because then we could not be sure that our secrets and innovations would be kept hidden, until the patenting and more details were completed, says Jørgen Stannow.

staff was involved in the work. Efforts were made not to let outsiders know about the new compressor and its construction. The several hundred operators in L2 were informed about the project at meetings, where 20-30 people at a time were told about the plans and were motivated to help ensure that we would be able to surprise customers and competitors at the introduction.

Even though maybe 500 people were informed of the plans, they succeeded in making sure that nothing slipped out before time. The loyalty of those involved was unique, says Jørgen Stannow.

The quality demanded zero defects

When an innovative new product like the TL compressor is about to enter the market, to replace the well-serving and well-known PW-compressor in a foreseeable future, an occurrence of quality problems would be fatal. With all the new features that were introduced in the TL, it was therefore necessary to have 100 percent quality control of all processes, including assembly and testing. Not a single defective TL compressor could be allowed to reach the customers during the first difficult start-up period.

Therefore, a setup process in which all manufactured compressors "were supplied internally" to a critical "customer" was established. This "customer" consisted of a control team with an experienced quality inspector in charge. With a pedantic "input control" they could reveal the sources of error, which are inevitable for such a comprehensive operation like the establishment of a new production.

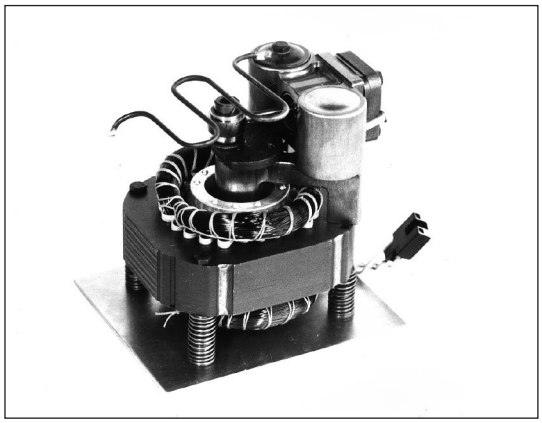
The system was effective, and the error rate fell quickly, without involvement of the external customers. Since every system showed the desired quality, the TL was ready for market introduction. Incidentally, this occurred exactly as planned four years earlier.

Come and see ...

The introduction was as a festive event with a popping champagne cork, symbolising the situation.

The large OEM customers such as Bauknecht, Electrolux, Bosch, and others were separately flown to Nordborg without knowing the real purpose of their visit. Here, they were to get a considerable surprise: a new and improved version of their own fridge.

– We had meticulously prepared a full demonstration of the TL compressor in the customer's own refrigerator, says Jørgen Stannow.



The compressor block was cut from a discarded vice.

– The same cabinet, however, equipped with the conventional PW compressor stood beside it. The low noise level of their cabinet with the TL, a consequence of the highly reduced vibration and low acoustic noise of the TL, seemed convincing.

After the demonstration and a thorough description of the entire innovation, the customers were allowed to take as many samples as they wanted, says Jørgen Stannow. At the same event, Danfoss showed an cocky side towards its competitors, which was very unusual for the company:
– Since we started so well, we sent test samples to our competitors too, so they did not need to bother our clients to get hold of the new machine, says Jørgen Stannow

A success was born

Cocky or not – the Havnbjerg group and Danfoss had hit the spot with the TL compressor.
Sales were well under way, and Danfoss could register a sale of 1 million TL's in less than 18 months. Production capacity was increased, and today there are more than 100 million TL's in operation.
At the same time, Danfoss managed to keep

The success of the TL is celebrated by the "Havnbjerg Group" with champagne.

COMPRESSOR PRODUCTION AT EYE LEVEL

Helene Cehofski was employed as a production worker in the compressor production in Nordborg 1972-1984. Throughout the years, Helene worked at the same machine where she worked with compressor motors. Every day she described how she experienced her work situation:
Here are some excerpts:
"The machine was running exceptionally well. Only, when we arrived, there were nicks in the cores again. – The eyes a little better today. We were fresh and awake all 3 of us. I stood at the welding machine, as Calle said, "Plastic, Lene". "I can tell you no, you,"
I replied, "I am awake and there is plenty of plastic". He laughed out loud.
At approx. 5:00 am I asked if we should relax for just 5 minutes.
Calle: "Yes, we must. I am surprised that it came from you. It is the first time in the 2 years I've heard you ask for a break. "End of the week - quite good".
"Today I have been at Danfoss in Dept. 808 for 5 years and shall begin on the 6th year after the summer. During all this time, I have written a diary each day. I have always been happy to be in the department since we have nice foremen with whom you can discuss things thoroughly. I attach great importance to this. I also have a good relationship with all other workmates, no matter who it is".
"A terrible day. The machine had been repaired, but good Lord, everything went wrong. There was so much wrong with it that I do not want to mention it. It would fill a whole page in my diary. I felt so sorry about everything. The switches on the machine I do not know particularly well:
"What now, Lene," and I stood like a stupid cow and could not tell how to use it, and every time we looked at each other and laughed. I also told them that I had said that I did not know all the switches. I was so depressed that I did not even eat my packed lunch".

"Everything was in perfect order. Mrs. Mads Clausen (Bitten) was on tour in Dept. 80800 with her guests. She was wearing a green dress that suited her well. She greeted and smiled - a very nice lady. Edith has taken the watchdog job instead of Otto, who had his hand caught in the wrap machine.
"The old machine was operating well today. There were small repairs, but otherwise it went well. The time also passed quickly. Dres control came today and said: I do not bloody want to control your work, Lene. "Well, Dres", I replied, 'How come"?" Yes", he replied, "I'll tell you, with your work there is never something to complain about"."

the design protected by a basic patent of 15 years; therefore Danfoss' competitors could not produce copies of the compressor. The patent has expired today, leaving the TL with the status of being the most copied small single-cylinder refrigeration compressor.
Danfoss' success with the sale of the TL was unambiguously good for the turnover. Perhaps the most important aspect for Danfoss was that the planned closure of Danfoss' production of small refrigerator compressors – which had been decided in 1972 – was dropped. If the opposite had happened, Danfoss would not possess the status as one of the major players in this area today.

The TL project sat new standards

With this new design principle, conditions were created that the assembly could take place according to the sandwich method, and thus the conditions for a both partly and fully automatic installation could be completed.
In 1970, a suitable assembly line system appeared, namely the new Bosch-Transelastike mounting system, with single-palettes and a mechanical identification and control system. It could be a major step towards automation with integrated quality monitoring.
The prerequisite for a smooth, uninterrupted use of the system was that all components for the assembly process were delivered very uniformly and would comply with all tolerances. Therefore, for the processing of the main component, the compressor block, a fully automatic transfer working machine was acquired, which worked in one clamping and with an integrated honing of the block.

Also for the compressor housing with its many fittings, a fully automated welding line was developed and installed as a prerequisite for a very high-automated assembly line.
This resulted in the paradox that many rather meaningless welding fittings had to be produced with much higher precision than what was required by its function.

With this newly developed mounting method, the workforce of manual labour could be halved, and as a further impact this had a very positive influence on the quality. Quality monitoring became progressively fully integrated in the assembly processes.
According to this method, in the years 1978-1982, four assembly lines were installed with a total capacity of 4 million TL compressors per year. With this a new compressor was born, which created great attention in academic circles and assured Danfoss a great leap forward by:

- using 35 percent less material
- using 50 percent less staff for the installation process
- having greatly improved vibration and noise characteristics
- using much more environmentally friendly materials
- having a lower energy consumption

PATENT WINS PRAISE

In 1976 in connection with the development work with the TL, Danfoss sent a patent application in Germany (DE 2,617,369) on the design of a spring suspension system for hermetic compressors. This system sets new standards for how low vibration levels can be obtained for these small, interior spring suspension refrigeration compressors.
The patent application was later nominated by the Deutsches Patent County as follows: "dass Erfindungshöhe vorhanden ist und auch eine eindeutige Lehre zum technischen Handeln vorliegt ". It is rare to see such an unreserved recognition from the Deutsches Patent County!

The potential of this assembly concept became visible over the years, where it was vigorously developed and expanded, for example to full electronic data collection.
This is now the basic concept for all Danfoss compressors, wherever they are produced.

Testing of compressors.

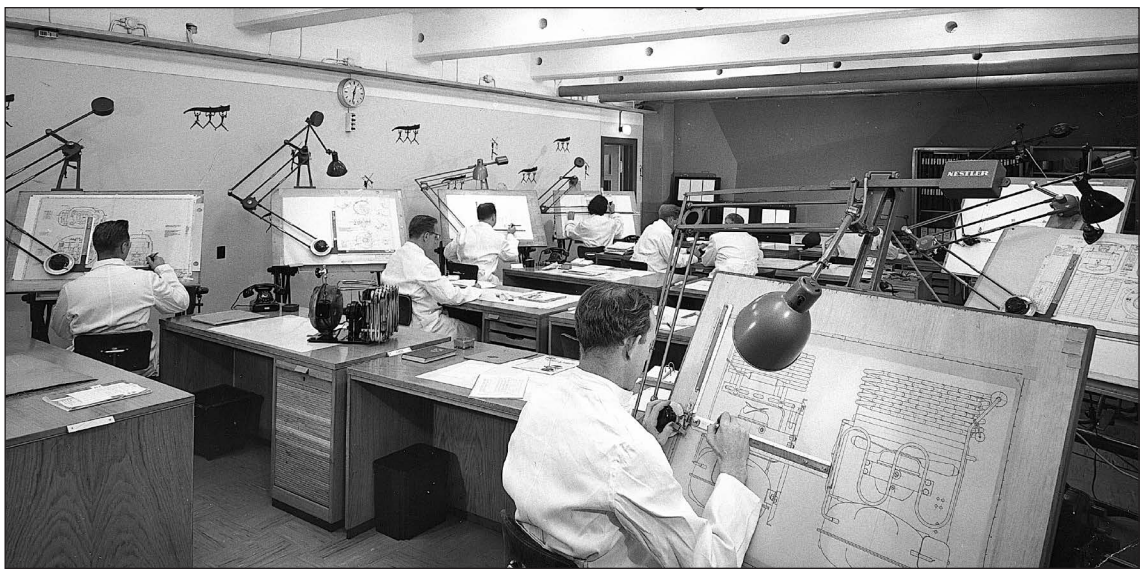
The organisation is constantly trimmed

Efficiency improvements and adjustments improve the business for Danfoss, who – with good products – has obtained a leading role in Western Europe, and Danfoss now also has ambitions on other continents.
However, just as Danfoss had adapted itself as a continental player, the continental view is replaced by a global outlook. Danfoss has to learn how to trade with the Chinese and the Mexicans.

Hindsight has a way of creating an excruciatingly bright light. Reality is always easier to dissect when time has passed - which means that contemporary behaviour can look a little inappropriate from a distance.

Working life at Danfoss at the beginning of 1980 is no exception. Civil engineer Jens Lorentzen arrived at Danfoss in 1980, and he came to a workplace where working methods and social manners were not significantly different from the ones which characterised the Danish business sector during those years. The way Danfoss had organised itself did not in any way match the innovation and new ideas, which were attached to the Danfoss products. Seen in retrospect

– The wave of cooperation courses had largely passed: ties and suits were no longer common (at least for the younger employees) the tone of communicaton had becore more informal, and the departments had made good progress regarding the organisational cooperation, says Jens Lorentzen.



Drawing office.

In contrast, we did – also at Danfoss – stick to an outdated documentation culture and a typical everyday example was the completion of numerous long reports and a lot of written communication between the departments. – Another typical problem was the backlog – sometimes up to several weeks - because of time needed for typing and the general wish for perfection in terms of orthography. It was a significant limitation of effectiveness, says Jens Lorentzen.

How department A informs department B

As mentioned earlier, the efficiency experts from McKinsey had been at Danfoss in the early 1970s. Thanks to their allocation of portfolio responsibilities in divisions, the company should be more effective. However, ten years later, in the early 1980s, there were still many things at Danfoss that were implemented inappropriately.

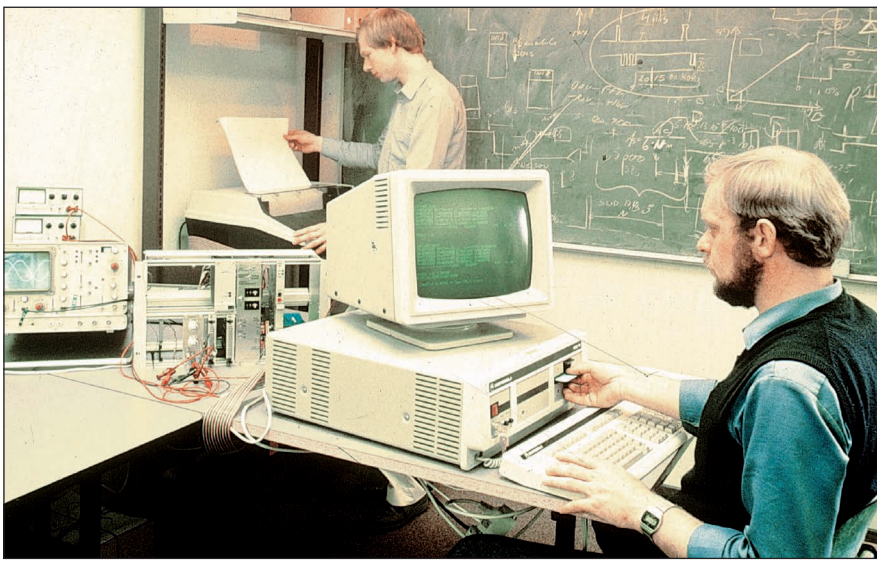
Examples from everyday life:

- For product releases, all departments wrote long reports (some with virtually the same content).
- All functional managers and section managers should be present at every product release.
- The preparation of drawings and design messages was manually done and the handling went across many levels in the organisation (graphic designer/technician/engineer/section leader/AC) – which all had to approve the the work with their signature.
- The workstations for all technicians were equipped with a drawing board – but virtually no workstation for the engineers were present. The engineers only created sketches.
- The routines were to some extent created only to describe "how dept. A had to deliver documents to dept. B.
- The interaction between research and engineering was poor. A lot of (good) knowledge was developed to end up as reports on a shelf without being put into the products.
- One had plenty of time (e.g. to read professional literature during working hours).

The computers arrive

Many of these inexpedient workflows and methods were becoming obsolete in the course of the decade. From the beginning of 1980, and over the following seven to eight years, there were several rounds of cost-saving measures, which also led to the fact that several less important routines were abolished.

In 1980, KIMS was introduced. KIMS was an abbreviation for Construction of Information Communication System. The KIMS program should make the workflow transparent and led to the removal excess of paperwork. As something new, it was now possible to do technical data processing from your own computer, instead of going to a central computer room.



In 1990, the first PCs arrive at Danfoss.

In 1990, the first actual PCs entered the departments and conclusively eliminated time losses associated with typing. It led to the establishment of networks where everyone had access to the same data and this meant quite a significant improvement in quality and efficiency.
The introduction of electronic mail and electronic appointment calendar had the same effect.

It would seem abstract to describe how the introduction of electronic data processing impacted a company like Danfoss.
Perhaps this is best concretised by looking at three important steps for Danfoss, from the 1980s and onwards – and the difference that can be seen on the three projects solely because of the technological possibilities.

The Embraco license agreement primarily took place from 1981-1985 and the communication was limited to telephone, telex and regular mail.

When Danfoss engaged in projects in Slovenia and Mexico during the 1990s, it was possible to use the KIMS system (partially) online from the start. However, the distribution of drawings was manually done. And when Danfoss entered the Slovakia projects, e-mail and video conferences were crucial success factors.

The compressor business becomes concentrated

As was the case in the beginning of the previous decade, the 1980s were dominated by rising oil prices.
An energy crisis on the same scale as before was not the case, but one could feel it.
In 1979 and 1980, oil price increases followed in the wake of the upheaval in Iran when the Shah Duchy was overthrown.

This meant that investments in Denmark in 1981 were at their lowest level in the postwar period in relation to the total production, and the industrial production and investment in most of the Western European countries declined for several years in the first half of the 1980s. Only after the mid-1980s did an upward trend in production return.

The fight against inflation was the dominant factor during this time. The frequent devaluations in the postwar period were eliminated. Instead, a policy of stable exchange rates was chosen.
This, in turn, made it essential to keep costs at a much more stable level than before.

QUALITY CONTROL IN PRACTICE

Until the late 1980s, compressors were produced both in Flensburg and Nordborg. At both plants, a notion prevailed that their particular factory did best and they were not too proud to gloat and tease when they proved better than the "competitor", i.e. the other factory.
Peter Mortensen, quality manager, remembers an example when the Flensburg factory was better than the other – with a somewhat peculiar background:
– The electrical winding wires in the compressor motor were assembled with nylon cord. For this purpose, among other things, a sharp stick fitter made of metal was used. The stick fitter could cause damage to the wire insulation, and thus, a fault in the final compressor. Such errors were carefully registered and efforts to minimise these were arranged, says Peter Mortensen:
– Eventually such types of errors were no longer to be found in the motors from the Flensburg factory, which was a triumph for the Flensburg employees. It turned out that the women working in mounting in Flensburg had been fighting and they had poked each other with these rods.
The metal rods were then replaced by those made of plastic, which damaged neither the isolation nor the women. Thus a source of error was corrected and the work environment was also significantly improved, allegedly, says Peter Mortensen.

Flensburg becomes compressor centre

When Denmark joined the EEC in 1973, Danfoss decided that all future investments in compressor capacity and expansion should be placed in Flensburg – and that all products other than compressors had to be moved away from Flensburg. Therefore, the production of the newly developed TL compressor was exclusively established in Flensburg. This was the first time that Danfoss did not begin a production of a newly developed product in its home base in Nordborg.

The increasing concentration of compressor activities in Flensburg meant that the weight of business activities shifted more and more towards Flensburg. In 1987, management decided to relocate all remaining compressor operations to Flensburg and not just production. This time, it also included the relocation of departmental functions; Construction and Development, Sales and Marketing, Finance and Bookkeeping.
In 1988, the compressor business had all its activities consolidated in one geographic headquarter in Flensburg. In 1989, the NL series

EGON-TEST

Other Danfoss divisions also had their special relationship with quality tests.
Egon Nielsen, head of construction in the automatic group, which manufactures valves, has given name to the "Egon test". In order to pass this test, the product must be strong enough to be thrown on the floor. In the same department, the "Mathiesen test" is performed, which is an extended version of the "Egon test", you may say – here the item must be able to survive with a trip down the stairs. (see photo page 55)

Compressor no. 100.000.000. From left: Director H.J. Gustavsen, Bitten Clausen, Jørgen M. Clausen and Peter J.M. Clausen.

TWIN COMPRESSORS

The market requested compressors with even greater capabilities, and therefore calculations and studies were carried out. They showed that it would require large investments in production equipment to be able to make larger compressors. Thus, the brilliant idea to connect two SC compressors came up.

In this way, the SC Twin compressors were born, and the Danfoss compressor capacity range was doubled once more. In 1983, this meant that Danfoss would now have the ability to supply products to the commercial cooling market too.

The compressors were mounted closely together on a frame with an oil-equalising piping between the compressor housings and a common suction.

The compressors should still be able to work at a single-phase supply grid. Therefore, a time delay relay was fitted; whereby the second compressor would not start until the first compressor would no longer require the high starting current.

It was also simple to use compressors with capacity control. Both compressors were running during cooling or during freezing, but when the desired temperature was reached, one of the compressors could switch off and thereby save energy.

When the intention is to remove the transmission heat, one compressor is sufficient to maintain the temperature level. The Twin compressors were also marketed as versions for use in heat pumps.

was introduced as a replacement for the FR series and in the same year, Danfoss was able to deliver its compressor no. 100,000,000.

Around the mid-1980s, it was decided to cease the manufacturing of the PW compressors and trying to sell the equipment. At that time, more than 100 million PW compressors had been produced globally, of which more than 60 million had been sold from Nordborg and the TL had already proven its strength as successor.

Over a relatively short period, Danfoss manufactured the PW components which were still needed according to contracts with licensees; then the PW could finally be phased out and in 1985 the PW production stopped.

”Long nose” draws wins out

An Austrian agent, on behalf of the Government in China’s Sichuan Province, examined the possibility to buy a second-hand production plant for the manufacturing of hermetic refrigeration compressors. At that time, the Sichuan Province had more than 100 million residents, and it was actively transitioning a part of the province’s agricultural production to industrial production – especially cooling and freezers.
The Chinese first sought a second-hand plant at AEG in Germany, but in 1985 they met with Danfoss. Here, at first, Danfoss was dismissive because they felt obliged to honour its licensees – but nevertheless the Chinese request was considered. As license responsible, Knud Roelsgaard was the person to examine the case.

– Without knowing anything about the Chinese or how such an agreement could be realised, I assessed that it would certainly require patience and probably take a long time. Probably also so long that our obligations to licensees would be thinned out, says Knud Roelsgaard.

His summary presented to the Executive Board regarding the Chinese request described that it could probably be possible to meet the Chinese request under certain circumstances. The response from the Executive Board was a trifle less hesitant:

They said: ”Then you can just do it, Roelsgaard” and then there was only one direction and that

Twin compressor.

was forward, says Knud Roelsgaard, who was neither "inhibited" by having sales experience in China nor did he have any experience with selling production equipment.

However, he soon gained experience within this field of expertise.

The Chinese had appointed Jianchuan Machinery Factory, at the Minjiang River, south of the capital Chengdu in the Sichuan Province, the place where a future compressor plant would be located. It was far out in the country side, even considering Chinese conditions, and a "long nose" (Caucasian) like Knud Roelsgaard was a bit of a rarity.

Negotiations took shape and the patience Knud Roelsgaard knew was needed, was about to run out many times during the course of negotiations. Many meetings, many detailed drawings of virtually the entire factory and its production facility took time, and it wasn't until the autumn of 1987 that a telex arrived from the government of Chengdu, saying that they now wanted to finish the negotiations, so that space for the project would be allocated within the Seventh Five-Year Plan.

– Bo Jørgensen, lawyer at Danfoss, and I went to China with power of attorney to sign "any contract in the Peoples Republic of China ". We brought a draft contract based on what we had discussed and agreed to with the Chinese, says Knud Roelsgaard.

– After the first few days of negotiations, we wondered why we had only met about half of the Chinese people that we had negotiated with so far. We discovered the reason for this about one week later when we met an employee from an Italian compressor plant at our hotel. He was in China on the same errand as ourselves, but now, he was deadlocked by the situation and asked if we could relieve him of the Chinese, so that he could go home, Knud Roelsgaard remembers.

Testing of compressors.

FAULTS – A RELATIVE SIZE

A great effort has always been applied to analyse errors on the compressors that were returned from the market. Foreman Alfred Hildebrandt was responsible for this activity.

One time, the sales manager, Per Hansen, had agreed with a customer (who annually purchased more than one million compressors) that all compressor failure from his market should be returned to the analysis department.

Hildebrandt prepared well for this task. He hired an extra person and obtained 500 m2 of additional space for this purpose. He was somewhat disappointed as only a total of 31 compressors were returned.

After a few days, the Italian employee disappeared – and now only Danfoss was left in the race.
But the contract had still not reached a conclusion:
– The Chinese found out that the total contract price exceeded the limit within which the provincial government had its economic freedom of action. The project therefore had to be sent to the central government in Beijing for approval. This had to be avoided at all costs. Therefore the provincial government demanded the contract be divided into two separate contracts, which were each within their limits. It required a lot of cutting, pasting and typing, but we succeeded. This also happened thanks to a fantastic interpreter, who not only managed to translate what the Chinese

▲ *Danfoss directors H.J. Gustavsen and H. Agerley sign a license agreement with China National Technical Import Corporation and Tianjin International Trust and Investment Coproration.*

were saying – but he also understood what they meant, which was even more important, says Knud Roelsgaard.
The negotiations threatened to break down repeatedly, because the Chinese demanded price reductions. Every time the Danish delegation managed to avoid this by offering additional extras from a specially prepared catalogue instead of accepting price reductions. Finally, there was nothing more to offer, and Knud Roelsgaard made it clear to the Chinese that he had booked his ticket home and would leave with or without a contract.

– Then they got busy. They explained that they were well aware that I would not be punished by coming home without a contract. They more than indicated that they were very interested in reaching a positive outcome of the negotiations. They had also found out that I was born in the Tiger Year and Bo Jørgensen in the Snake Year (perhaps very appropriate for a lawyer!), and this could be the reason why we were so resilient. During the remaining 30 hours of our stay we got one hour of sleep. However, at 5:00 in the morning (I had to fly from Chengdu at 10:00), the contract was signed, reports Knud Roelsgaard.

In Flensburg, the Chinese were instructed on how to operate the systems and tools. The plant then had to be disassembled and packed into 82 shipping containers. When everything had to be reassembled again in Jianchuan, more than 20 Danfoss employees were ordered to assist with the installation and test runs. The finished plant was delivered to the government and representatives on 13 June 1991 – this was about six years after the initial request from the Austrian agent.
– It was the biggest logistical challenge for Danfoss to date, and the Chinese experience became useful as the growing globalisation of activities brought new tasks of relocation and re-positioning, says Knud Roelsgaard.

The ozone layer calls

Until the mid-1970s, questions about the refrigerants to be used for cooling had not been raised. The used CFC/HCFC refrigerants R12, R502, and R22 were all introduced in the 1930s as safe and harmless substitutes for ammonia, sulfur dioxide and methyl chloride, among others.
It is true that R12 (Freon 12) is not stable in the cooling system and responded at elevated temperatures with oil coking of the valve system

ROTARY COMPRESSOR

The threat from the rotary compressor presented a continued demand for energy improvements.
1980 was a very turbulent decade. A decade during which the debate about energy and the environment began to take shape. Although at first, these two areas were not closely connected to the refrigeration sector. In 1980 and 1981, the Japanese companies challenged the competitors with low-energy refrigerators, equipped with rotary compressors (rolling piston type), and it looked as if this type of compressor would see a revival and become the compressor of the 1990's.
There was not much new in the compressor. The roller stamp principle was the same as Frigidaire used in their "Meter-Mizer" in the 1950s, and Linde in Germany, moreover, also produced this type of product during the same period. However, there were certain elements in the construction, which justified the expectation that a higher efficiency could be obtained, than what was the case for the conventional reciprocating compressors. One of the prerequisites was that the rolling piston compressor could be produced with the necessary, accurate fitting and within this area progress had been made since the 1950s. Both grinding technique and measuring technology had improved, and especially the progress in computer technology had made it possible to handle the large amount of measurement data from the long tolerance chains in the rolling piston compressor.
In the autumn of 1981, Danfoss began a rotary compressor project to remain in line with current trends. The technical development on the project was satisfactory in relation to the assessment criteria we had defined, but it turned out that the acceptance of the rotary compressor at the customers, and thus their market penetration, did not at all progress as expected.
Therefore, the economy of the project was not acceptable, and the project was terminated in August 1985. A decision – as the subsequent development has shown - was correct.

as a result. It was, however, a problem, which the compressor manufacturers had learned to live with by keeping the maximum temperature around the valve system suitable low.

The first indication that the use of these CFCs (chlorofluorocarbons) had unexpected consequences came in 1970 when the British scientist James E. Lovelock found R11 in the atmosphere.
Based on that fact, M.J. Molina and S. Rowland presented in 1974 the theory that the CFC could break down the ozone in the stratosphere, which would lead to an increased amount of harmful UV radiation reaching the earth's surface. After additional scientific evidence in 1985, where an ozone hole was discovered over the South Pole and accompanying international negotiations, the Montreal Protocol was signed in 1987by the 46 most important industrialised countries.

With the signing of this Protocol the countries made commitment to incrementally reduce the CFC consumption by 50 percent before 1999.

For the compressor division, it was clear that CFCs would disappear within the next few years. Not so much due to the original Montreal Protocol, but rather because of the fact that, especially in the Nordic countries and Germany, a sharp public debate had sparked that demanded a tightening of its provisions since the ozone hole continued to grow. The big question now was which refrigerant would replace R12?

The Montreal Protocol

The remarkable thing about the Montreal Protocol is that for the first time in history, all industrialized countries agree to act without having a well-founded scientific basis to support the decision. It was an agreement that inflicted extraordinarily high costs on the entire refrigeration industry.

Based on the information obtained, Danfoss had prepared three action scenarios for the future development of the coolant situation, and at a product committee meeting on 4 October 1988, it was decided to pursue the scenario "actively convert" in favour of "wait and see" and "prepare".
Since R134a was considered as the most likely alternative, the decision was made to initiate the development of the compressors for use for this refrigerant, and the research/pre-task was finished in April 1990, i.e. over a year and a half.

Danfoss encourages the ICI to do more

Before 1992, the thermodynamic properties for the new refrigerants were not determined by the accuracy which is necessary in order to calculate the performance and efficiency within a few percent.

A few measurements were published worldwide. These showed that the efficiency would be reduced by 5-15 percent when using R134a compared to R12. However, all these measurements were performed with compressors that were not suited for the R134a.

During the autumn of 1988, motors were dimensioned to suit R134a in several series of test compressors; the TL and NL. Calorimeter measurements all gave a unique result: A slight reduction in performance of 3-8 percent, but unchanged or slightly increasing COP (coefficient of performance), 0-2 percent.

These results were so groundbreaking that, in

TL4F compressors with the ozone-friendly refrigerant R134a.

cooperation with the refrigerant manufacturer ICI, Danfoss succeeded in getting the opportunity to present them before a gathering of 5-600 professionals at ASHRAE's summer meeting in Vancouver on 28 June 1989.
After this presentation, the discussion about the loss of efficiency with R134a had ceased entirely.
The results also meant that ICI with greater certainty dared to release funds to invest in the first commercial plant in Runcorn near Manchester for the production of R134a. It started production on 17 January 1991.
These results brought a positive side-effect, namely that ICI considered Danfoss to be the best partner in Europe. As a result, Danfoss, at the beginning of 1989, got access to the required amount of R134a, which at that time was only produced in very limited quantities on small test plants.
In November 1990, the first delivery of a batch production of TL4F compressors with the new ozone-friendly refrigerant was supplied to Vestfrost.

Vestfrost sold the cabinets with these compressors to a housing association in Esbjerg, and ten years later Danfoss Compressors bought ten of these cabinets to test their condition. The results of the investigations demonstrated that the compressors met the same standards as when they were produced. This was the final proof that the transition to R134a had been carried out with success.

Ozon layer.

The application of R134a was an advantage to the ozone layer.

The industry unites about R134a

To obtain recognition for R134a, it was important to bring the other compressor manufacturers together to opt for the preferred refrigerant. For this purpose, we invited all major compressor manufacturers and suppliers to join a meeting on 6 July1989 in Sønderborg.

The meeting was initiated by DuPont, who outlined their view that R134a and new PAG oils were the right solution. Furthermore, at the meeting, the participants shared experiences with R12 replacements and especially R134a.
It was clear that all manufacturers expected that R134a would be the solution.
Later in the autumn of 1989, they managed to agree on a press statement, in which it was stated about the R134a that "no other realistic long-term final substitutes can be presently seen".

This meeting was later followed by similar meetings in the same circle of professionals.

Also, Danfoss arranged countless meetings with customers. Among other things, all seven former Danish refrigeration appliance manufacturers were invited to an information meeting by Danfoss Compressors. Reportedly, it was the first and only time that competitors were in the same room for a joint meeting to exchange experience. Incidentally, Danfoss Compressors, during that period, was a very keen participant in all organisations where refrigerant conversion was the topic of discussion, including participating in the so-called Freon group by the Confederation of Danish Industry, in the UN advisory group regarding the Montreal Protocol's implementation under UNEP, in ASHRAE's technical committees, the DIN committee and others.

R134a under attack

However, not everyone saw R134a as the great saviour in relation to climate impact. Particularly in Germany, R134a was attacked by the environmental organisations to be the

Danfoss compressor factory in Slovenia.

wrong choice because of its global warming potentials. Greenpeace led a campaign against R134a, which was consistently called "Climate Killer R134a". It was their wish that a "natural" refrigerant without an impact on the ozone layer and without the greenhouse effect would be implemented (Kyoto Protocol).

While R134a has no effect on the ozone layer, it is a greenhouse gas many times stronger than CO2. Together with the former GDR refrigerator manufacturer Foron, among others, Greenpeace convinced the public that safety of flammable refrigerants, in this case a mixture of propane and isobutane with largely the same characteristics as R12, was no problem since the quantity in the cooling circuit corresponded to seven to ten gas lighters. And if safety is not problematic, both propane and isobutane are obviously quite excellent refrigerants.

The public storm against the use of R134a intensified in such a way that both Bosch-Siemens and Liebherr decided to accelerate a phase-out of the recently introduced R134a. On 22 December 1993, the technical management of Bosch-Siemens visited Danfoss Compressors Flensburg. They demanded that if Danfoss Compressors wanted to keep Bosch Siemens as a customer, then, by the end of June 1994, Danfoss should have a complete program with isobutane (R600a) refrigerant ready.

There was in reality no other way. It was time to get started.

Fortunately, it quickly turned out that the same materials that were developed for R134a – could all be used for isobutane. However, R600a only brings about 60 percent cooling capacity compared to R134a for the same displacement. To cover a full capacity program, however, as was wanted by the big German customers, both the TL and NL compressors had to be expanded with larger displacements.

They succeeded, and as it turned out, it provided Danfoss Compressors with a great advantage since several of the competitor compressors could not be extended with significantly larger displacements due to different geometric reasons.

A problem that needed to be solved urgently was to procure measurement facilities for R600a. There was no calorimeter that could measure this flammable refrigerant so it had to be built in a hurry.
By ripping a few older calorimeters and build new water-heated measuring boxes, it was possible to build a manual isobutane calorimeter, enabling the start of calorimeter measuring at the end of January 1994 in laboratory environments that were safety approved.

SMOKING BAN WITH RESERVATIONS

The first widespread smoking ban in offices and meeting rooms were found in Sweden. Coincidentally, Danfoss' largest customer was located here.
– Both Vice President Egil Halvorsen and I were smokers, remember Sales Manager Per Hansen.
– So we dared to pretend that we had not seen that there was a smoking ban throughout the headquarters. Then, we politely asked if we could smoke here? To our great surprise, the answer came promptly from the purchasing manager's assistant:
"Yes!"
It turned out that when the guests were allowed to smoke, the staff was also allowed to smoke, says Per Hansen.
He also remembers that this story within Danfoss got a slightly different tune; that Halvorsen and Hansen were easier to socialise with - implicitly also with regard to price discussions - if they were permitted to smoke.

This calorimeter, which is certainly the world's first isobutane calorimeter, is still (2008) used for special measurements.

Compressors for both refrigerants

For an independent producer like Danfoss Compressors, it is important to be able to offer the customers the compressors for the refrigerant they need. During the 1990s, both refrigerants existed – R134a and R600a – side by side in Europe. The refrigerator producers in Southern Europe used R134a, while R600a had beed a preferred German phenomenon for a long time. This meant that all German manufacturers and all European manufacturers, supplying refrigerators, etc. to Germany (which everybody did), more or less were forced to produce refrigerators with R600a as refrigerant.

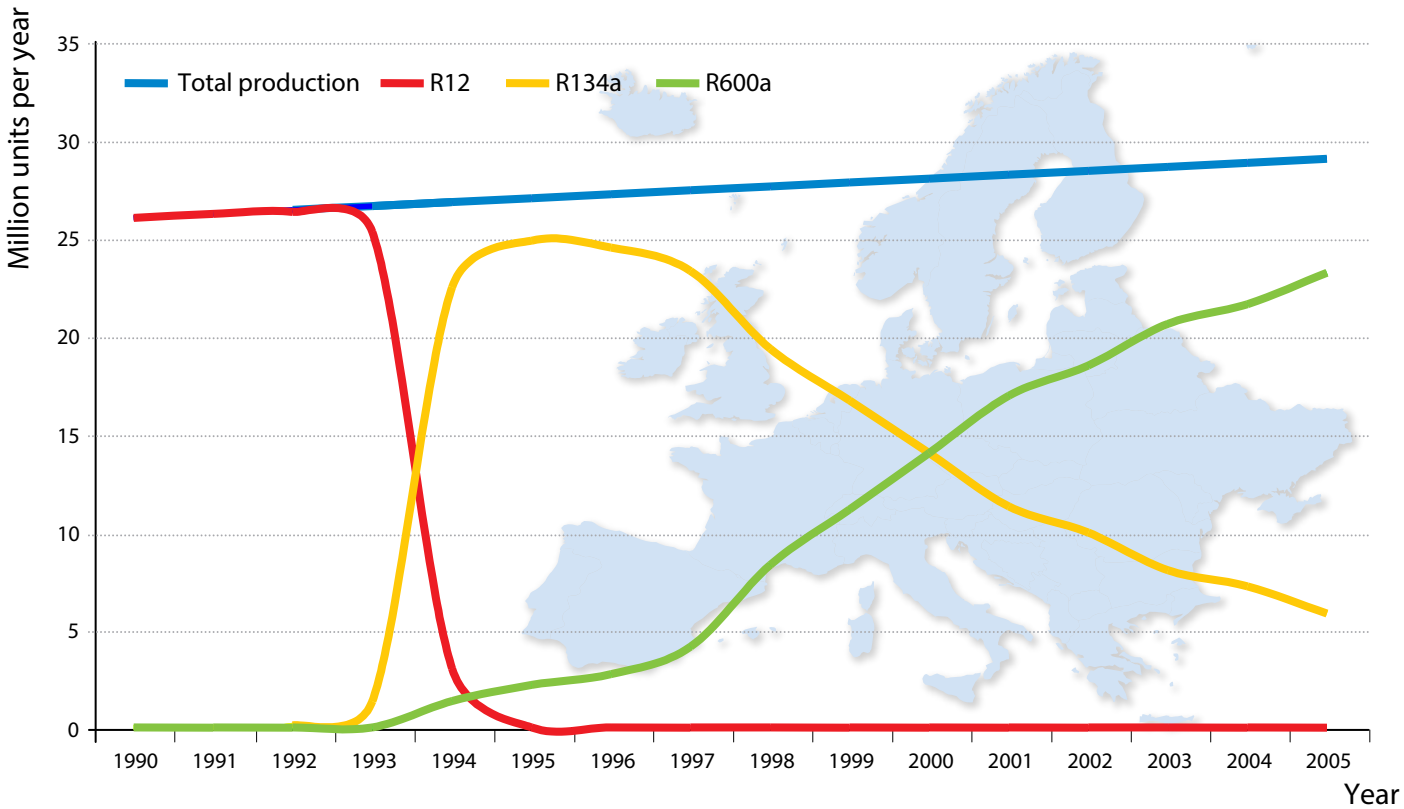
Seen in retrospect, there is no doubt that the chosen strategy, i.e. actively pursuing and forcing the conversion of refrigerants, brought results that could be felt not only on the volume of the business, but it also had a highly positive effect on Danfoss' reputation/image.

After the millennium, R600a has become the dominant refrigerant in household refrigeration in Europe while e.g. R134a still reign supreme in the United States. For commercial refrigeration equipment, HFC R134a and R404a are still (2007) dominant although the use of the HC propane is slowly increasing.

The era of the Iron Curtain ends – Danfoss goes east

Towards the end of the decade, it was clear that Danfoss did not have to move outside Europe anymore to find attractive and new markets.

The development of compressors for R12, 134a and 600A in Europe.



Political developments in Eastern Europe meant that the hitherto almost closed markets under Soviet control underwent quite dramatic changes towards much freer structures. The fall of the Berlin Wall in 1989 heralded a new Europe.
It opened up new opportunities, and it fell nicely into place with Danfoss' overall strategy, which, in 1983, had been changed to implement an aggressive volume strategy. A larger sales volume and production closer to markets was considered essential for long-term survival, especially towards the end of the decade.

The first step was Yugoslavia (now Slovenia, ed.). Gorenje, which had been Danfoss' assembly licensee until this point, found no reason to continue to assemble the PW compressors after the political upheaval, to meet their own need for these compressors.
Half-way through the negotiations between Danfoss and Gorenje regarding a new assembly license agreement, it was clear to both parties that with the new changes and the approaching free market conditions, such a production would soon become unprofitable.

This resulted in an agreement where Danfoss bought the buildings including the machinery from Gorenje, as well as taking over some of the staff. It provided Danfoss with the opportunity to relocate a production line for the manufacturing of the FR compressor.

Danfoss had also been co-operating with an agent in Italy, the largest national market in Europe for compressors for household refrigerators and freezers. The move to neighbouring Slovenia created renewed interest from the Italian manufacturers with Danfoss as a supplier.
It was not only Danfoss, who wanted to speak to the Italians, but the Italians were now also interested in talking to Danfoss. Throughout the 1990s, sales in Italy reached more than 2 million compressors per year.

The burgeoning market change, later known as globalisation, proved to be successful for Danfoss. Danfoss had utilised its western economic strength to make a production in a low-wage sector profitable – something the local businesses were unable to accomplish.
In consequence, it was possible to reap the benefits of a modern production line in a low-wage sector.
The new times and market conditions were promising and seemed splendid for a company like Danfoss.

However, it should turn out that globalisation was not just a friend.

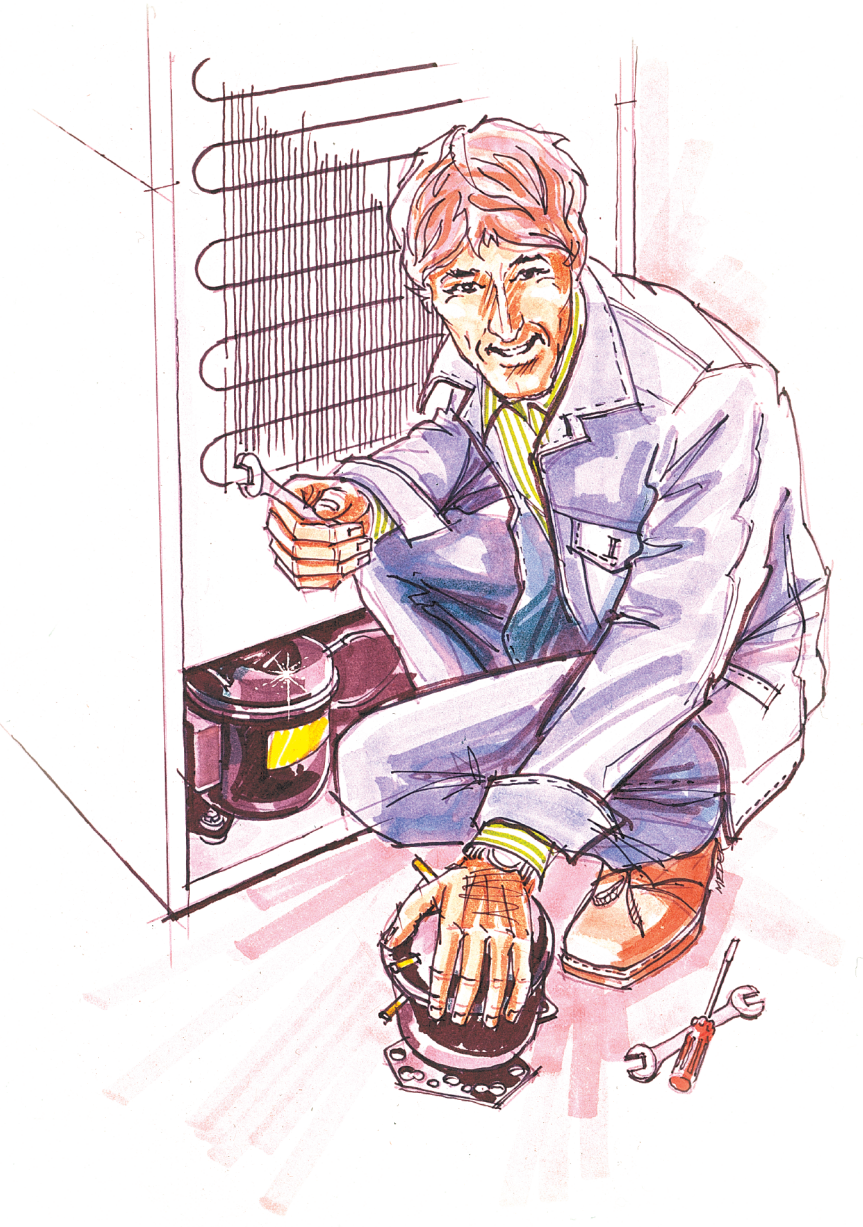
Purchases must keep up

With the adaptation to the international market conditions - not only in terms of production and the market ratio – the purchases also had to be adjusted.
The establishment of the compressor production in Flensburg in 1956 did not equally result in a complete transfer of the purchasing function from the Nordborg factory. Purchase of strategic materials such as steel, copper, cast iron and copper lacquer wires was until 1988 performed by the Nordborg factory.
At this point, it was decided to centralise the entire purchasing activities for the compressors in Flensburg.
The responsibility for the establishment of an independent purchasing function for compressors was transferred to the former purchasing manager Egon Hansen.
The same year, the function's first PC was purchased, and the "Symphony" program overcame big challenges.
However, several years were to pass before the writing staff had overcome their skepticism and were ready to let the electronic word system take over in the department.
In the year 1989, the foundation for a strategic purchasing function was defined by the delegation of the operational purchasing tasks to the newly established logistics function.

The competition goes global

Walls are falling and Danfoss exploits new markets to position itself in a competitive situation that spans around the globe. It's going well – but also poorly. What will the future bring?

The development of the market structure for compressors can be divided into ten-year periods, each with its own characteristics. Developments have been similar in many parts of the world (also for other product groups than compressors, of course), and it is illustrated quite well by looking at how Danfoss produced and marketed its products in the four decades from the 1950s to the 1990s:

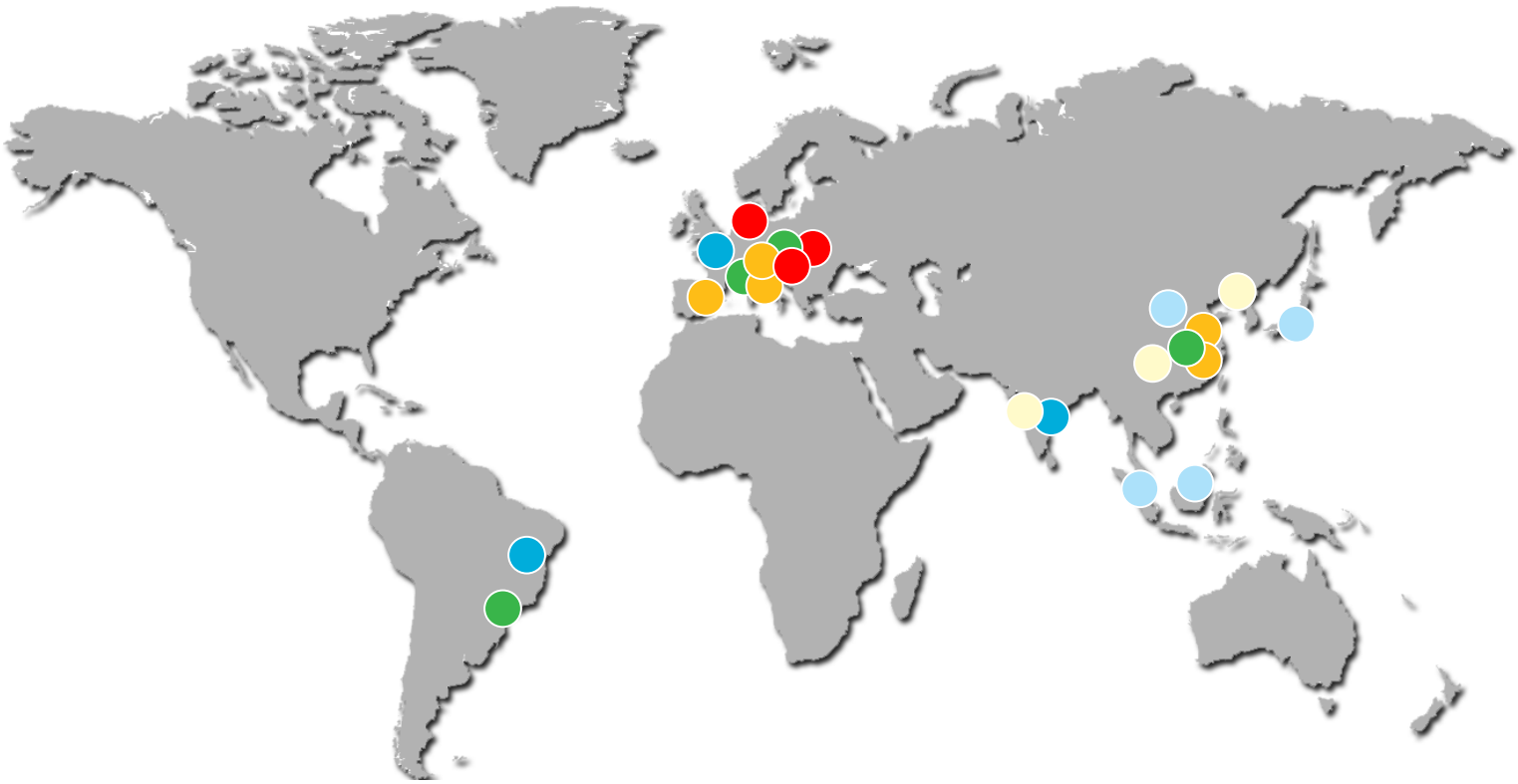


- The 1950s is the start of an emerging refrigerator industry: first in North America and later in Europe. This is based on purely national markets with very little import/export, both of finished refrigerators and components. More cabinet manufacturers begin to manufacture compressors, and a few independent manufacturers start production of compressors, also called non-captive producers – including Danfoss.

- In the 1960s, the market changes its national character to consist of companies that operate regionally. Import/export within the region is quite widespread throughout the 1960s, and new players are appearing. Danfoss mainly operates in Northern Europe and Germany.
  Danfoss has also now established manufacturing sites in Germany.

- Through the 1970s and 1980s, the market changes gradually from regional to a more continental pattern. The first sign of an incipient consolidation among cabinet manufacturers takes place. Danfoss expands the capacity in Germany step by step, and, at the end of 1980, the entire compressor production is concentrated in Flensburg. Both sales and purchasing become a more continental spread.

Global compressor production 2005/2006



- The 1990s and the beginning of the new millennium can be described as an opening to the global market. First, Eastern Europe opens and several Asian markets become accessible (primarily China and to some extent India), just like the access to certain markets in South America becomes easier. This means that Danfoss gradually establishes sales in North America and Asia, and later on also to South America.
  There is much talk about consolidation of the industry, but the consolidations do not reach the extent that was expected.

It becomes particularly important to Danfoss that an increasing number of non-captive compressor manufacturers decide to discontinue their production. The 1990s is the decade when Danfoss is "going global", as production in Southern Europe is established in 1992. Throughout the 1990s, this production expanded strongly. In North America, a compressor factory is acquired in 1995. In the new millennium, remarkably large production units are relocated to Eastern Europe.

ON TOUR IN RUSSIA

Danfoss saw its share of the unpolished capitalism that characterised the former Eastern Bloc in the late 1980s and early 1990s. Danfoss learned to operate in markets that were not regulated by western amenities like safe money transfers and a common standard for business-like behaviour.

Around 1997/1998, Danfoss had an urgent need for more production equipment for the manufacturing of motors due to the need for more capacity.

With such short notice, it was not possible through normal channels to obtain directly from the manufacturers the equipment which was so urgently needed.

However, Danfoss became aware that somewhere in Russia similar machines were for sale. Danfoss also learned that the machines were in excellent condition. Some were still in their original packaging, while others were unpacked and installed, but had never been used.

The Russians had bought this equipment in Western Europe, and this purchase had been favourably financed by the EU. Since these machines were purchased five years earlier, they had already been completely written off, and therefore offered for sale. For the Russians, these machines must have been very valuable because they were supervised by the military.

On the recommendation of, and with the strong support of, a German company specialised in such transactions, Danfoss acquired two complete systems: each located in different regions, for a price of approximately 20 percent of the originally value. However, Danfoss had to be in charge of disassembly and the partial wrapping on site, as well as the entire logistic process.

Axel Müller, head of motor production in Flensburg, travelled as Project Manager to Russia. At his disposal, he had many trucks, which were prepared for a specialised transport, organised in columns of five vehicles for each departure. Each plant had 25 trucks: 50 trucks in total. For the safety of drivers and cargo (at the time, security was still very poor), all vehicles were monitored by satellite.

Every time five trucks were ready to go, Axel Müller gave message to Flensburg that a partial payment could be assigned. Then, the five trucks were able to start and run in the column towards Western Europe.

This procedure was repeated several times, and everything went without delays and interruptions. However, upon loading of the last trucks, an almost incessant lack of help from the local assistants resulted in continual delays.

The locale supply of especially wood-packaging was delivered only in small quantities, which led to frequent interruptions. In addition, every time, and every day, Axel Müller had to pay cash on the spot to get something delivered at all.

At the beginning of the 1990s, Danfoss' strategy included integrated partnerships with customers and suppliers, globally orientated sales, production and procurement, a distinctive profile on product features, and customer service. Additionally, reductions regarding costs were prevailing– particularly the part that related to salaries.

Danfoss' role as a player in the global market with liberalised trade and relocation abroad due to the production costs, marketing and procurement was soon to be defined.

Success was imminent – but also having fingers burned.

The volume becomes crucial

The global reality of the early 1990s, meant that it was unthinkable for Danfoss to build new compressor factories that did not produce at least one million units per year. With this background, Danfoss advanced its production capacity to seven million compressors in the period 1990 to 1993.

Contributing factors to the capacity increase investments were also the gained leading position in the market in connection with the conversion of the R12 refrigerant (Freon 12) to R134a at first, and later the R600a (isobutane). Mutually binding agreements with the cooling furniture manufacturers also played an important part.

At the same time, there was a marked consolidation among manufacturers. Consolidations dominated the industry throughout the decade in which the large firms "ate" the smaller firms, and where some of the small producers gave up or joined forces. The consolidation reached a point where 50 percent of this sector's capacity – when it comes to "output" – had been reduced to 7-8 companies at the end of the decade.

This included Danfoss, which certainly did its best to strengthen the tendency that the large companies acquired the smaller firms.
– During the 1990s, consolidation was everybody's focus. The industry had a common perception that volume would be crucial for future success, says Jørn Westermann

Further development of the purchasing function

After having been placed under the central purchasing office in Nordborg until 1988, the compressor factory received its own purchasing department at the headquarters in Flensburg. With the start of the FR compressor production in Slovenia in 1992, and later in 1996, when the TL production was established in Mexico, the basis for the globalisation of purchases was in place.

UMWELTSPREIS

In 1993, Danfoss' focus on the environment and contribution to healthier working environment, along with energy-saving production methods and products, resulted in the "Umweltpreis 1993" award. The award was ordained by „Studien- und Fördergesellschaft der Schleswig-Holsteinchen Wirtschaft e.V". It should turn out to be the first of a series of awards that Danfoss was given for its environmentally conscious efforts, which can be described as the first official honours for the green tech vision, which is one of the cornerstones of the company today.

Under Hans Kirk's leadership, the general production strategy changed from "Assembly Competence" to "Vertical Integration", which meant greater processing depth of our products.

CEO Henry Petersen (left) and Dr. H. Müller accept »Umweltpreis 1993« on Danfoss' behalf. In the background, hidden from left: Director Hans Kirk, federal minister Dr. Klaus Töpfer and Dr. Dietrich Schulz.

CO_2 compressor

GS compressor

The base stays in Flensburg

Despite all relocation and restructuring measures, the factory in Flensburg remained as the base for Danfoss compressors. The factory in Flensburg partly worked as a buffer in connection with the relocation of production lines, and in 2008 the production of SC compressors still takes place in Flensburg – i.e. products for the commercial market, which also includes the recent expansions of the larger compressors called GS/GT.
Furthermore, the production of the DC compressor also remains in Flensburg, as well as the early infancy of compressor production for refrigerant CO_2 also having its starting point here.
Today, while the bulky capacity is relocated to areas with lower production costs and/or logistical advantages, the trend is that the production of more specialised types of compressors remains in Flensburg. In this way, it remains the competence centre of the compressor division.

This affected the purchasing function's operational area, which resulted in an increased global purchase of particularly copper lacquer wire, motor tin, aluminum, steel and castings.

The strategy "Vertical Integration" continued after the year 2000 and resulted in the establishment of own supply of motors. This took place at the newly purchased compressor plant in Slovakia.
The purchase function now introduced a KAM (Key Account Management) structure, in which the responsibility for purchasing for the respective groups of materials is placed and handled by teams of members from all four production sites.

In 2004, a brand new initiative in compressor purchasing was started due to the desire to enter into a purchasing cooperation with a suitable partner in order to achieve the advantage of larger volumes.

Following a request from Panasonic, the initial negotiations for such a cooperation was initiated.
In mid-2005, the agreement was in place, and the subsequent press release to announce that the new – and for some – unconventional cooperation between the two competitors was named PANDA (Panasonic Danfoss).
Targets, strategy, and cooperation were established for the next three years, and also

working groups with participation from both companies were established.
The evaluation after the first 12 months of work showed an overwhelming success both in terms of cooperation between the two companies and also for the progress of economic benefits derived from it.
In connection with DIPC (Danfoss International Purchasing Conference), held in Beijing in 2006, the compressor purchasing function received the prize as the best Danfoss purchasing team with the main justification that they were very successful in the application of new and more effective tools, as well as the PANDA collaboration.

The market position in Europe is strengthened

Danfoss was very aware that it had some of the largest labour costs in the entire industry by having production facilities placed in Germany. The high wage bill was followed by yet higher development costs to make sure at least to have the best technical product, when competition on price was impossible. Also, a higher degree of automation in the production was pursued.
The globalised economy and competition had its advantages and disadvantages. On the one hand, Danfoss was pressured by the Italian competitors and their improved conditions when it came to competitive advantages, due to the devaluation of the Italian lira. This devaluation actually meant that the price set by the Italian producers became standard for the European market, which was not beneficial to Danfoss.
On the other hand, the same problem led to the fact that the overseas competitors' interest in Europe declined significantly – to the benefit of Danfoss.

However, to keep up with the European competitors, Danfoss decided to reduce its prices by 10 percent to offset the Italians' devaluation advantage; this also led to a – moderate – growth in Europe.

At that time, Danfoss still had the benefit from high efficiency and technological level, which the customers assessed as being among the market leaders, and the refrigerant conversion in the mid-1990s helped to strengthen the position.
The competition was based on the cost, but the competition was also led by the technology parameters, and it gave Danfoss an advantage, as it still had a certain technology lead. Quality and service were no longer something you could differentiate on, but was regarded as an absolute minimum for being able to act in the market.

Far from the growth areas

However, it was not on the European markets that the battle for new market share and growth really took place in the mid-1990s. Danfoss was certainly active in Europe, but growth largely took place in the so-called third countries: the "new" Eastern Europe, China, and India.

The global marketing strategy was maintained, also in areas where it was not profitable in the short term. The Danfoss management estimated that the global growth was crucial, and although a downturn occurred on several markets in the period from 1990-1993, the volume strategy was maintained.

It was estimated that the level of sales in the long term would not be enough to assure an acceptable profit, and the trend during the recent years called for a revision of the market assessment. The political changes, especially in China, Eastern Europe and the former Soviet Union, as well as environmentally friendly claims on product innovation, escalated at an unprecedented pace, and from the mid-1990's the assessment of the market changed radically at Danfoss.

A comprehensive collection of technical information is availbale to the customers.

The regions identified were at the time characterised by a significant growth or potential growth. Earlier estimates of a market that was characterised by overcapacity had to be adjusted. The new markets and new demands for product innovation made several productions appear as outdated.

It then became clear that Danfoss could not achieve acceptable financial performance by continuing to focus solely on its past markets. It also became clear that Danfoss was not strongly enough represented in the markets where growth took or would take place.
The compressor production at Danfoss remained concentrated in Germany, where Danfoss manufactured 85 percent of its compressors. However, Germany had become the most expensive production site in Western Europe.
Therefore, product innovation and proximity to the growth markets became the key factors to success for Danfoss.
All aspects of globalisation, both for global marketing and more than ever also for global manufacturing and sourcing had to be used.

The first consequence of this development was the acquisition in Slovenia: the Gorenje compressor factory in 1992. The next step was the start of a production of Danfoss' own compressor types in North America, where Danfoss took over the Whirlpool/Vitro compressor factory in Mexico.

Danfoss was aware that the goal of a stronger global market position could not be achieved through organic growth based in Flensburg and Slovenia. The goal was to go from the 10.6 million compressors in 1996 to 12.6 million units in 1999.

Mexico back and forth

At the beginning of the 1990s, the walls of Eastern Europe came down, and hitherto closed markets became available.

The situation had already resulted in a rapid success for Danfoss in Slovenia with the acquisition of the former assembly licensee Gorenje in the city of Crnomelj. With this successful acquisition, Danfoss took over the factory, the crew and especially the location's geographical excellences that combined cheap manpower with logistical proximity to important markets. Now that Danfoss had an ambitious growth strategy and held the financial strength to follow this strategy, this model of acquisition should now be used elsewhere.

So when Danfoss began to look at new opportunities to position themselves closer to the North American market, they chose Mexico. Here they were in close proximity to a major consumer (Whirlpool and Vitro) and an existing compressor factory had the potential to be modernised. Professional employees were already present and at a low hourly wage.

The worn compressor factory Facosa was for sale in Monterrey. Vitro and Whirlpool wanted to outsource their compressor production to a specialist. It was compatible with Danfoss' desire to have a production located closer to North America to offset the steady and large fluctuations in exchange rates between the dollar and the European currencies and to provide Danfoss and customers with logistical advantages.

In the early 1990s, Danfoss' sales were rising in the North American market and simultaneously, the so-called NAFA Agreement between the United States, Canada and Mexico was established, which would gradually result in duty-free trade between these countries.

Danfoss took over Facosa, on the condition that Whirlpool would continue to purchase a large volume from the factory at competitive world prices and conditions. Then Danfoss began the process of phasing out the outdated Mexican compressor and to modernise and develop the company. A new TL production line was built and an existing NL production line was relocated to Mexico from Flensburg.

The time in Mexico

Finn Breuning became head of the Danfoss compressor business in Monterrey.
Or Mr. Finn, as he was called, since the Mexicans uses the penultimate name as the family name, and since Finn Breuning consists of only two names, it was Mr. Finn, who stepped in through

ENERGY REQUIREMENTS INCREASED THE FOCUS ON SMALL COMPRESSORS

Danfoss customers were working to meet the consumer demand for refrigeration and freezers with less energy use. It revealed a necessity for compressors with less cooling capacities than what had so far been the usual medium sizes. Furthermore, the idea of new product areas with cooling systems, which also required cooling capacities that were less than the previous ones, appeared.

Therefore Danfoss decided to engage in the development of a miniature compressor, which, with some overlap of the TL power range, could supplement this with sizes that provided a lower cooling capacity. In 1992, Danfoss began the piloting phase of the – at the time – smallest hermetic piston compressor; the PL type.
From the second half of the 1990s, a real focus on energy optimisation started, creating a tremendous demand for a renewal of the TL and NL programs.
The requirements that had been implemented to reduce the energy consumption of compressors for the American market meant that Danfoss was falling a bit behind its competitors – especially Embraco, who had the American market as its primary market, while Danfoss, at that time, had continued with Europe as its main market, but had the ambitions to also get a slice of the American market.

The battle to become the most energy-efficient manufacturer led to a stronger development effort, which would prove to form the standard for the market. It can also be seen in the number of patent applications filed by Danfoss. Four applications in 1994 increased to 11 applications in 1995, which was directly related to the energy optimisation measures. In the period 2002-2006, the level was around 20 applications per year.

PL type – the smallest hermetic piston compressor. ▲

the door as head of Danfoss Compressors S. A. de C. V., on 1 July 1995.

– It was a bit of a strange beginning we got, because they thought that they had been sold to Embraco. They knew nothing about Denmark, only that Michael Laudrup and Søren Kirkegaard were also Danes, says Finn Breuning.

Finn Breuning was pleasantly surprised with the Mexican work ethic and attitude despite previous misleading stereotypes. However, there were a few incidents that characterised cultural dichotomy in business practices between the Danes and Mexicans. From the Danish perspective, these incidents contained elements of deception and bribery.
An example is found in a story about a stock that Danfoss had in Mexico City. The location of this stock was a request from the customers so they would not have to travel to Monterrey to inspect the goods. However, some of them did apparently not have to pay the full price because there was a huge loss from the warehouse.

Danfoss compressor facotory in Mexico.

The Palaba – an indian straw hut – used for barbecues and more.

– We went up and looked at it. The warehouse was placed in an area characterised by a lot of crime. It was found that the warehouse manager had received a considerable secret commission, and we needed to have a serious talk with him. However, the conversation was held under police protection because the warehouse manager was armed, says Finn Breuning.

Another incident was during an extension. The Danish management received a tip that something suspicious was taking place with regard to the construction, and this was certainly the case. The Mexican Danfoss employees who dealt directly with the contractors had built up an inordinately close contact with the workmen.

- We fired four bosses immediately. One of them had held his birthday party at the contractor's home, and the others had committed other antics. So they had to go. The irony of the situation was that they took it very well without shame.

In Danish working culture, it would have been an embarrassment to have been caught in doing such things, and it would certainly have led to legal claims cases and other consequences. They accepted their fate like gentlemen. They packed their things and said goodbye politely.
That did surprise us though, says Finn Breuning.

Danfoss sets new standards

Apart from the instances of corruption and an armed approach to security, the meeting with the Mexicans was positive, and the Mexican workers were pleasantly surprised by Danfoss' management.

– It draw attention that the adventure in Mexico was initiated by clearing the site of 2,000 cubic metres of contaminated soil. The fact that a palaba was also built – a Native straw hut – for use for barbecues and parties was also unusual. Similarly, giving English lessons to the employees was far from the local standard of employee care.

We just took the standards that we knew from home and brought them to the plant in Mexico. It gave them a lot of rights they had not had before, but also a greater degree of responsibility. For example, one day we invited to a family day at the factory, and more than 3,000 came – all dressed in their best clothes, says Finn Breuning.

Still active in Mexico

In 2008, Danfoss employs more than 700 people in the factory in Mexico, and today, among others, the following products are being manufactured: fan cooled condensing units, thermostats, filter driers, and expansion valves.

The dollar brings the compressor production to its knees

Compressor production was consistent in Monterrey. When the factory was at its peak, 1.5 million units of compressors per year were produced.

However, major problems of which Danfoss had no control arose. Brazil devalued sharply, but Mexico maintained its binding to the USD. This made the competition in the USA, with the Brazilian competitor (the former licensee) Embraco, almost impossible. Danfoss' Mexican business ran into trouble.
At about the same time, a compressor factory in Zlate Moravce in Slovakia was up for sale. Years ago, this plant had been built by a Korean competitor, but it never officially took off.

Danfoss was offered the factory for a very reasonable amount, and thus the opportunity to gain further access to the growing market in Eastern Europe was tempting, as well as the access to employees with good academic qualifications in a low-cost area.
It all led to the difficult decision to close the compressor production in Mexico, and at the beginning of the new millennium, Danfoss transferred the whole TL production from Mexico to Slovakia.

Production environment in the factory in Zlate Moravce, Slovakia.

Danfoss' strong interest in Embraco

During the 1990s, Danfoss also possessed the willingness to buy its eternal – and partly self-created – rival Embraco, and in 1998 Danfoss was very close to taking over the Brazilians, says Jørn Westermann.

– We were very far in the process, and eventually our communications department was informed about the purchasing plans. The message from the communications department was that we had to inform promptly when things were ready, because they really looked forward to spreading the good news – and would like to announce before the holidays. It was also done, but unfortunately we had not closed the deal! An internal mail was sent saying that Danfoss had now bought Embraco. This announcement quickly reached the rest of the world too. Unfortunately, it happened just at the same time as a sharp devaluation of 70 percent occurred in Brazil. It made it impossible for us to complete the purchase as it was now a completely different setup than what we had negotiated, and therefore we backed out. However, we should have purchased them anyway, says Jørn Westermann.

Danfoss had to withdraw the happy message and on the same occasion revise its procedures for sending happy messages in the future. In 2008, according to Westermann, Embraco is the market leader of compressors, and Danfoss is number four or five.

New adventure in China

Throughout the 1990s, the major political upheaval in Europe had offered significant new market opportunities to Danfoss. The decade had created a new reality of global trade and competition. When the economic reforms emerged in China in the mid-1990s, new opportunities arose. First, China was attractive

WHEN PEOPLE FROM THE NORTH START TO TEASE

Working in the Far East is a meeting with foreign cultures. One of the most foreign curiosities, compared to Danish standards, is that the Asians constantly write notes of everything when foreign companies are visiting. It sometimes makes the Danes tease a bit. During a company visit to Singapore in 1985, Hans Kirk and Günther Löwe were followed by many employees from the company.
– There were three in front and five behind us and they wrote notes of everything. They probably did this to partly guard against industrial espionage and partly to document what we had been particularly interested in, and they did it thoroughly. At one point, we decided to tease them, so in their notes it is probably stated that the visitors from Danfoss were extremely interested in the plant's manhole covers and walls, says Günther Löwe.

BITTEN CLAUSEN AT THE HAIRDRESSER

Danfoss acquired the factory in Monterrey in 1995, and almost two years later, they were ready to invite to the inauguration of an ultra-modern company that had been renovated and rebuilt for DKK 500 million. It was a great occasion - so great that the governor attended, and the plant got its own exit sign by the highway.
– The entire Danfoss family came to the inauguration of the building, and the local governor was somewhat infatuated with Bitten Clausen. For several years, he asked several times to her well-being. Bitten moreover created quite an excitement when she went missing during the visit in Monterrey. We ran around looking for her. When we finally found her after a major search, she told me that she had just been at the local hairdresser, says Finn Breuning.

HENRY PETER FACED THE CONSEQUENCES

The decision to enter Mexico was taken by Henry Petersen, which was one of the last major decisions he had to make as a boss. In fact, the investment in Mexico was so huge according to Jørgen M. Clausen that Henry Petersen did not want to burden the new boss with it:
– Henry Petersen vigorously stood up for Mexico. It was an investment of a billion Danish kroner, and he did not want this decision, investing at this price level, to burden a new boss, says Jørgen M. Clausen.

TL MUST BE OPTIMISED

Towards the end of the 1990s, the sales prices were under pressure. It meant that the Danfoss TL compressor in 2001 turned into a bad business, because there had not been enough focus on the reduction of the cost price in the production.
It was clear that the TL would only have a future as an asset to the compressor business, if it could be produced at a cost price which was 10 Deutschmarks less.

The rationalisation project was dubbed TL 5 + 5. The name was based on the amount that needed to be cut back - then there was no risk of forgetting the purpose of the exercise! The first 5 DM should be found in the purchase of raw materials and the rationalisation of the production. The other 5 DM should be retrieved through energy-optimised components, the production of stator and rotor in Slovakia, and "other items".

A major analysis revealed many potential savings, and they were executed. However, since the material prices also rose, the goal was "only" reached by a saving of 8 DM and not the DM 10, which had been wanted.
It was, however, by a simultaneous relocation of the production to the low-wage area Slovakia, enough to let the TL-compressor survive.

MR. LOVE IN CHINA

The Danes cannot always figure out how to pronounce German names. Worse yet, neither can anyone else from around the world. An example of this can be found in Singapore where Ernst Günther Löwe and Hans Kirk were summoned as experts to assist in the start-up phase in 1985. Löwe had travelled there on several occasions. However, Hans Kirk tremendously questioned his work when a woman with a sensual voice welcomed "Mr. Love".
What is going on here, Günther? Hans Kirk responded. Ernst Günther Löwe could only smile innocently.

as a country of production with regard to low labour costs and abundant, available labour.
Second, in the mid-1990s, much indicated that the Chinese flirtation with market economy and capitalism could well contribute to a development of the Middle Kingdom – to become a large and attractive market.
The thought of what options it would bring, if the Chinese would develop an affluent middle class, got almost all western export companies to look to the east.
Danfoss did too.

Danfoss started to increase its exports to China and trade boomed. The Danfoss compressor division had already worked together with the Chinese when, at the end of the 1980s, they sold a used PW plant for the production of hermetic refrigeration compressors to the Sichuan Province.
But now, Danfoss wanted to be present in China themselves.
Danfoss decided to find the right joint venture partner in 1998.

Danfoss acquires a locomotive!

In 2002, a new opportunity to make an acquisition opened up to Danfoss. A board meeting was held at the company Sauer-Danfoss at its factory in Slovakia, and Hans Kirk participated as a board member. He met a man who turned out to be secretary to the minister of the Slovak Industry. The secretary chatted with Hans Kirk. He casually asked whether Danfoss was interested in taking over a factory with compressor production in Slovakia.

– I answered that it sounded interesting, or something similar – then he hurried to his phone and called the Minister, and immediately thereafter he announced to me that the Minister had time tomorrow! Then I got nervous because we had no thoughts or plans

in this direction at that time, says Hans Kirk. But apparently the meeting must have been to everyone's satisfaction because two days later Danfoss had bought a factory in Zlaté Moravce, Slovakia. "Factory" was actually an understatement. It was a very large facility, and the equipment was estimated to be between DKK 700 and 800 million.

Danfoss bought the factory for DKK 20 million – and even got a locomotive included in the deal! With the agreement Danfoss undertook to employ at least 600 people from the surrounding area. It was a crucial point to the Slovaks, but a point which Danfoss was only too happy to meet, considering the experience in Slovenia. In 2008, the factory in Slovakia counts nearly 2,000 employees.

How to cut the cake

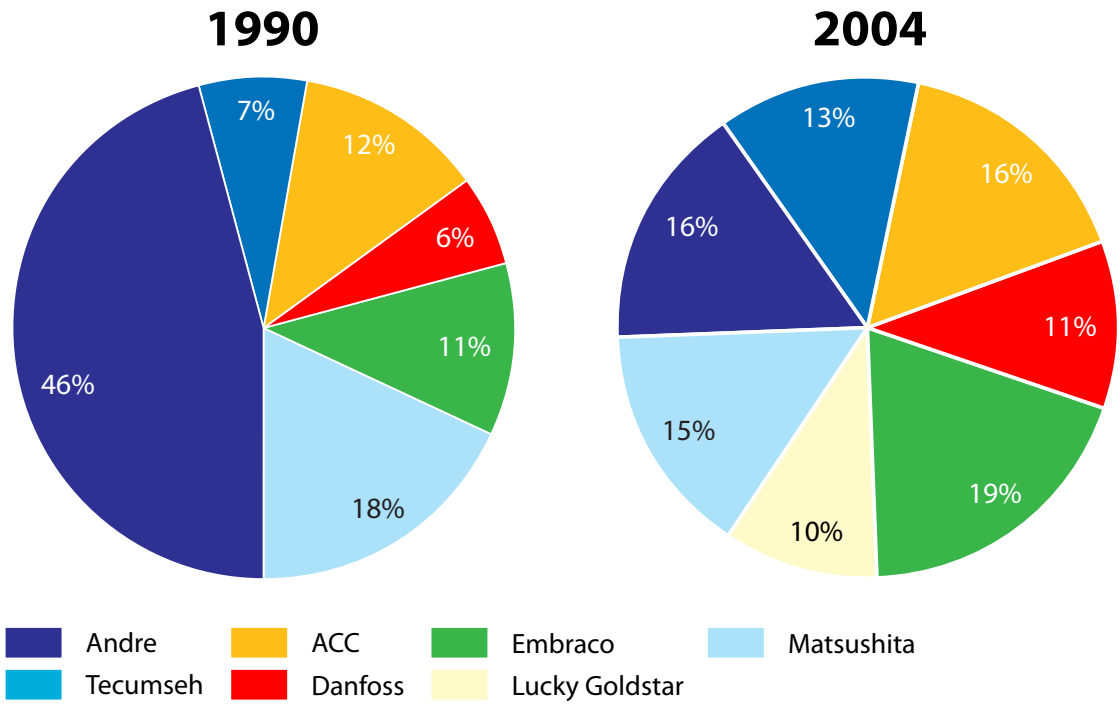
Consolidation among both the refrigeration appliance manufacturers and the compressor manufacturers throughout the 1990s meant that there was a well-established mutual balance of strength within the cooling industry.

An summary of the compressor industry in the early 1980s showed that the industry had about 75 "players", only 13 of which had a production of over 1 million compressors annually. The acquisitions, development, and competition in the 1990s meant that the numbers shrank significantly. Already in 1990, about half of the total production capacity remained with the five largest manufacturers.

Around 2004, the globalisation had further helped to shape the development. The market had significantly increased, but so had the market share of the large players. The large players previously had half of the market, but they now supplied 5/6 parts of the market. A striking difference in the distribution of the "cake" from 1990 to 2004 was due to the geographical location of the factories. Previously, this had been a large influence for the starting point for the balance of power. In 2004, the matter of location had become blurred. The manufacturers had been able to move the capacity to areas where the sales took place.

The factory in Zlate Moravce, Slovakia.

Global production of compressors by manufacturer distribution



The compressor business in 2008

Today, Danfoss has compressor production in Germany, France, China, Slovakia, Slovenia, and USA. In 2008, Danfoss produces about 14-15 million compressors.

Danfoss has moved an increasing proportion of its production to low-wage countries. The production of compressors for households in Flensburg was produced with a loss during the last closing years, but since the move from Germany to Slovakia from 2005 to 2007 this business has again prospered. Today, Danfoss focuses on compressors for households, compressors for light commercial markets, and compressors for mobile applications. The latter two have been an especially profitable business in recent years, but in general the compressor business is an extremely important and profitable market for Danfoss. However over the years, considerations by the Danfoss top to phase out the compressor production have been brought forward.

– When I came to the Executive Board during the start of the 1990s, we made many calculations on how much it would cost to close the facilities in Flensburg, says Jørgen M. Clausen.

– We were under great pressure from competitors, and the production costs were too high.

The compressors impacted us on a massive scale without earning as much as other business areas. Therefore, the compressors were also frowned upon by the management outside of the Executive Board. However, it would be extremely expensive to close the facility, so the

idea was abandoned. The one-off costs would have made it impossible. We also discussed cooperation with Electrolux and GE - which was very challenging for us, but that did not work either. Instead, we chose to focus on larger volumes, so the compressors could become more profitable, says Jørgen M. Clausen.

He is happy today for this decision.

– The compressors have taught the rest of Danfoss a lot of things. For instance, the FR compressors taught Danfoss how to relocate. The model we used for the FR relocation (where a foreign company becomes the platform for a new relocation) has later been used in many other places inside Danfoss, says Jørgen M. Clausen.

The experience with the compressors has also determined Danfoss' vision with regard to the demand for even more restrictions.

– At the time of the refrigerant switch from Freon, we lobbied a lot to prevent it. However, Henry Petersen predicted that the politicians would prohibit Freon regardless, so we might as well get started to find an alternative. We found it, and we were the first in the world to do so, which again gave us a great advantage. Also, it meant that we mentally changed our view with regard to fighting against restrictions. Now we are fighting for more restrictions! Today, the debate about global warming is heavy. I share Henry Petersen's view of what is coming, namely that we shall probably never find out what causes the global warming. However, the politicians surely will decide something anyway. Therefore, we must do our part to reduce the emissions of CO_2. Therefore we lobby for more restrictions, and we bet on green tech industry – because it is in the restrictions, you will find innovation, says Jørgen M. Clausen.

The future calls for cooperation

Although the compressor business today is geared to the future, both Jørgen M. Clausen and Hans Kirk assess that the coming years will bring major changes to the market, especially for household compressors.

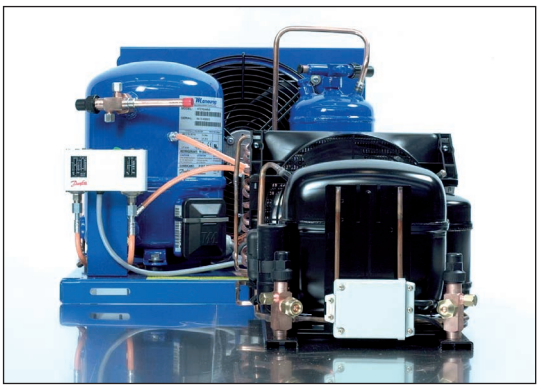
It is extremely important to gain a foothold in China. The large growth in the demand for refrigerators will take place in China, which is why we have now established a production in China. Additionally, you will also see a new group of competitors, because China will become such a large market, finds Jørgen M. Clausen.

Also Hans Kirk points out that Danfoss will need to be present with a production in the Far East, South America, and Europe in a way that is not yet the situation today. It will lead to mergers with one or more competitors, he assesses.

The number of manufacturers become increasingly fewer, but the remaining ones are larger than they were previously. Therefore, you will also see that Danfoss Household Compressors will merge with others, because the group does not have a size that is large enough to succeed in the future. And instead of trying to create something new from scratch, the growth will come through a merger, concludes Hans Kirk.

Evaporator thermostats develop and grow

Fan-cooled condensing unit.



Future compressor needs

The head of the compressors, Jørn Westermann, predicts that future productions might not be geographically determined by wage costs to the same extent as has been the case in the past.

– It is always important that wage levels adapt in the same way as the other production costs. However, it may well be the availability of skilled labour, which determines how we expand next time. The access to qualified personnel represents an important factor and has become more important today, says Jørn Westermann

The differences in regional growth will also play a role. It is expected that the market in Europe and North America will only show little growth over the next eight to ten years while large parts of Asia and South America will become more important.

The compressor business has led to many additional products over time and it continues to do.

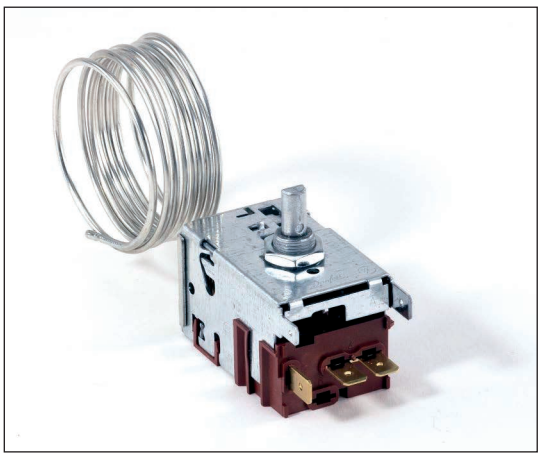
The purpose of these products is and has been to offer a variety, so that customers can perceive Danfoss as a full-size supplier and thereby also lead to supporting compressor sales.

The first additional product was the product line of evaporater thermostats, which began almost at the same time as the compressor. Since the late 1970s, this business has been a separate business unit with their own strategies, their own income statement, and it has actually outpaced the compressors with regard to the number of produced pieces per year.

So even though this book primarily is about compressors and the compressor business, the Danfoss evaporator thermostats must also be mentioned for the sake of completeness.

As mentioned, Danfoss' production start-up of thermostats for refrigerators and freezers began almost simultaneously with the start of hermetic compressors. Physically, the thermostats were quite large, which met the requirement of enabling start and stop of the compressor (or heater in an absorption system) in the cabinet several times per hour to obtain and comply with the desired temperature in the cabinet.

In the beginning, it was only this function which was of interest, but over the years the need



Cooling thermostat 077B.

for special designs with special temperature characteristics and with various electrical switches for special functions and indications became necessary.

With the opening of the European market, and also the global market, the competitive situation became tougher. Therefore, during the entire period, breakthroughs in achievements and automation in the manufacturing of parts, the assembly process, as well as new materials, were used as an explanation, which in turn called for re-engineering and redesign.

In the 1980s, there was a market for electronic thermostats, which Danfoss also offered in parallel with the mechanical products. This was enabled by better temperature control, the possibility to obtain energy savings, and the manufacturers' request to differentiate on their models.

In the early 1970s, it was already clear that a continued existence on the thermostat market would require an automation of the manufacturing process. There was a need for experience in automatic assembly and also a thermostat design suitable for mounting on machines.

The existing 90B type provided the necessary foundation to begin the design of a new thermostat and related production machinery for the 077B type, which is still the latest addition to the production program. In order to start production as soon as possible and to trim the structure fully in place before the assembly machines were delivered, the production was started at manual work stations. The assembly machines were introduced successively, and towards the end of the period two automatic and two manual production lines were operating.

It should be mentioned that the 077B includes five main types and about 800 types or code numbers in total. The reason is that each refrigeration appliance type basically requires a carefully adjusted thermostat.

Until the middle of the period, focus was primarily on Scandinavian and Northern European customers, but as the largest of them became multinational companies, the sales efforts also expanded to cover an increasing number of countries and continents, well aided by Danfoss' sales subsidiaries and agents. When it came to licenses, a steady increase also took place.

From the mid-1990s, it became clear to all that the sales of thermostats needed to grow considerably in order for future gains to be achieved. The main customers were becoming even bigger with a global production of refrigerators, and these customers demanded that the subcontractors would follow, as concepts such as "Just in Time" delivery and currency risks grew in importance. Therefore a comprehensive globalisation project was developed and implemented. It included the new factories in Mexico (the North and Central American markets), in Brazil (for the South American market) and a factory in China, which

in addition to the Chinese market should also cover the Southeast Asian market.

Along with the factories in Europe, in Denmark, and in Italy (bought by Danfoss), the same type of thermostat (077B) was now produced in five Danfoss-owned factories and in licensed factories in Turkey and Slovenia. The benefit was an almost optimal coverage of the global thermostat market with optimal conditions for flexibility and "Just in Time" delivery. This resulted in a growth of the total market share of about 20 percent.

However, with the increasingly globalised market, the competition from low-wage countries (most of all from China) intensified during the more recent years, and this, of course, required a review of the globalisation strategy. It was changed towards a strategy of global supply, though with less production plants which had to be located in developing countries (low-wage countries).
This meant that the fully automated Danish factory was moved to an existing Danfoss plant in Slovakia, and the Brazilian factory was moved to China. The Turkish license factory was closed and part of the production plant purchased. The Slovenian license factory was closed, and the production facility was purchased and moved to Slovakia, and the Italian fully automated factory is now on the way to Slovakia. Subsequently, there are three thermostat factories left: the one in Mexico, the one in Slovakia, and the one in China. All three are located on large Danfoss facilities where other Danfoss products are also being made. The management of the thermostat factory along with the global technical functions, sales and finance, are still located at Danfoss headquarters in Nordborg. With the global "setup" of the current product, which is designed for automatic assembly and with the fully automatic and semi-automatic production equipment, found at the factories in the selected countries, the Danfoss thermostats are well prepared to meet the market requirements of current and future customers. None of the competitors have the same size, same global coverage, and same automation and investment rate.

Condensing units and charging boards

Another additional product known as Condingsing Units, which in its simplest form is an air-cooled condenser with a built-in fan and compressor. These units are used for cooling/freezing systems that are individually constructed on the application site.

They are mainly sold through wholesalers to minor companies that have specialised in the furnishing of cold storage on site (i.e. the local butchers and other food trades in almost every sense, bars, restaurants, and more). Condensing units are used to produce the refrigeration equipment that is needed at the particular location.
Danfoss thus offers a prefabricated solution with one of our compressors to both the wholesaler and the small refrigeration company. Finally, it is also worth mentioning the product charging boards. These were in particular offered to the companies that were not familiar with the special technical requirements, which were needed for the use of hermetic compressors or cooling systems with regard to evacuation and accurate filling of the refrigerant.
When the industry had found its structure, this business area was sold to an interested party in the late 1980s, where the business was better suited and further development was ensured.

The production of charging boards was sold in the late 1980s.

A D D E N D U M

The compressor business – Danfoss Compressors (HC), which this book is about, is a business unit in Danfoss Refrigeration & Air Conditioning Division.

In January 2007, Mogens Søholm was appointed Senior Vice President and Head of Danfoss Household Compressors (HC) with responsibility for production in Germany, Slovenia and Slovakia, and he is today Chief President of Danfoss Compressors GmbH in Flensburg.

Mogens Søholm has been with Danfoss since 1992, most recently as head of Danfoss Appliance Controls. Before that he was from 1998 to 2001 plant manager in Monterrey, Mexico, in charge of the thermostat output. Mogens Søholm is a qualified engineer and also has a degree in organisation (graduate diploma in business administration).

About the genesis of this book

In 2005, Danfoss Historical Association took the initiative to write a book about the Danfoss Compressor Business.
The idea was presented to Jørgen M. Clausen, who gave the green light to go ahead with the job, then a drafting committee was set up to undertake the project management. The editorial group consisted of Peter J. Mortensen, Knud Roelsgaard, Per Hansen, Ernst Günther Löwe, Paul Bachmann and Helle Larsen, Jens Peter Nielsen and Aage Junker.

In August 2005, the first editorial meeting was held, and the final project description was approved. Among other things, the project description states:

The book will of course have some technical content, but it should NOT appear as a technical textbook that can only be read and understood by engineers.

The target group is primarily thought to be the employees and the Clausen family, and other stakeholders, for example, company partners.

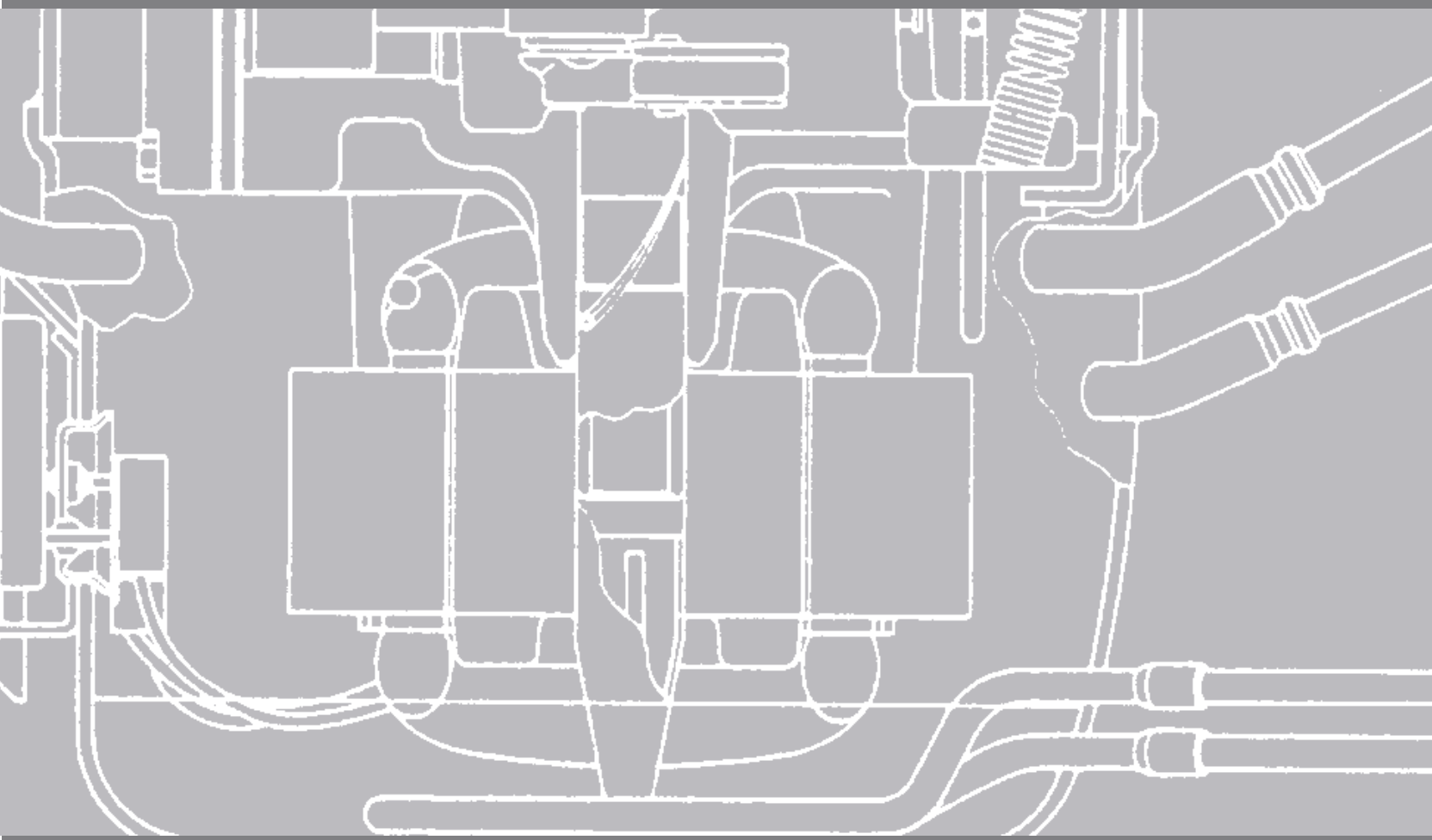
But the book should also be readable for readers who want to know more about the history of an industrial company.

It is the intention that the final result – the book about the history and development of the Compressor Business – will reflect Danfoss' history and culture, including vision and core values.

The goal has therefore NOT been to write a book about compressors and cooling technology – these were the ingredients. The goal, however, has been to create a book that draws a picture of Danfoss' history, and thus a book that renders visible the company's employees and values.

We hope to have met this goal and would like to express a sincere thanks to the many past and present employees who contributed to the book with their input.

THE EDITORIAL STAFF



Compressors through time

1933 Danfoss was founded

1951 "Pancake" compressor

Pancake

1956 PW compressor

1956 Danfoss Flensburg was founded

PW

1958 Production in Flensburg

1960 Synthetic materials and oils

SC

1970 SC compressors and PTC

1976 TL compressors

SLV

1977 BD compressors

Air Con 300 DC

1988 Concentration in Flensburg

1989 100,000,000 compressors

FR

1990 NL and TLES compressors

1991 Compressors for R134a

BD150F

1993 Compressors for R600a

1993 Danfoss Maneurop

BD80F

1993 Danfoss Compressors d.o.o Slovenia

PL-BD

GS

BD

TL

TLV

PL

TN

BD35F (220V/12-24V)

NLV

NL

1995 Danfoss Compressors S.A. de C.V. Mexico

1997 150,000,000 compressors

1998 BD35F for 12 or 24 volt DC

1999 TLV variable speed

2000 NLV variable speed

2001 ePTC electronically controlled starting device

2001 200,000,000 compressors

2002 Danfoss Compressors spol. s.r.o. Slovakia

2002 BD150F for 12 or 24 volt DC

2003 CO_2 compressors for small commercial applications

2005 GS/GT compressor

2006 SLV variable speed compressor

Biographies

Ole Bachmann, born in 1961, educated as electrical engineer and has throughout his career worked at Danfoss – first at Danfoss Drives and then in the Central Group and since 1995 with a focus on compressor. For ten years he was a head of the development of compressor electronics, and today he is Director of Danfoss Power Competence Centre.

Poul Adam Bachmann, born in 1932, mechanical engineer, came in 1958 to Danfoss and the development department for hermetic compressors. Actually, he had imagined a short stay on the island of Als, but instead it came to 41 years in Danfoss' service. The years went by primarily in the Compressor Group, where he was not only in the development department but also worked with information and services. From 1994 until his retirement in 1999, Poul Bachmann, was head of Visit The function of Danfoss Nordborg.

Finn Breuning, born in 1941, educated as production engineer, was in 1967 employed at Danfoss in the hydraulic department. In the period 1971-83 he had managerial responsibility in the Compressor Division, particularly within production and licensing and quality in Nordborg. In the years 1983-95 he was head of the Burner Division Nordborg, and then for five years he was Director of the Danfoss compressor plant in Mexico. In his six years prior to retirement in 2006, he was Director of Central Services/Industrial Services in Nordborg.

Finn Fastrup, born in 1941, educated as engineer at "Odense Teknikum" in 1964. Got in the same year employment at Danfoss and he had different positions in marketing, sales and quality in the Automatics Division (AG) until 1986. In 1986 he became the director of AG and was until 1987 Director of Danfoss sales company in the United States. From 1987-93, he was director of the sales company division for North, Central and Eastern Europe, and in 1993 he became Director of Automation Division. In 2001 he became director of Refrigeration & Air Conditioning Division – a position he held until his retirement in 2004.

Erwin Brix, born in 1927, graduated as a machinist and engineer and he also worked for 33 years as production manager at Danfoss Flensburg before he retired in 1991. Brix had through the years also had the production responsibility at Danfoss' departments in Kiel and Schleswig – and for the last 11 years in the company, he had the title of Assistant Director.

Erik Brøndal, born in 1929, lower secondary education from Marselisborg Gymansium, Aarhus and various additional language exams. He spent more than nine years in Canada, where he worked as a claims handler at the Workmen's Compensation Board, Toronto, as a statistician at Canadair, Montreal, and grain salesman at Louis Dreyfus, Winnipeg. Erik Brøndal was employed as a case worker/seller at Danfoss 1960-1980. Then translator, interpreter and director of his own company Brøndals Bureau.

Hans Emil Carstensen, born in 1931, graduated within commerce, was in 1962 employed at Danfoss Nordborg as Secretary to the Executive Board. He has predominantly worked with financial tasks on German territory. In 1972 he was appointed budget manager in the Compressor Group. Between 1978 and until his

retirement in 1994, he was confidential clerk and chief accountant, latest finance manager in the compressor factory in Flensburg and contributed to the start-up of the compressor factory in Yugoslavia, among other things.

Jørgen M. Clausen, born in 1948, educated as electrical engineer, and MBA from the University of Wisconsin, was from 1981-2008 employed at Danfoss Group, the last 12 years as CEO. He is the eldest son of Manufacturer Mads Clausen, and before becoming CEO he was, among other things, Head of Technical Coordination and Research and Head of Mobile Hydraulics Division. Jørgen M. Clausen stepped down as CEO in the autumn 2008 and it is expected that he will be elected as new Chairman of Danfoss A/S in 2009.

Markus Draeger, born in 1973, economist, came to Danfoss in 2001 to help increase marketing activities of the Compressor Division. He did this work so well that he since 2006 has the title of Strategic Marketing Director of Commercial Refrigeration OEMs.

Poul H. Frerks, born in 1938, educated as technical assistant, worked for 42 years at Danfoss – first 28 years in Nordborg and then 14 years in Flensburg. During all the years, he worked with compressors and travelled around most of the world to assist with his technical knowledge. Poul H. Frerks died in April 2008, 70 years old.

Vibeke J. Gustafsson, born in 1945, bachelor of engineering specialising in chemistry, joined the Compressor Group's material laboratory in 1969 and was later project manager in the development and was from 1985 to 1999 associated with Danfoss' key development and technology function as project manager and program manager for Technology The Pyramid. She is today working in the concept group at Danfoss Business System as an advisor.

Hans Jørgen Gustavsen, born in 1939, came to Danfoss from Moller & Co. in 1972 and was for many years from 1982 Director of the Compressor Group. From 1988 to 1993, he was also a member of the Group Executive Board at Danfoss. He later left Danfoss and became Director of Asea Brown Boveri and Gram.

Egon Hansen, born in 1942, educated in commerce, worked for over 40 years for Danfoss Compressors Flensburg. He started in 1963 as an employee in the purchasing department and became in 1981 Procurement Director. He retained this position for 16 years, until in 1997, he first became Director of Sales and Marketing and since Global Procurement Director. From 2001 until his retirement in 2007, Egon Hansen was Director of Personnel and Communications.

Per Hansen, born in 1936, educated as a mechanical engineer, was in 1962 employed at Danfoss in the application department for Automatics cooling. During the first years, he primarily worked with the application of thermostatic expansion valves, later he worked with the entire automation program. During the years 1979-1981, Per Hansen was posted to the sales company in Offenbach, where he at first was responsible for establishing a technical function and later he became an assistant to the sales manager. From 1981, active in Nordborg, he served as regional sales manager responsible for Scandinavia, the UK and the Americas. From 1990, he was appointed head of sale of the compressor department and in 1992 with the title of Vice President. Per Hansen retired in 2001.

Poul Erik Hansen, born in 1948, civil engineer, Ph.D solid state physics, was hired in 1977 to join Danfoss in the development department in the Compressor Group. In 1979-1982, he was employed in the central research department (TC). In 1982, Poul Erik Hansen became lifetime and material expert in the Compressor Group, In 1988, he took over management of the compressor laboratories and the group's technical experts. In the period 1992-2001, he was also responsible of the design department. From 2001-2007, he was project manager on several development projects including "UFO" project. In 2008, Poul Erik took over the management of Mechanical R & D as well as all laboratories. Poul Erik Hansen has been an examiner at both DTU and AAU several times.

Jörg Heubel, born in 1941, educated as social worker, was for 25 years from 1982 until his retirement in 2007 HR Director at Danfoss Compressors in Flensburg. Before his career in Danfoss, Heubel was HR manager in different German companies.

Thorkild Holm, born in 1945, educated as auto mechanic and mechanical engineer. Holm has been employed at Danfoss in various functions for more than 30 years. Since 1988, he has, except for a short period, been associated with Danfoss Flensburg, where he is currently sales manager.

Gustav-Adolf Johansson, born in 1930, graduated as engineer and joined Danfoss in 1956 in compressor manufacturing – first in the inspection department and subsequently in the quality department. From 1958, he worked in the application department for technical customer care and as a worldwide "Troubleshooter". He retired at end of 1990, when he was senior manager at Danfoss Flensburg. Johansson has developed various tools for the manufacturing of hermetic cooling systems, including a patented, fully automatic charging board for different refrigerants.

Niels Jørgen Josiassen, born in 1945, graduated as civil engineer, has been with the Compressor Division from 1971-1981 as Director of development and from the beginning of 1990 as Vice President in charge of development and construction as well as business development. From 2000, Josiassen has, with formal responsibility for business development and quality, been responsible for the establishment of factories in Slovakia and China.

Hans Kirk, born in 1942, educated as auto mechanic and production engineer, joined Danfoss in 1970 and celebrated his 30th anniversary prior to his retirement in 2008. For several years he was employed with quality and production tasks along with production management and control. From 1979 to 1981, he was quality manager of compressors and 1981-1983 plant manager for the Danfoss factory in Offenbach, Germany. Then he became production manager for compressors, including the license production of Danfoss compressors to overseas markets. In 1985, Hans Kirk, became head of the production section in the Central Production and Services, and in January 1988, he also became responsible for the service section and in 1989, he was appointed director of the Central Production and Service. From 1993-1996, Hans Kirk was Director of the Compressor Division, before he in 1996 became the Executive Vice President and member of the executive - in 1999 with the title of Chief Operating Officer (COO) and from 2005 as Chief Development Officer (CDO).

Kjeld Kjeldsen, born in 1930, educated as electrician and electrical engineer, was for 40 years employed at Danfoss. For many years, he was part of the development team in the compressor section and in 1969, was head of Danfoss Acoustical Laboratory. When the compressor department moved to Flensburg, Kjeldsen went along too – however, he still handled the acoustic interests of other departments.

Jens Lorentzen, born in 1946, educated as civil engineer; was more than 25 years with Danfoss – and all the years in the design department. Before he joined Danfoss, he was head of the order planning at the yard "Lindøværftet", and at Danfoss he worked over the years as project manager for a variety of projects. He retired in 2008.

Ernst Günther Löwe, born in 1941, educated as mechanical engineer, worked for more than 40 years with compressors at Danfoss. He was employed by Danfoss Flensburg in 1965 and worked until 1987 with responsibility for various technical functions. From 1988 to 1999, he was the head of production in Flensburg and Schleswig, and from 2000-2005, he crossed the Atlantic and was president of Danfoss in Mexico.

Flemming Madsen, born in 1948, graduated as electronics technician and holds a degree in commerce. He has worked at Danfoss since 1973, with a detour to Arcodan, where he was purchasing manager from 1986-1988. Flemming Madsen began in the development department, but later came to the central purchasing department in Nordborg. Since 1988, he has worked with purchases at the Compressor Group.

Peter J. Mortensen, born in 1934, graduated as Radio TV mechanic and electrical engineer. He joined Danfoss in 1965 and worked until his retirement in 2001 mainly in quality assurance, both in the Compressor department and generally at Danfoss. Peter Mortensen has thus both been corporate quality manager, factory manager of the spring factory in Tinglev, and "Corporate Environmental Manager". Peter Mortensen was for many years examiner at both Aarhus School of Business and University of Southern Denmark. After his retirement, he continued as a freelance Consultant for Danfoss.

Axel Müller, born in 1940, engineer in mechanical engineering, came to Danfoss Flensburg as production manager for the Automatics group in 1970. In 1973, he started the production of motors for hermetic compressors, and in 1995, he was appointed head of the department. Until his retirement in 2005, about 200 million motors were produced under his responsibility.

Jürgen Neumann, educated as mechanical engineer and holds a degree in commerce, has been with Danfoss since 1970 and in all the years worked with compressors. First with construction of compressors, then with the coordination of license projects in cooperation with Embraco, Gorenje and Volaš, and later with coordination of production in China, today as project manager for business development.

Hans Uve Nissen, born in 1928, electrical engineer, was first employed at Danfoss in 1954, where he came to the drawing office headed by Egon Nielsen and took charge of the control boxes for oil burners. Nissen, who is a German national, only had a one-year work permit and therefore, already in 1955, he had to say goodbye to Nordborg. However, when Danfoss established its business in Flensburg in 1958, Hans Uve Nissen was employed right away as quality manager – a post he impressively held

for 34 years until his retirement in 1992. Before that, he managed to steer Danfoss Flensburg through the Quality Certification at BSI.

Steen Nissen, born in 1946, MSc. Economics in business administration, has since 1995 been head of HC Finance, Controlling and IT from the compressor headquarters in Flensburg, since 1999 title of Vice President. Steen Nissen came to Danfoss Nordborg as project economist in 1976 and moved in 1988 with the Compressor Group to Flensburg, where he became head of the HC financial management.

Marten Nommensen, born in 1954, educated as mechanical engineer. Nommensen joined Danfoss in 1982 as production engineer with a focus on quality and has since worked in the compressor section. For a time he was stationed at Danfoss' compressor plant in Mexico, and since then from 1999 to 2001 he was head of production in Danfoss Flensburg. Today, he manages development projects in the compressor section.

Hans Nørgaard, born in 1935, educated as mechanical engineer, joined Danfoss in 1958, where he worked for 42 years until his retirement in 2000. During the early years, he worked in the design department of hermetic compressors, and in 1966, he moved to the central purchasing department and became head of section for the purchase of iron and metal castings.

Poul Petersen, born in 1942, trained as electro mechanic and low-voltage engineer, worked for nearly 40 years with compressors at Danfoss. He joined the company in 1969 to work in compressor design and took over management of electrical engineering and electrical lab in 1980. In 1988, he moved with the design centre to Flensburg, and he retired in February 2007. Until September 2008, he did, however, continue to work on a consultancy basis.

Dieter Poeppel, born in 1965, educated as biologist and has previously worked at the University of Kiel. Since 1995, he has, however, used his knowledge to improve the environment at Danfoss Compressors – not only in Flensburg, but also projects in Slovenia, Slovakia and Mexico. Poeppel has through the years received several awards for his environmental work at Danfoss.

Knud Roelsgaard, born in 1926, engineer in mechanical engineering, was for 30 years from 1962 until his retirement in 1992 construction manager in the Compressor Group. Roelsgaard joined Danfoss already in 1951 and helped to launch the PW compressor in 1956. In the 1980s, he was also responsible for licensing relationships at the Compressor Group and did among others help to relocate the production of PW compressors to China. Roelsgaard has through his career had 15 patents approved, all within hermetic compressors, and for several years he worked as examiner at Institutes of Technology in both Sønderborg and Odense.

Erik Rudbeck, born in 1945, graduated in freight forwarding and Bachelor in economics and marketing, worked for seven years at Danfoss, before he in 1976 joined the Compressor Group as a section leader with responsibility for the planning of sales efforts and market research. In 1980, he transferred to the sales department and became among other things responsible for sales of charging boards and aggregates from the factory in Offenbach. In 1988, in connection with the transfer to Flensburg, Erik Rudbeck became responsible for sales to the commercial customers.

Magne F. Schøler, born in 1917, educated as engineer, joined Danfoss in 1948 and soon became head of construction and development. In 1956, he was appointed Director of Construction and Development and member of the board headed by Mads Clausen. In connection with organisational changes, he became director of the cooling control system in 1970. Magne Schøler retired in 1982.

Jørgen C. Stannow, born in 1940, educated as civil engineer in 1965, specialising in refrigeration technology and management. That same year, he joined Danfoss, where he worked until his retirement in 2005. In the years 1970-1978, he was development and project manager of the Compressor Division and was responsible for the TL compressor project. Later he worked on new initiatives for the Compressor Division, for the research of the group and was from 1993 leader of development in Automatics. From 2000, he led the RA's long-term development of cooling technology.

Peter Steensen, born in 1949, educated as auto electrician and mechanical engineer, has since 2002 been head of the global quality function in the Compressor Group. He joined Danfoss in 1980, as quality and product engineer and was later section manager, before taking up his current position.

Mogens Søholm, born in 1968, educated as machinist, mechanical engineer and diploma in business administration, Since 2007, he has been responsible for the budget in the HC Household Compressors Division. He is trained as a machinist at Danfoss and returned to the company as a rotation engineer in 1992. Later he has also been quality and laboratory manager, project leader for the establishment of production in Mexico and plant manager for the thermostat factory in Mexico.

Stig Sørensen, born in 1922, engineer in mechanical engineering, was for many years, from 1955 to 1971, closely connected to the Compressor Group at Danfoss. He came to Nordborg after having held positions at Vestas and Cemox, among others, and he was immediately involved with the compressors, where over the years he rose through the ranks from operating assistant, head of department to operations manager. In 1971, he became production manager for oil pumps, hydraulics, production management and apprentices department – a position he retained until his retirement in 1987.

Hans J. Tankred, born in 1948, educated as machinist, and engineer, had basically planned to stay only a few years at Danfoss when he was hired in 1971 to join the construction department of compressors. Instead he stayed there for almost 40 years and was among other things responsible for the conceptual framework and construction of the TL compressor. He later transferred to the production at Danfoss Nordborg and until the transfer to Flensburg, he was production manager of the compressor production. In Flensburg he founded the BD and PL compressors and was later responsible for the CO_2 compressor.

Niels Thorsen, born in 1940, educated as production engineer, joined Danfoss Refrigerator Thermostats in the production engineering department in 1966. Later he became responsible for product development and logistics and over the past 15 years until his retirement in 2006, he was responsible for global sales from the product line. Throughout his career, Thorsen had seven patents approved.

Knud Vagn Valbjørn, born in 1932, graduated from the Polytechnic Institute (DTU) in 1957. Already during his studies, he worked in the summer holidays at Danfoss, and afterwards he came to the compressor department as a developer in 1959. He retained this position for ten years – only interrupted by a short stay at Danfoss in the United States – before he became a professor at the Universidad del Norte in Chile for two years. Back at Danfoss, from 1986, he was head of development for compressors and valves, and he is responsible for up to 40 patents within this area. Knud Valbjørn retired in 1993.

Holger Vilhelm Vind , born in 1922, graduated as electrician and engineer in electronics. Worked among others at SAS before he joined Danfoss in 1955 in connection with the start of the production of the hermetic compressor, where he became leader of the development of electrical components. Vind was at Danfoss for 32 years until his retirement in 1987.

Bent Westergaard, born in 1947, graduated in commerce, joined Danfoss in 1970 and started as a purchaser in the Central Procurement Function in Nordborg. When the purchasing function was decentralised in 1990, he built up and led a purchasing department in the Burner Division. Since 2001, he has been responsible for the global procurement function in HC.

Jørn Westermann, born in 1945, joined Danfoss in 1974 in the Central Finance Function. After having been posted for two years in the Danfoss Sales Company in Offenbach, he became financial controller at Danfoss' sales organisation. From 1982 to 1990, he was connected to the Compressor Division as respectively budget manager and logistics manager. Then, until 1996, he handled the setup of the M & A organisation for the Danfoss Group, after which he, until 2001, was division director of the Burner Components Division. In 2001, he then returned to the Compressor Division as Senior Vice President. From 2006 to 2008, he was responsible for the entire Danfoss Group's compressor operations.

Bitten Clausen with Compressor no. 100.000.000.

Compressor no. 100.000.000. (second from right)

Vocabulary used in this book on Danfoss Compressor Business

Application
Application.

Calorimeter
Apparatus in which the refrigeration compressor capacity, energy consumption, power consumption, and temperature conditions are measured under various conditions.

Capacity
The ability to absorb energy quantities under given conditions.

Capillary
Copper tubes with small internal diameter and great length. Reduces the pressure of the refrigerant from high to low level and refrigerant vapour is converted to liquid. Provides refrigerant to the evaporator.

Capacitor
Component from which heat from the refrigerated space and some heat from the compressor are transferred to the surrounding air. Hot refrigerant gas is cooled and converted into liquid.

CECOMAF
The European Committee for producers of air handling and cooling equipment.

Charging board
A device for refrigerant charging.

Clearance area
The volume over the piston, which cannot be compressed.

Community
The European communities.

Condensing unit
Assemby of a compressor, condenser and fan.

Condenser
Gas changes to liquid. See condensation.

Condensation
Process in which the refrigerant gas emits heat and thereby is converted into liquid.

Coal and Steel Union
The European Coal and Steel Community.

Compressor housing
Welded pot and cover that encloses pump and electric motor.

Compressor
Compressors designed for cooling systems.

Cooling System
Pipe connections between compressor, evaporator, condenser, restrictor and filter drier soldered together and designed for cooling purposes.

Cooling
Removal of heat, so the temperature drops in a specific area.

Discharge connector
Connector on the compressor for connection of pressure line.

Displacement
Cylinder's area x stroke.

Dust-tight spaces
Assembly room in which there is pressure in relation to surroundings.

EFTA
European Free Trade Association.

El equipment
Electrical components to start and protect compressors.

Enameled wire
Paint applied to the motor's start windings and main windings to avoid leakages between the individual windings.

EU
European Union (formerly EC).

Evacuation
Generating a low pressure with a vacuum pump, whereby the non-condensable gases and moisture are removed from the cooling system.

Evaporator
Component in the refrigerated space, in which the refrigerant evaporates (boils).

Evaporator thermostat
Thermostat, where the sensor is placed on the evaporator.

Evaporation
The process by which the coolant boils/ evaporates. In this way, heat is absorbed from the environment, and the temperature is reduced in the space to be cooled.

Expansion valve
Valve in which the refrigerant pressure is reduced from high to low level and refrigerant vapour is converted to liquid. Controls the amount of refrigerant to the evaporator by pressure or temperature.

Filter drier
To absorb the amount of moisture that secretes from the refrigeration system during its lifetime. Is mounted behind the condenser and in front of the throttle valve. Also works as a dirt filter.

Fluid cooler
Cooling device for liquids.

Freezer
See freezer furniture.

Freezer furniture
Furniture designed for freezing and storing of food for longer periods below minus 18 degrees °C.

Heat pump
Cooling system in which the condenser heat is being utilised.

Heat pump compressor
Compressor for heat pump system.

Heat exchanger
Soldered connection between the suction line and the capillary tube, whereby the suction gas is additionally heated, to avoid occurrence of drops of liquid refrigerant in the compressor.

Hermetical
Everything is soldered or welded together.

Klixon
Company name of protective devices for motor windings. Consists of heat wire and bimetallic strips, which are under the influence of the absorbed power from the compressor. Located outside the compressor.

Leak detector
An apparatus capable of determining very small leaks.

Marshall aid
Financial assistance for the reconstruction of Western Europe in 1948-51 offered by the United States' Secretary of State G. C. Marshall.

Main winding
The winding (main winding) in the motor, cut in when in operation.

Motor Protector
Electrical switch with bimetal and heating wire external to the compressor. Switches off by overcurrent or overtemperature.

OEMs
Original Equipment Manufacturer. Manufacturer of finished products to the end user.

Oil cooling
Cooling of oil in the compressor with cooling coil, in which cooled gas is led. This reduces the winding temperature.

Pot Press
Drawing up of the steel plate to the compressor pot and cover.

Process tube
Tube in the cooling system, from which evacuation and filling of refrigerant and oil can be made.

Pressure line
Pipe connection between the compressor and condenser.

PTC
Positive Temperature Coefficient. Provides increased electrical resistance at increasing temperature. Used as a starting device.

Refrigeration and Air Conditioning
Apparatuses for controlling cooling systems.

Refrigerant
Liquids with low boiling/evaporation temperature.

Refrigeration units
Furniture designed for the storage of food at 0-5 degrees °C for a short time.

Refrigerator
See refrigeration.

Rubber foot
Insulating element between the compressor footplate and cabinet.

Rotor
Motor's rotating part. Is usually mounted on the crankshaft.

SAP
Business name of the computer system that can control the company's information.

Searching for leaks
Scanning for any leaks in the cooling system's joints.

Slot
Punching in the stator iron plates, in which motor windings are placed.

Slot insulation
Insulation between the iron plates and the windings in the slots of the stator.

Sound measuring room
Insulated room with low noise level.

Start device
Electrical equipment for compressor start.

Starting capacitor
Cuts in simultaneously with the start winding in order to increase the starting torque of the motor.

Start relay
Relay that cuts the start winding in and out.

Start winding
Winding (auxiliary) to start the motor.

Suction accumulator
Expands the volume on the suction line to avoid liquid in the suction line and the compressor.

Suction line
Pipe connection between the evaporator and compressor.

Suction connector
Connector on the compressor where the suction line is connected.

Test room
Special room where a refrigerator may be exposed to different loads, and data recording can take place.

Thermostat
Controls the cooling system start-up and operation depending on predetermined temperature limits.

Throttle valve
Capillary tube or expansion valve.

Transfer Line
Production machine that represents a coherent production process.

Twin compressor
Two compressors connected with an oil-equalising piping and common suction manifold.

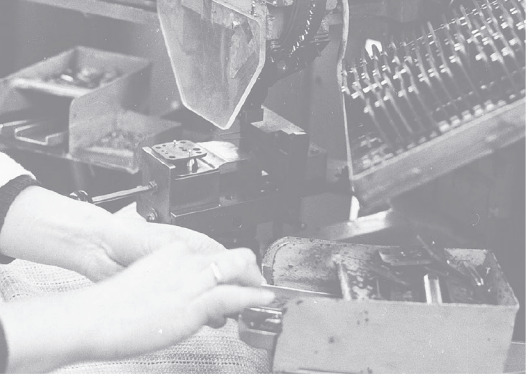
Vacuum
Pressure lower than that of the atmosphere.

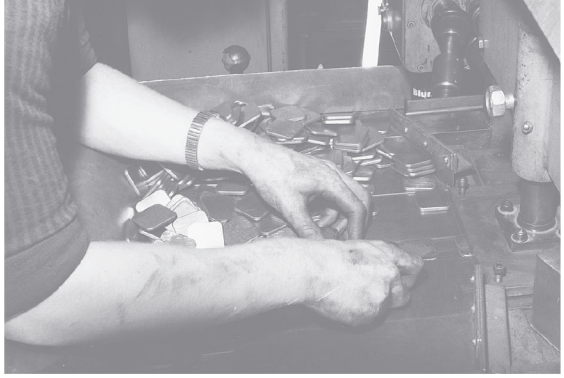
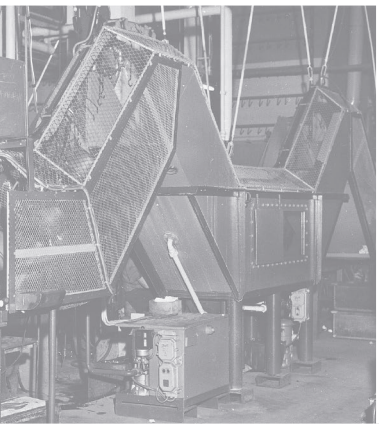
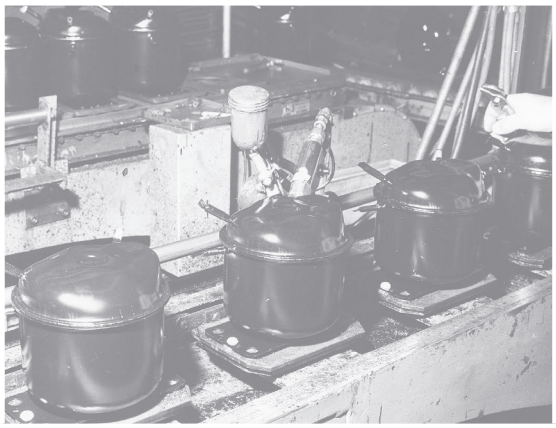
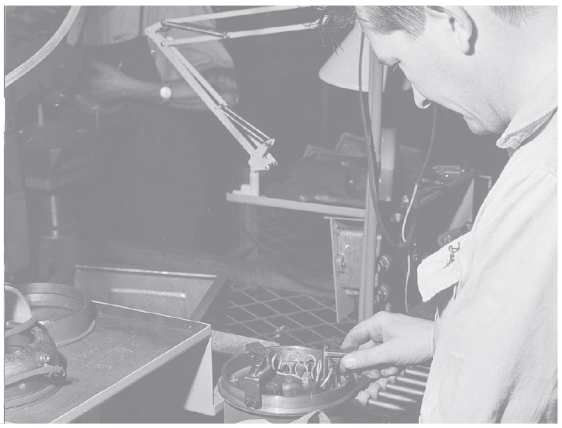
Vacuum pump
Pump capable of producing very low pressures.

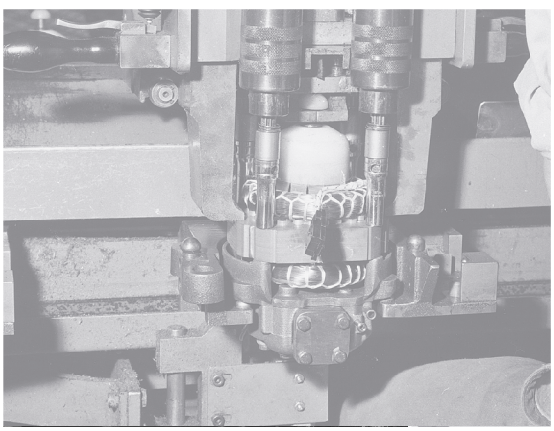
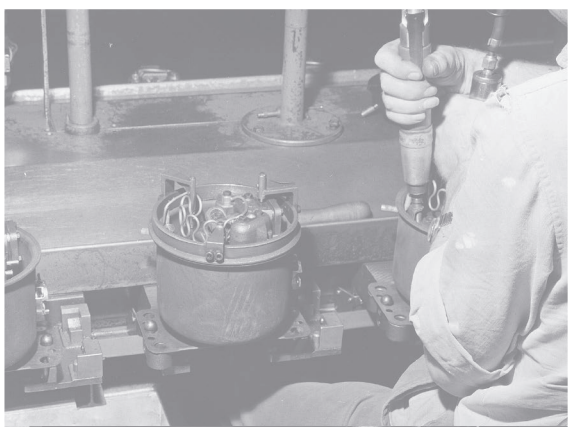
Winding protection
Encapsulated electrical switch disposed in contact with motor start windings and main windings.

Wirtschaftswunder – Economic miracle
Reconstruction of the German economy after WW2.

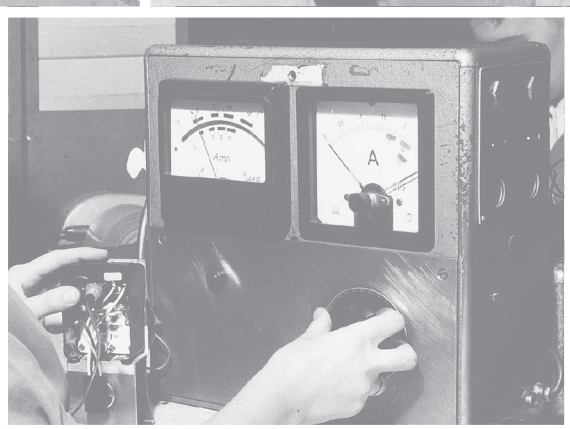
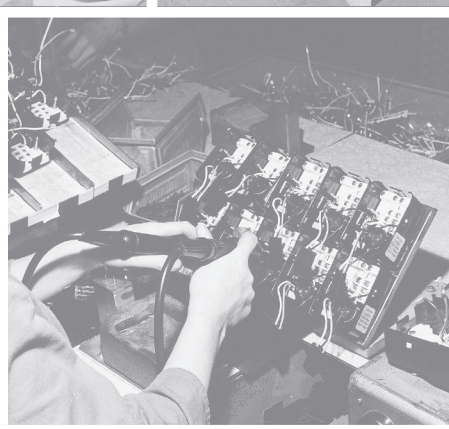
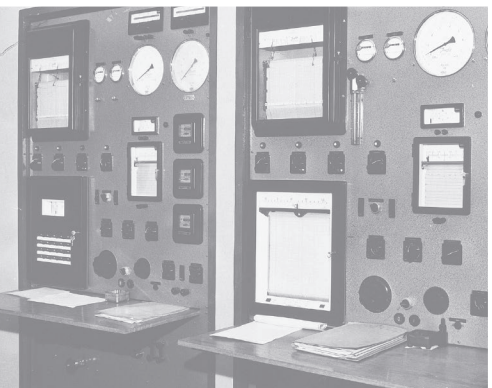
Zero series
The first production of the new product. The precursor of actual production.

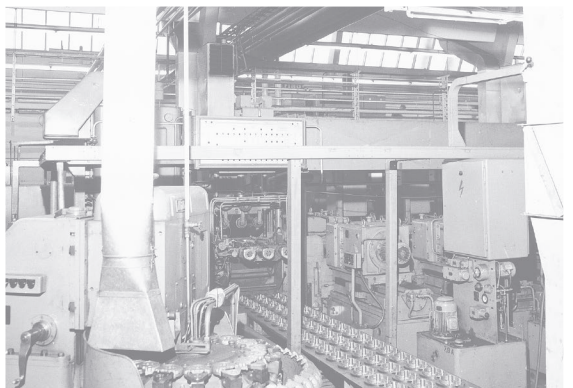


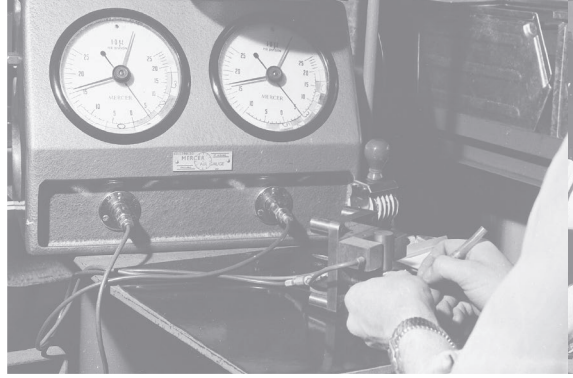
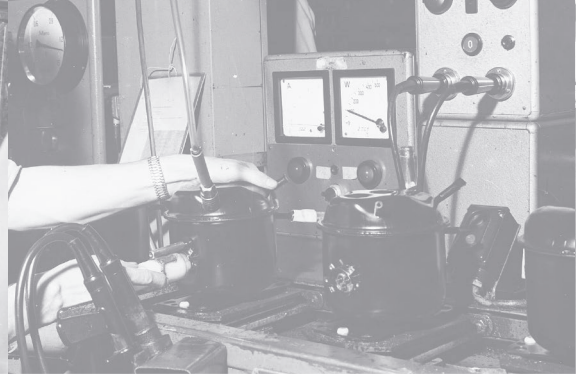
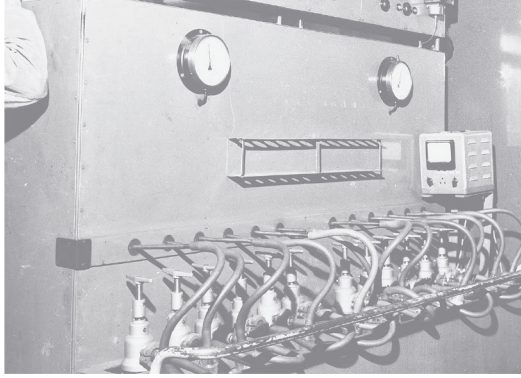
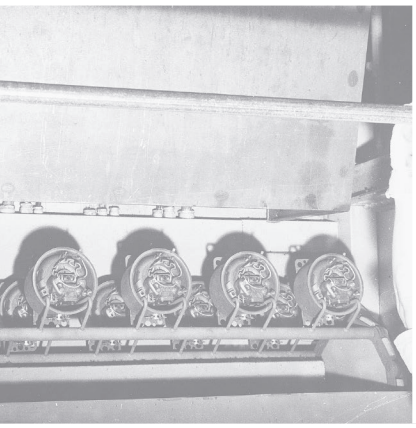
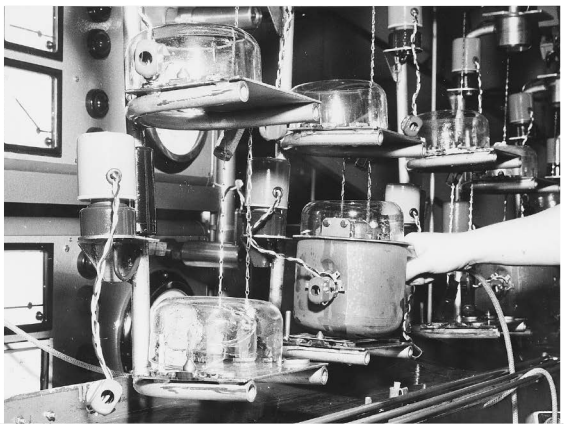
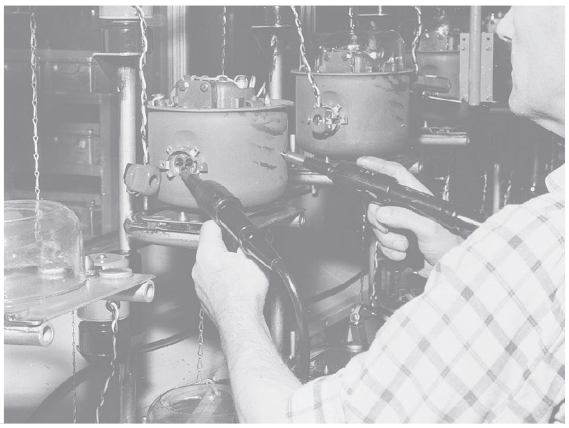





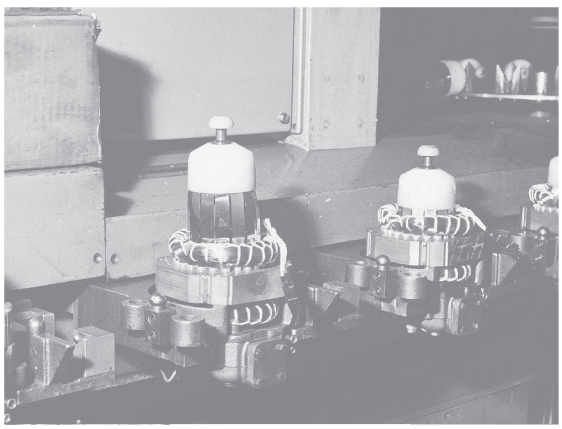
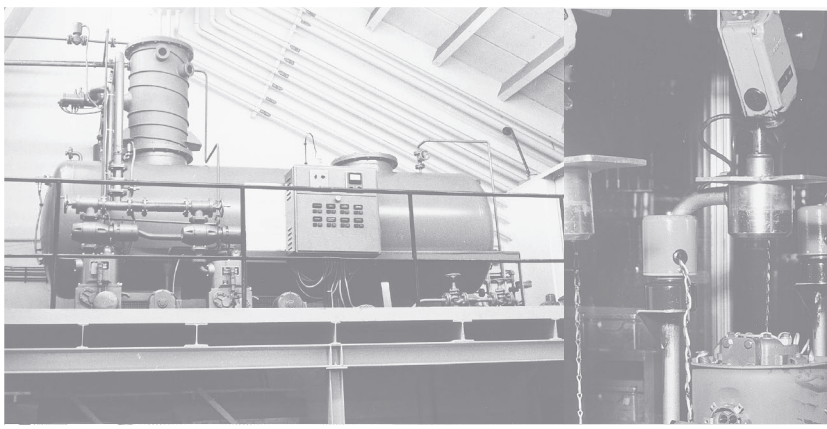




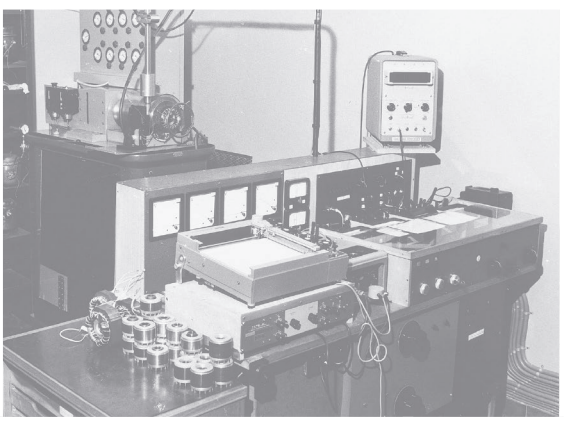
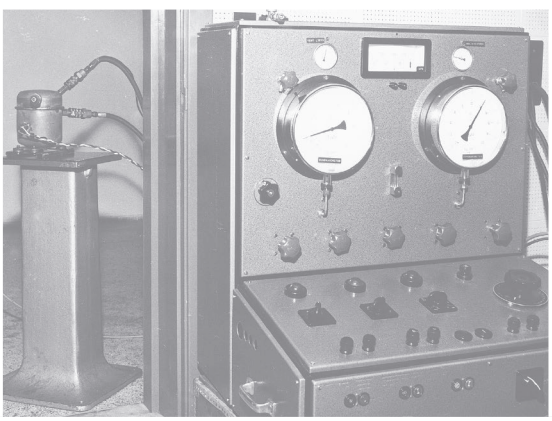
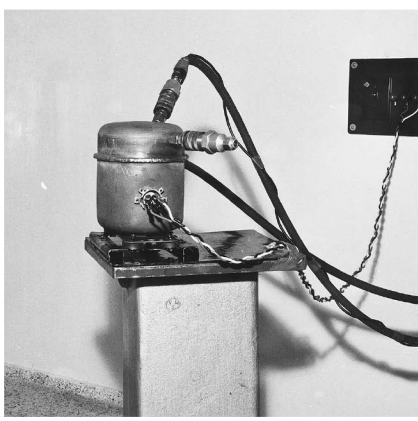
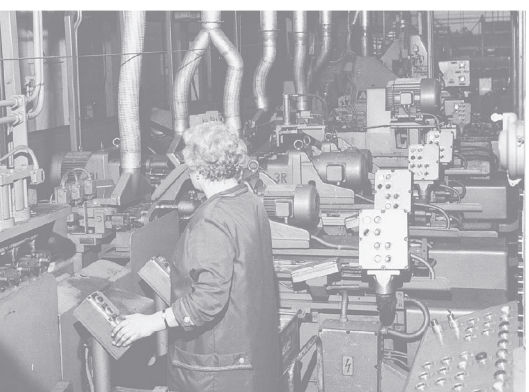
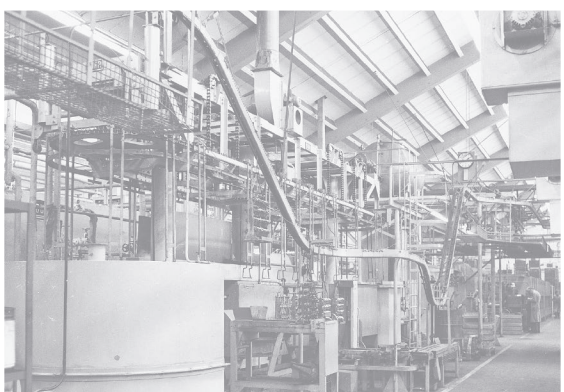
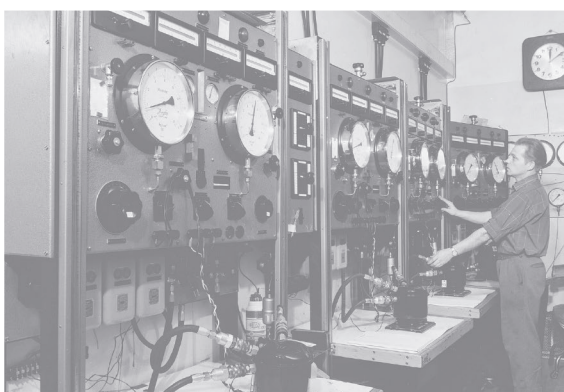




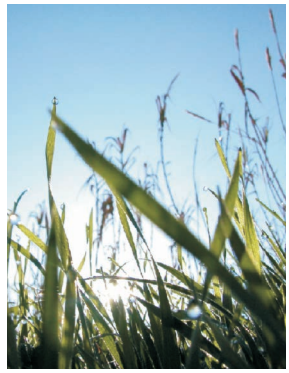







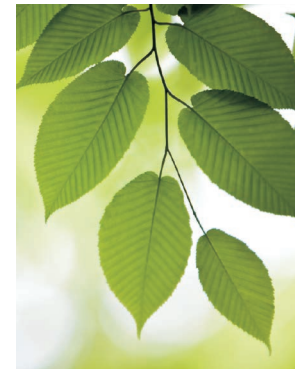
OUR IDENTITY

At Secop we are committed to our industry and are genuinely passionate about the difference we are able to make for our customers. We understand their business and objectives and the challenges of today's world of refrigeration and cooling systems.

We work in a straightforward way, being open, direct and honest because we want to make things clear and easy.

Our people are committed to increasing value for our customers and constantly strive for better performance, knowing that our own progression and success is dependent on theirs.





OUR JOURNEY

1956
Production facility and headquarters in Flensburg, Germany founded.

1958
Start up production of PW compressors.

1970
Introduction of SC compressors.
The birth of a standard setting platform in the light commercial market.

1972
Introduction FR compressors.

1977
Introduction TL and BD compressors.

1990
Introduction NL compressors.

1992
Introduction PL compressors.

1993
Start of production with natural refrigerant R600a (Isobutane)
Production facility in Crnomelj, Slovenia founded.

1999
Start of production with natural refrigerant R290 (Propane).

2002
Production facility in Zlate Moravce, Slovakia founded.

2005
Introduction GS compressors.

2008
Production facility in Wuqing, China founded.

2010
Introduction SLV-CNK.2 and SLV-CLK.2 variable speed compressors.

Introduction BD1.4F Micro DC compressor.
Introduction of DLX and NLU compressors.

2013
Introduction of the XV compressor.
Opening a new chapter in refrigeration history.
Secop acquires ACC Fürstenfeld, Austria.

Secop GmbH · Mads-Clausen-Str. 7 · 24939 Flensburg · Germany · Tel: +49 461 4941 0 · **www.secop.com**