Adventures in Heat and Cold:

Men and Women Who Made Your Lives Better

By Bernard A. Nagengast with Randy C. Schrecengost

Completed in celebration of ASHRAE's 125th anniversary

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About the Authors

Bernard A. Nagengast, Member ASHRAE, is an HVAC&R engineer in Sidney, Ohio. He has an associate degree in applied science in air-conditioning technology from Hudson Valley Community College and a bachelor of science degree in environmental engineering, as well as a master's degree in business administration from California Polytechnic State University. Nagengast is a well-known author and lecturer on the history of heating, ventilating, air-conditioning and refrigeration technology, having researched industry history since 1967. He has been a member of ASHRAE since 1968 and has been member, chair, and consultant to ASHRAE's Historical Committee. He is also a member of the Society for the History of Technology and the Society for Industrial Archeology. In this book, Nagengast authored the chapters on Ashley, Audiffren, Boyle, Cooper, Cramer, Galson, Gorrie, Jones, McNary, Sturtevant, Tellier, Voorhees, and West.

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EDITORIAL NOTE

This is an electronic version of the 155-page book "Adventures in Heat and Cold" published by ASHRAE in 2020 to celebrate their 125th Anniversary.

The published book contains 18 illustrated biographies of "Men and Women Who Made Your Lives Better."

In appreciation of the work of these Pioneers, this mini-electronic version features the 18 opening pages and portraits of each.

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BMR November 2021

Ideas Ahead of Their Time... or Right on Time

How did a cobbler design the basic air-side heating and ventilating system we still use today? Why do we call it "air conditioning"? How did refrigerators come to have door shelves? Does the invention of the hermetically sealed compressor really trace back to a monk who wanted to cool wine?

Adventures in Heat & Cold: Men and Women Who Made Your Lives Better answers these questions and more. This book tells the stories of 18 men and women whose pioneering innovations have had far-reaching influence, detailing their technical advances and sharing interesting aspects of the lives of these inventors who in many cases are relatively unknown and whose contributions are either unknown or forgotten.

Many of the stories are about innovations that required considerable personal sacrifice, as with physician John Gorrie, who essentially invented comfort air conditioning but who died at a young age, despondent over a lack of acceptance of what he considered was a humanitarian ideal. Then there are stories about David Boyle and Constance West, who had ideas that required the help of their spouses to achieve success. There are stories of people who were so devoted to innovation that their ideas took precedence over financial gain, as in the cases of Frederick Jones and Charles Tellier, and there are stories of people who saw success with their ideas in the professional and corporate world, namely Henry Galson, Margaret Ingels, and Roderick Kirkwood. Some stories concern individuals who did not initially have great interest in the fields of air conditioning, heating, or refrigeration but had related ideas that required commitment to new careers, as was the case for shoemaker Benjamin Sturtevant, textile engineer Stuart Cramer, and farmer Madison Cooper. Some of the stories tell of individuals who were intensely active in one area for a short time then move on to different interests or careers, like Marcel Audiffren, Helen Donnelly, and Robert McNary. And of course there are also stories of the geniuses–Carlyle Ashley, Ole Fanger, Mary Pennington, and Gardner Voorhees.

Every story herein is about someone who made a contribution to make life better. These stories will inform, entertain, and hopefully inspire you to innovate and make life better, as well.

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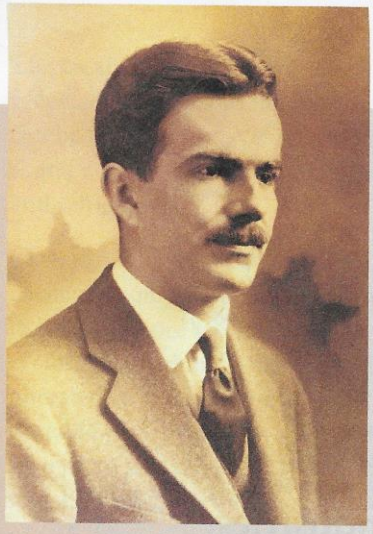


Carlyle Ashley, ca. 1930.
(Photo from Helen R. Staley)

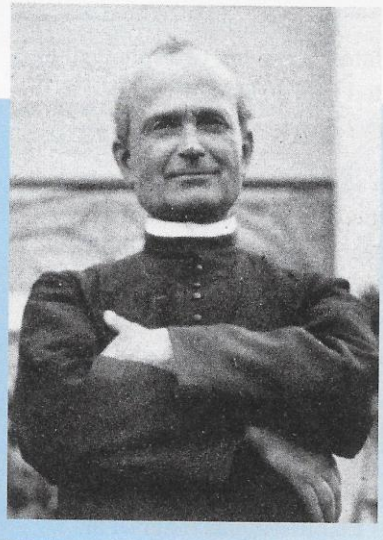
"I Took into Account Energy Use in Everything I Designed"

Carlyle Martin Ashley

(1899–1993)

Carlyle Martin Ashley was born in Indianapolis, Indiana, in 1899, son of George and Mary Martin Ashley. Carl's mother attended Cornell University, and his father graduated from Cornell with a mechanical engineering degree. George Ashley ultimately earned a Ph.D. in Geology from Stanford University. Carl's father later lived in Washington D.C., working for the U.S. Geological Survey, and then in Harrisburg, Pennsylvania, as State Geologist.

It seems that, from a young age, Carl was different from other boys– he had an out-of-the-box way of thinking, coupled with a very creative mind. Ashley later recalled: "I made all kinds of things. I had all kinds of ideas." His uncle, Willis Carrier,[1] would often visit Carl's parents, and once commented, "Don't allow him to stop being creative and be careful to be sure that this creative talent is not lost."[2] Carl was academically smart also, graduating from high school at age 16. His parents felt he was too immature to go to college, so he got a job with his uncle at Carrier Engineering Corporation for a short period in 1916–1917, during which time he was sent to Connecticut to assist in experiments on humidity control for curing tobacco. Upon completion of those experiments, he was assigned to conduct various tests under the direct supervision of Willis Carrier. Shortly after, Carl was in Bigpine California, attending Deep Springs College. Although he was called for service toward the end of World War I, he may not have served due to a physical disability.[3] Afterward, he enrolled in the mechanical engineering department at Cornell University, graduating in 1924, and began his career at Carrier Engineering in Newark, New Jersey. He married Dorothy Keens in 1926. Carl Ashley stayed with Carrier until he retired, occupying various positions, from staff to management, in research and development.



Reverend Marcel Audiffren, about 1912.
(From The Audiffren Drinking Water System. Bulletin D-201, 1921)

A Dumbbell that Cooled Wine

Reverend Marcel Antoine Audiffren

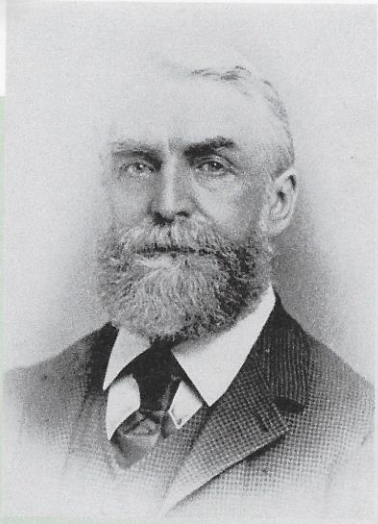
(?–?)

One important advance in refrigeration technology was the invention of the hermetically sealed compressor. This technology is actually 125 years old and traces back to a relatively unknown Catholic monk who wanted to cool wine.

Little is currently known of the history and life of the Reverend Marcel Antoine Audiffren. We do know that he is responsible for one of the most important advances in refrigeration technology–sealed, leak-proof refrigeration systems.

The Reverend Audiffren was a member of the Roman Catholic Cistercian Order of Monks and Nuns, also known as the *Trappists.* He was a physics teacher as well as Abbot (head) at the *Petit Séminaire* (a high school or college) in Grasse, France. In the early 1890s, Audiffren devised a unique package refrigeration system that was leak proof. Up to this point, no one had been able to permanently solve the problem of leaks in vapor-compression refrigeration systems. Not only was it difficult to seal piping joints, but leaks at the open-drive compressor/piston shaft were particularly troublesome. The story goes that Reverend Audiffren was merely trying to come up with a good method of cooling the wine that was made at the monastery.

Reverend Audiffren designed a self-contained refrigeration system with two rotating, connected, and hermetically sealed metal housings. One housing contained a compressor, and the other was essentially hollow, serving as an evaporator. The assembly was mounted so that the lower-third of each housing was immersed in a separate tank. The exterior of the compressor housing rotated in a water bath; thus, the compressor housing served as a condensing surface for the refrigerant. The other housing, being used as an evaporator, rotated in a



David Boyle.
(From *Ice and Refrigeration*, July, 1891, p. 24)

Selling Lemonade to the Yankees and Inventing Ammonia Refrigeration with the Help of my Wife

David Boyle

(1837–1891)

Many historical sources say that the ammonia refrigeration compressor was invented by David Boyle. We can argue for and against that claim, but Boyle is legitimately a refrigeration pioneer whose career is much more interesting when you consider his arduous journey to success–with the help of his wife!

David Boyle began that journey in Johnstone, Renfrewshire, ten miles west of Glasgow, Scotland, where he was born in 1837. His father was a grocer and liquor dealer who enjoyed tinkering with mechanics, and even building a cork-cutting machine. David Boyle was said to enjoy playing around machine shops and cotton factories and enjoyed reading *The Glasgow Mechanics' Magazine*. His budding technical interests were thwarted by his father who insisted that he go into the grocery business, which he did, ultimately rising to foreman of a wholesale grocer. He emigrated to Mobile, Alabama, desiring to start a grocery business. The American Civil War ruined his progress and, by the end of the war, he only had 250 dollars to his name. By that time, he was living in Demopolis, Alabama, and had recently married Margaretta (Margaret) Henry, who was from Ireland. Northern soldiers were stationed in Demopolis, and Boyle seized the moment by selling iced lemonade to them.[1] Boyle later recalled the event:

> I was keeping store and making and selling ice cream and lemonade. A brigade of Federal troops were stationed there and were a bonanza to me. I had a shipment of ice from New Orleans.... The weather was hot and it did not take long to get rid of it. I used it to cool lemonade and sold it at a good profit to the Yankee soldiers. The unreliability of transportation, the high cost, and the absolute need of ice at Demopolis set me to thinking and determined me to attempt the making of a machine to supply the wants of Demopolis. Just think of it! The wants of Demopolis! And that was my idea.[2]

Madison Cooper in 1905.
(From *Practical Cold Storage*)

In the Name of Refrigeration and an Iris

Madison Cooper

(1868–1946)

Toward the end of the nineteenth century, a new use of mechanical refrigeration became popular–cold storage. The fact that food could be preserved by keeping it cold led to the adoption of refrigerators by homeowners and merchants; however, the distribution of refrigerated foods needed centralized storage. Refrigeration systems already well developed for brewing and ice making had to be modified and adapted for the cold storage of foodstuffs, and one of the pioneers in this new area was a man who not only had some good refrigeration ideas but also gave a refrigeration-related name to a town and even gave his name to a flower.

Madison Cooper was born in "New York's Icebox," the Tug Hill Plateau region in the northern New York state town of LeRay, on March 19, 1868. He was the youngest child of Madison and Diana Cooper and spent his early years growing up on his parent's ancestral farm. Although his parents soon moved off the farm to the next-door village of Evans Mills, Madison continued his farm connection, working seven months a year making cheese at the farm as a teenager. By the age of 19, a developing interest in journalism and publishing resulted in his purchase of a small printing press, which he used to launch his own four-page hometown newspaper, *The Evans Mills Graphic*. He also attended the Utica Business College, where he met his wife, Clara. In the meantime, Madison's parents had moved to Ottumwa, Iowa, to launch a butter and egg shipping business. Madison and Clara also moved there, where Madison worked in a crockery store, and then a bank. Offered a job in hotel management, the couple then moved to Arrowhead Springs, California. Meanwhile, his parents moved their business, to Minneapolis, Minnesota. Madison followed when his father offered him a job as bookkeeper. After the move,

Stuart Warren Cramer.
(From various online sources)

Let's Call It "Air Conditioning"

Stuart Warren Cramer

(1868–1940)

Many have experienced air conditioning. Many know something about what it is or even where it is coming from. Hardly anyone knows why it is called *air conditioning*. We have Stuart Cramer to thank for the *name* and the *why*.

Stuart Warren Cramer was born into a plantation-owning family in Thomasville, North Carolina, on March 31, 1868. After studying naval, and then mining, engineering, Cramer went to work for and became Chief Assayer at the United States Assay Office (formerly the U.S. Mint) in Charlotte, North Carolina. (Yes, there was an operating mint in Charlotte between 1838 and 1861 that produced U.S. gold coins.) Cramer's job was to supervise the analysis of gold ore and bullion that was deposited in the Assay Office to determine the proper payment to the depositor. In 1893, Cramer left the Mint to work for Textile Mill Engineer Daniel Tompkins, rising to chief engineer and manager of Tompkins's firm. Two years later, Cramer went into business himself as a consulting textile mill engineer and contractor.

Stuart Cramer had a traumatic personal life at the beginning of his career. In 1889, while attending college, he married, only to lose his wife six years later. Fulfilling his wife's deathbed wish, he married her sister, only to have her pass away within months of his second marriage. He then married for a third time. Three children resulted from his marriages.

Cramer Realizes Success

Along the way, Stuart Cramer became interested in the application of newly available electric power to mills, and even helped found the Duke Power Company electric utility in 1905. At the turn of the nineteenth century, it was common for factories and mills to use a

Helen Innes in 1926.
(From *The Brooklyn Daily Eagle*, December 5, 1926)

Engineering Oddity

Helen Innis Donnelly

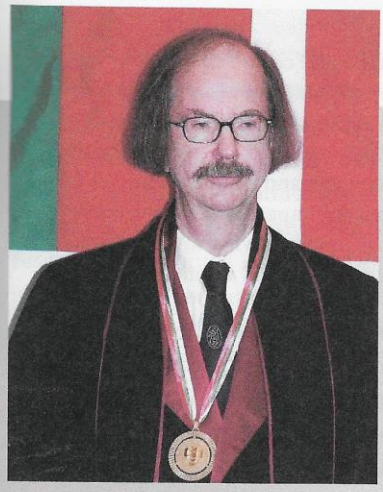
(1892–1935)

In the late nineteenth century, the science of heating and ventilation, although still not well understood, was beginning to advance. Most of the work was done by contractors, and very few of them were formally educated. Many were really businessmen, anxious about getting work and making money. In fact, during most of the nineteenth century, it was rare for anyone to have earned any formal training in engineering, so engineers interested in the art of any science were in the minority.

During the nineteenth century, most people actively engaged in any art, discipline, or profession acquired their knowledge through on-the-job training while laboring in shops or businesses, where many of the tasks involved hard, physical, even sometimes dangerous, work. These efforts were almost universally viewed as masculine work and not appropriate for women. Even at the turn of the twentieth century, engineering education and many of the technical areas of refrigeration, heating, ventilation, and others were still predominately male dominated. In technical areas where women studied or worked in engineering, the women were "perceived as oddities at best, outcasts at worst, defying traditional gender norms."[1]

Helen R. Innis, born on June 3, 1890, in Brooklyn, New York, became more known as a "heating engineer" when,

The American Society of Heating and Ventilating Engineers was incorporated in the State of New York on January 24, 1895. Many of our present-day ASHRAE rituals are tied to this first group.
(From *Proclaiming the Truth*, 1995)



Pavel Ole Fanger
(From American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.)

The Smells Have It

Pavel Ole Fanger

(1934–2006)

We spend much of our living and working time indoors; thus, the quality of the air we breathe inside has become increasingly important, especially since energy conservation has mandated tighter building technology, such that buildings do not "breathe" as much as they used to. Sometimes they smell! Many engineers have studied and developed solutions affecting indoor air quality. One of the most prolific engineers of that interest was Ole Fanger.

Pavel Ole Fanger was born July 16, 1934, in Veilby, Denmark, but not much is known of his personal history as a young man. He attended local schools, including the Marselisborg Gymnasium in Arhus, and entered the Technical University of Denmark (DTU). He received the Cand. Polyt. degree (Candidatus rerum politicarum) or Master of Science (M.S.) in civil engineering in 1957 and then served in the military for two years. Once out of the military, Fanger joined the faculty of DTU in 1959, taking an academic appointment as an assistant professor. He eventually became an associate professor from 1967 to 1977, receiving his Doctor of Science (D.Sc.) in 1970 from DTU for a thesis titled "Thermal Comfort." In 1977, he was promoted to professor, where he guided more than 100 M.S. and Ph.D. students. P.O. Fanger became well known through his knowledge of work about thermal comfort and indoor air quality (IAQ).[1]

The Work Begins

P.O. Fanger started his work on thermal comfort in the 1960s. His early research was directed toward people's responses to indoor environmental conditions. He worked on quantifying the thermal sensation and comfort levels on individuals, and introduced various indices for these factors. He and his associates began identifying the impact of IAQ on the quality of life and productivity level of office and factory

Henry L. Galson, about age 60.
(From ASHRAE Library and Historical Archives)

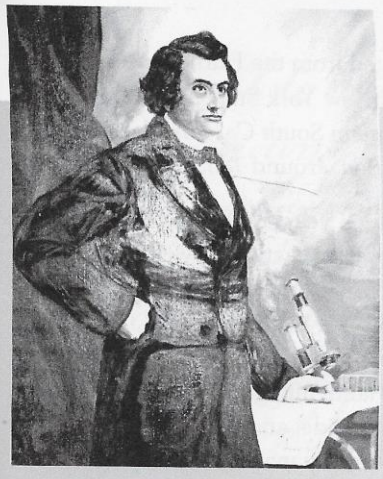
The Henry Ford of Air Conditioning

Henry Leopold Galson

(1900–1963)

The most widely known pioneer of the automotive industry is Henry Ford, who is credited with applying the latest technology and mass production techniques, resulting in the Model T, the first truly affordable automobile. The Model T has often been referred to as "The Peoples' Car." But did you know that the air-conditioning industry also had an innovator who influenced mass production technology at different manufacturers to make "Peoples' Air Conditioners"?[1]

Heinrich Leopold Galitzenstein was born in 1900 in Vienna, Austro-Hungarian Empire, son of Dr. jur. Leopold and Helene Galitzenstein. Heinrich's father, a lawyer, died when he was five years old. To provide income for the family, his mother turned their home into a boarding house for American physicians, who were traveling to Vienna to study medical advances. This provided the opportunity for Heinrich to learn the English language. After service in the Austrian army during World War I, Galitzenstein attended Vienna Technische Hochschule, graduating as a mechanical engineer at age 22. He got a job as an engineer in a bread factory; however, his life was racked by the after-war adverse economic and social conditions. The Austro-Hungarian Empire was breaking up, and hyperinflation was wrecking the economy. The cost of living index rose from 1640 in 1918 to 83000 in 1922. The inflation was so bad that it required a suitcase of currency to buy a loaf of bread. Disgusted with the turmoil, Galitzenstein entertained leaving Europe. One of the American physicians living in his mother's home offered to sponsor his emigration to the United States. He accepted, arriving in the U.S. in 1922, anglicizing his name to Henry Galson. He was able to find a job as a project engineer in Philadelphia, Pennsylvania, at Procter and Schwartz, manufacturers of industrial drying and processing equipment. During



John Gorrie from a daguerreotype photo taken in the 1850s.
(From Florida Memory, Florida State Archives and Library)

Trying to Cool the Face of Civilization

John Gorrie

(1803–1855)

Doctor John Gorrie is known for inventing one of the earliest machines for making ice. His invention was considered so significant to his local newspaper editor that he printed Gorrie's complete description of his ideas on the disease malaria, including his proposed machine, as a series, with the conclusion: "The discovery and the invention which our correspondent proposes to apply to this object are calculated, if true, to alter and extend the face of civilization." But soon after Gorrie was also referred to as "a crank… who says he can make ice."[1]

Did John Gorrie indeed "alter and extend the face of civilization" or was he just a "crank"? And was it all about ice or something else–such as air conditioning?

Since his death in 1855, schools, a bridge, a ship, and a state park have been named for him. Books have been written about him, and he has been often credited with the invention of the first ice-making machine as well as the invention of air conditioning. There is even a life-size marble statue of John Gorrie in the United States Capitol.[2] So, what did he do that merited such praise and honor?

Compiling the true story of John Gorrie's legacy is not easy. It has been said of John Gorrie that he was born on two different dates in two different countries, graduated from medical school on two different dates, and died on three different dates.

Since the 1890s, a number of individuals have investigated the life and accomplishments of John Gorrie, resulting in numerous articles, papers, and books. Although the volume of information is large, it is amazingly based on few hard factual sources. No personal notes, papers, plans, or artifacts (except a patent) have survived, and much

Margaret Ingels.
(From University of Kentucky, photo # 075_ftb)

A Blacksmith Apron to Petticoats

Margaret Ingels

(1892–1972)

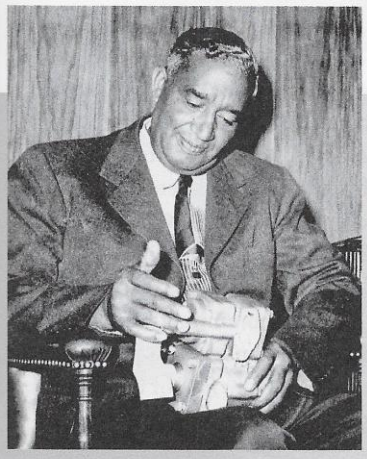
As the twentieth century was born, there were no women engineers, or at least any women with an official engineering degree. But that soon changed, and the HVAC&R industry was no stranger to that progress.

Margaret Ingels was born October 25, 1892, in Paris, Kentucky. Margaret was educated in the public schools of the state and entered Kentucky State University (KSU) in 1912. She became the first woman to graduate from the University of Kentucky School of Engineering in 1916, with a bachelor's degree in mechanical engineering. Margaret originally intended to study architecture, as she was always interested in houses, and their planning to ensure maximizing beauty with comfort and efficiency.[1] However, the local university did not offer any architectural courses, so she was persuaded to "take it all while she was there" and do mechanical engineering instead.

Ms. Ingels thus became only the second woman to receive an engineering degree in the United States and the very first woman to receive one at the University of Kentucky. She went on to pursue higher education, becoming the first woman in the United States to receive a master's degree from the University of Kentucky in mechanical engineering in 1920.

Roughing It in Engineering

Margaret was fortunate to be born in the late 1800s, when the "professional study of technology" and engineering education in the United States was beginning to change. The changes began to allow women to participate in the predominantly male technical world. Before that time, "girls who expressed technical interests were steered into the science side of home economics." However, at that time, and into the



Fred Jones, holding the reversing valve he developed for defrosting the evaporator used in the transport units. (From Thermoking Corporation div. Ingersoll Rand)

Move Food with a Cool Truck!

Frederick McKinley Jones

(1893–1961)

We can go to a store and purchase various foodstuffs that are safe to eat because they are properly preserved, often by refrigeration. Consider that all that refrigerated food had to be transported to the store, and today refrigerated transport is accomplished reliably and at reasonable cost. Who designed those cooled trucks you probably see every day?

Frederick McKinley Jones was born in May 1893, in Covington, Kentucky. His early life story comes from his own memory as related to his wife, as well as a few people who knew him well.[1]

Fred Jones's parents were apparently unmarried. His black mother left soon after his birth, and his white father, wishing for him to have an education he could not afford, turned him over to a Catholic Church and went away. Fred never again heard from his parents. Within a year, Fred was enrolled in the first grade. To satisfy his room and board, he worked in the parish rectory, faithfully doing whatever jobs he was assigned to. He had a tough childhood in other ways, enduring teasing and fighting with other boys because he was a mixed-race kid. He endured it all, concentrating on the pastime he loved from an early age–taking things apart and putting them back together again to see how they worked. His obsession with mechanical things, especially automobiles, led to boredom with chores and schoolwork. At age ten, he fled the rectory, crossing the Ohio River to Cincinnati, where he wandered, doing whatever work he could find to pay for food, clothes, and boarding. Within a year, he was working in a garage and, at age 14, was hired as a full-fledged mechanic. His obsessive study of repair manuals and hands-on expertise soon led to a promotion to shop foreman. Soon Fred was working with racing cars, and then designing the cars. He became restless and went south, finding a job on a steam-

Roderick Richard Kirkwood.
(Photograph from ASHRAE Leadership Recall, June 29, 1992)

High Energy Impact

Roderick Richard Kirkwood

(1920–2010)

Energy conservation is now one of the most important considerations in building design. Although energy use has always been important to engineers, a need to do better became evident in the last quarter of the twentieth century, drawing the focus of government, professional societies, manufacturers, and building design and services firms. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) assumed leadership in developing energy conservation methods and standards such that building design is today influenced worldwide by ASHRAE's voluntary efforts of more than 40 years ago. That legacy exists principally due to the persistent effort and leadership of Roderick Kirkwood.

Roderick Richard Kirkwood was born January 11, 1920, in St. Paul, Minnesota, and became involved in the American Society Heating Ventilation Engineers (ASHVE) in 1946. At the local chapter level, Kirkwood held all positions in the Puget Sound Chapter. In 1963, he became a member of the Board of Directors of ASHRAE and served as President of ASHRAE in 1973–1974. He designated "Optimum Energy Utilization through Technology" as his theme for the year, as his presidency coincided with the 1973 energy crisis, which brought an oil shortage, fuel price increases, and long lines at service stations. As ASHRAE President, he understood the importance of an energy standard in American HVAC design, and Kirkwood noted in his presidential speech,

> ASHRAE's membership is concerned about the utilization of energy, not with its production. We, as engineers, designers, manufacturers and technicians, can help to reduce the shortage of energy by using our technology to assure that the utilization of energy is optimized. If we don't take the forefront in this, we must expect others to take over.

Robert Reed McNary
(From *ASHRAE Transactions*, Vol.105, pt.1, p. 1203)

Create a Miracle, Invent a Nightmare

Robert Reed McNary

(1903–1988)

For almost five decades, the HVAC&R industry considered the chlorofluorocarbon (CFC) refrigerant family one of the most important developments of the twentieth century. You could say that inventing a refrigerant that had every desired property an engineer could dream of was a miracle—and how the actual development came about fits right in with miracle making. However, that dream-turned-miracle later came to be considered a nightmare.

So, What Happened?

A miracle refrigerant was, in fact, once needed. In the 1920s, refrigeration systems were well developed and accepted for brewing, cold storage, and ice making. But these applications were industrial in size. There was a new part of the industry being perfected in reliability, efficiency, and affordability: homes and small businesses. And there was the impetus to extend refrigeration technology into air conditioning. However, there was one big stumbling block: the refrigerants available at that time had problems—mainly toxicity or flammability—and that reality was restricting expansion of refrigeration technology into inhabited areas, particularly where many persons would be present. Frigidaire Corporation, one of the pioneering companies in household refrigeration, became very concerned that their expanding business was threatened.[1] In the summer of 1928, Frigidaire's chief engineer, Lester Kielholtz, expressed those concerns to Charles Kettering, vice president in charge of research for General Motors, the owner of Frigidaire. Kettering agreed to see if anything could be done, and, the next day, a Friday in July, he asked Thomas Midgley, Jr., a mechanical engineer at the research lab in Dayton, Ohio, where Frigidaire was located, to meet with Frigidaire personnel to discuss the possibilities. That meeting, on a Saturday morning, led to an afternoon brain-

Mary E. Pennington, photograph.
(From biography, 2019 National Inventors Hall of Fame)

Eggs-plaining Food Preservation with Refrigeration

Mary Engle Pennington

(1892–1952)

Mary Engle Pennington was born October 8, 1872, in Nashville, Tennessee, and became one of the earliest people interested in, and one of the country's greatest authorities in, the research and development of knowledge for safe handling and preservation of perishable foods. Her interest in understanding the sciences, and tireless work for the general betterment of mankind, led her to first become a bacteriological chemist, and slowly evolve into an early food scientist. Along her career path, she eventually became a refrigeration engineer.[1,2]

At an early age, Mary Pennington moved to West Philadelphia, where her entrepreneurial father became involved in a label-manufacturing business, as well as an enthusiastic gardening hobbyist. Mary enjoyed the garden as well and began a lifelong interest in flowers, local fauna, and even chickens at the markets. Ms. Pennington's interest in science was triggered at age 12, when she became fascinated with a Rand's Medical Chemistry book while browsing in the Philadelphia Mercantile Library. After reading about "oxygen and nitrogen (things she could not touch, or taste or smell) yet were elements in the air she breathed, and in the soil and in the water," she stated that she had some understanding of "the idea of the realness of the invisible world." Once she became interested in chemistry, her family supported her efforts to become more educated.[3,4]

Even though science was not considered a project subject for young women, Mary Pennington approached the dean of the University of Pennsylvania and was admitted at the Towne Scientific School at the University in 1890. She studied chemistry, biology, bacteriology, and zoology, and completed all of the class work in just two years. She was the only woman in her class, and she received a "certificate of proficiency" in 1892. Even though she completed all the required classes

Charles Tellier in 1860, age 32.
(From Compte Rendu Officiel de la Manifestation Internationale en l'Honneur de Charles Tellier Père du Froid, p. 73)

Starved by Refrigeration?

Charles Tellier

(1828–1913)

"Tellier Starved to Death?" read a headline in 1913.[1] Refrigeration pioneer Charles Tellier had died, starving and penniless, or so some news sources said. *The New York Times* described his end this way:

> Succor came too late to Charles Tellier, the famous inventor of cold storage, who is dead. Mr. Tellier… was found several days ago in dire straits in a single room, dying of hunger and cold. A sum of $20,000 was publically raised for him a year ago, but he never got a cent. Representatives of a large cold storage firm came to his door to present him with $200 just as he was breathing his last. The savant was aged 85, and died in terrible agony in the presence only of an old concierge, but did not complain.[2]

Did Charles Tellier's lifelong contributions to the art and science of refrigeration somehow kill him?

Charles Luis Abel Tellier was born June 29, 1828, in Amiens, France.[3] His father, Louis-Augustin Tellier, owned a successful spinning mill. When Charles was about 15 years old, an economic crisis affected the textile industry such that his schooling was interrupted when he and his family moved to Paris. Apparently, he had no further continuous formal education, but he showed a precocious inventive behavior, teaching himself science, particularly chemistry. After a few years he worked for an export commission house and, during his spare time, began a study of the properties of ammonia, amine compounds, and ether. He experimented with the manufacture of methyl ether and was burned and almost blinded when one of his experiments exploded.

Around 1855, Tellier became fascinated with the properties and potential uses of ammonia. He became convinced that ammonia could be used as a motive force and constructed an experimental ammonia-

Gardner Vorhees at age 30

Freeze a Whale, Cool the World's Fair

Gardner Tufts Voorhees

(1869–1937)

Two technological advances saw considerable maturity in the last half of the twentieth century–air conditioning and energy efficiency. But these advances were not new, and we can look back in time to find someone who was way ahead in both areas.

Gardner Tufts Voorhees was born June 6, 1869, in Stamford, Connecticut, son of Abraham and Caroline Voorhees. His father was a farmer-turned-lawyer, and his mother was a kindergarten teacher. Gardner's father died when he was only 13 years old.[1] Gardner Voorhees graduated from the Massachusetts Institute of Technology in 1890 with a degree in mechanical engineering. His senior college yearbook lists his only extracurricular activity as a member of the "Technology Cycling Club."

Starting a "Whale" of a Career in Refrigeration

Gardner Voorhees apparently began his work in refrigeration as an employee of the Quincy Market Cold Storage and Warehouse Company in Boston where he "helped plan and develop the first installation of mechanical refrigeration in that establishment and planned new cold storage buildings, laid out and installed street brine pipe systems…"[3]

It seems that Voorhees was enthusiastic about the possibilities of refrigeration technology. When a 43-foot Right Whale was captured off Boston's coast in 1895, Voorhees made a deal with its owners to refrigerate the whale for exhibition:

> The whale was stored on a (scow)… inclosed in a glass case… where he lay blocked up in the position he would take when in the water. His jaw opened to the extent of say seven feet, and his great tongue lay exposed to full view, just like any other man who talks too much in the newspapers; while all around was a triple glass case 45 × 15 × 22

Constance Lane's senior photo when she graduated in 1927 from the Western College for Women.
(From *The Multifaria*, 1927, p. 172)

Why Doesn't the Door Have Shelves?

Constance Lane West

(1904–1981)

We take many modern conveniences for granted, one of the most useful being our home refrigerator. We buy one, plug it in, and it keeps our food cold or frozen, makes ice, dispenses cold water, and conveniently serves as a bulletin board for notes, news clips, photos, and anything important to our life that we wish to stick on the door. When we open the refrigerator door, we are met with a display of food items, not only on the inside, but also on the shelves inside the door. Did you know that those refrigerator door shelves never used to be there?

Although household refrigerators debuted early in the twentieth century, their doors were just that–simply doors. There were no shelves on the doors, and 20 years passed before someone thought refrigerator door shelves might be a good idea. And that someone was Constance Marie Lane West.

Constance Marie Lane was born February 29, 1904, in Essex, New Jersey, daughter of Clarence and Sadie Lane. Her father was a dealer in food provisions and her mother was a real estate contractor, according to the 1910 U.S. Census.

Lane graduated from the Western College for Women in Oxford, Ohio, in 1927, having majored in art, English, and literature. During her college years, she was a member of the hockey and swimming teams, as well as the YWCA and the French Club. She also acted in some class plays.[1]

The Team–Lane and West

Frank Russell West (1895–1947) was an engineer with early interests in automotive engineering and, beginning around 1926, in household refrigeration. Frank West was born in Trenton, New Jersey, in 1895,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