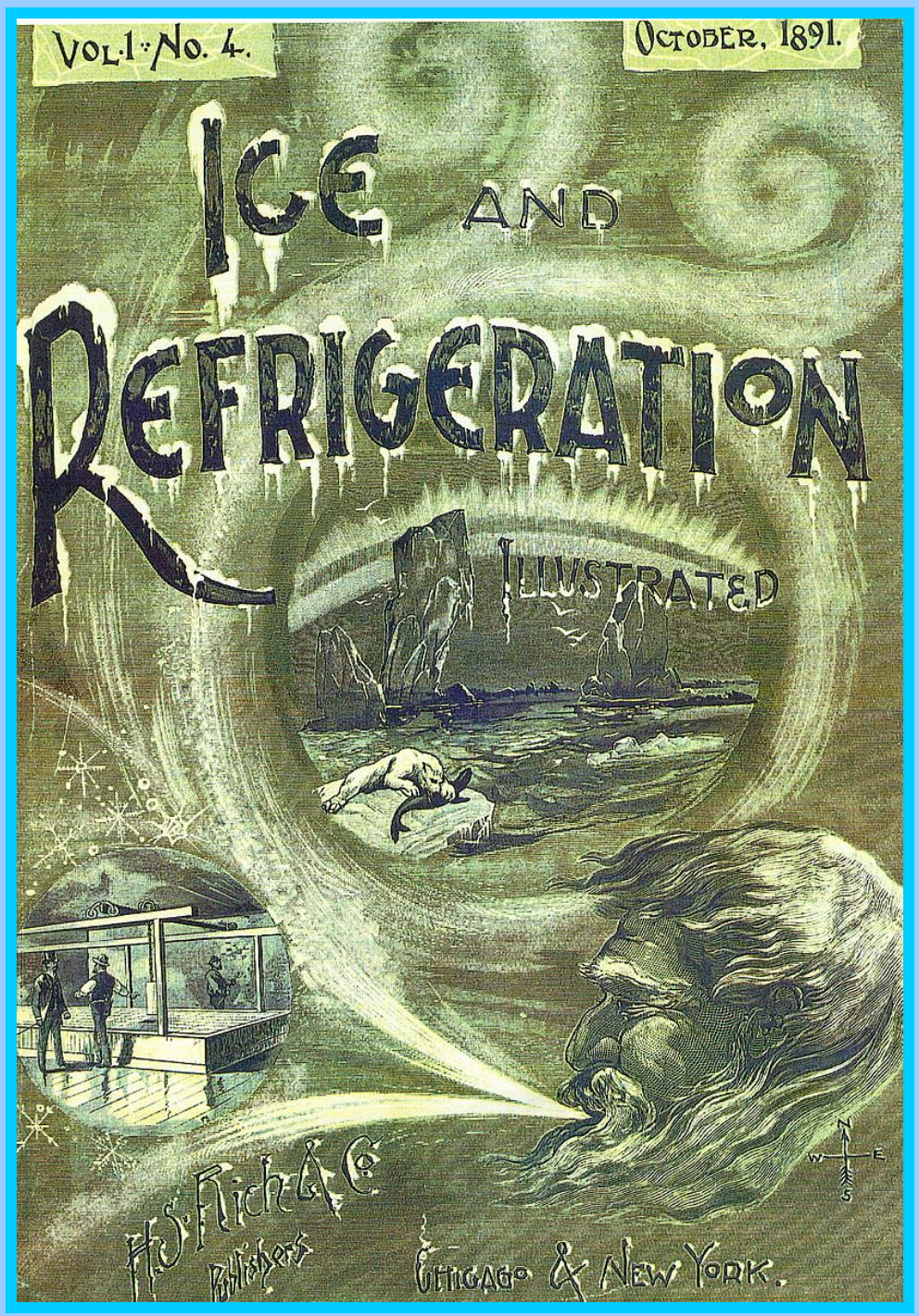
The COLD MAKERS

Pages 33-42



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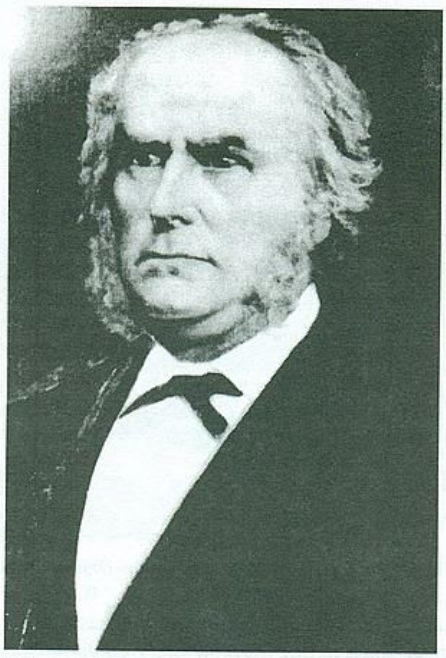
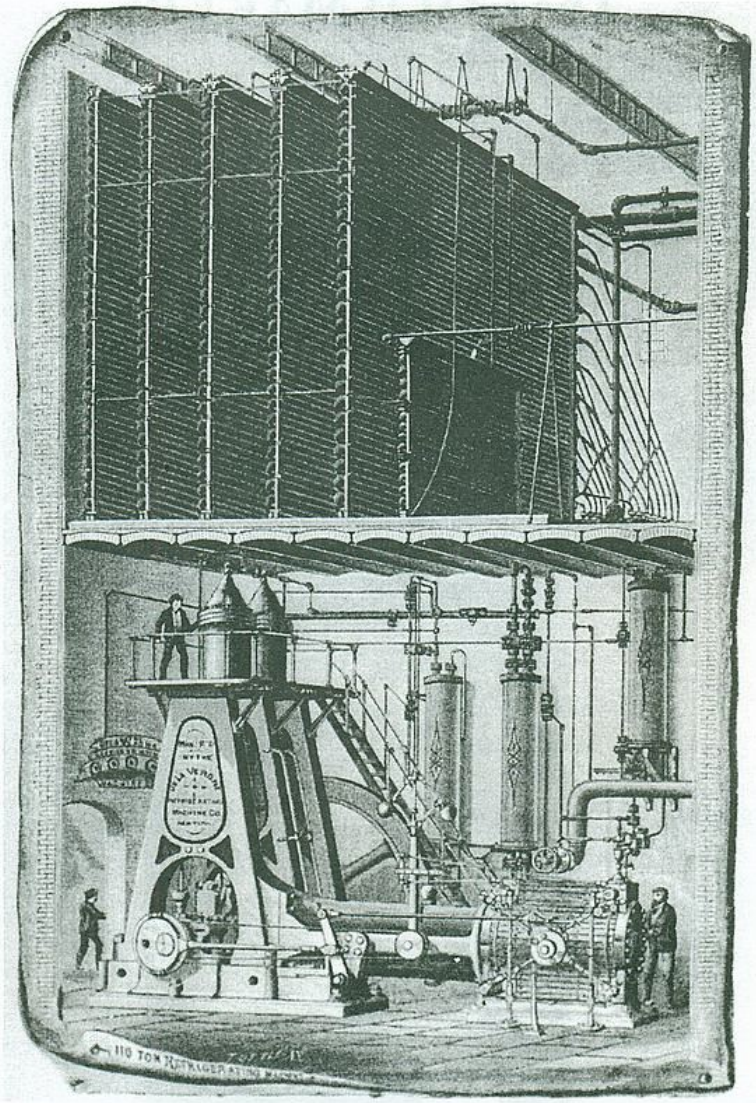
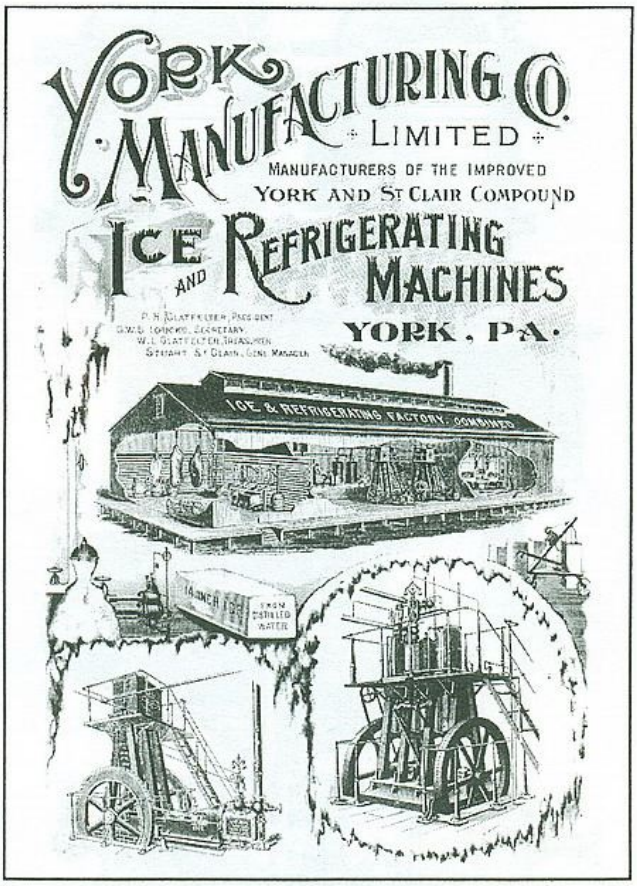


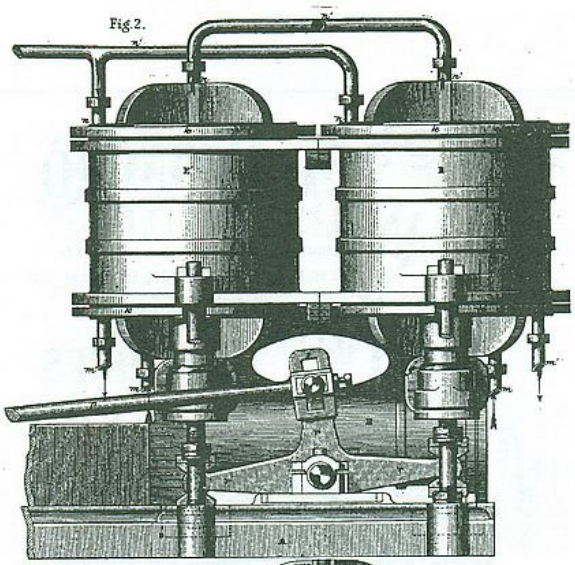
James HARRISON [80]

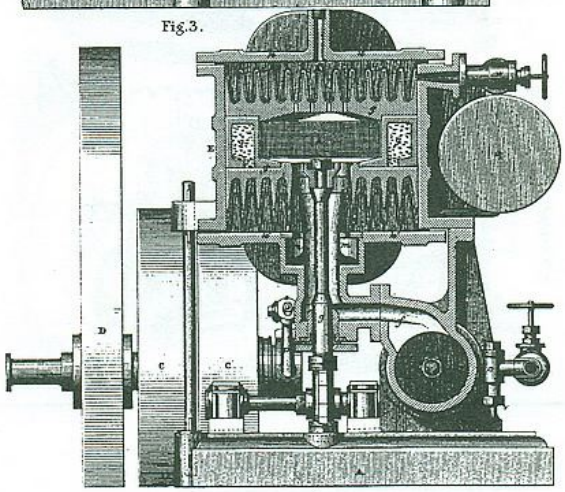


19. Catalog Drawing: A 110-ton Capacity Steam-Driven Ammonia Refrigerating Machine with an "Atmospheric" Water-Cooled Condenser.
Mechanical Refrigeration, Processes and Apparatus of the De La Vergne Refrigerating Machine Co., *New York, 2nd edition, 1887.*



20. Advertisement: Ice Refrigerating Machines.
York Manufacturing Co., York, Penn.
Ice and Refrigeration, *October 1891, inside back cover.*





18. Bookplate: Refrigerating Apparatus.
Figs. 2 and 3 from a drawing of unknown origin found in a second-hand bookshop.
The apparatus has similarities with the Lightfoot cold-air machine of 1886.
(B.M. Roberts Collection)

[76] William CULLEN **1719-1790**

Professor of medicine and chemistry at the University of Glasgow. Lectured in Edinburgh on *Of the Cold Produced by Evaporating Fluids, and of some other means of producing Cold* (1755) and is credited with creating low temperatures by boiling a volatile liquid in a vacuum.

17. *Thévenot. Portrait from Smithsonian Institute, Division of Engineering and Industry.*

[77] Jacob PERKINS **1766-1849**

Born in Massachusetts and a friend of Oliver Evans [16]. Moved to England (1819) and secured a number of patents relating to boilers and steam engines. He became interested in refrigeration and corresponded with Trevithick [18]. Patented a closed-cycle vapor-compression machine (BP 6662: 1834) described as *Improvement in the Apparatus and Means for Producing Ice, and in Cooling Fluids*. The machine was constructed by John Hague in London and used ethyl ether to produce a small quantity of ice. It was notable for the use of a weighted expansion valve.

98. *Billington and Roberts, pp. 246-247. See also* **105.** *Roberts, fig. 71. Portrait from* A Dictionary of Arts, Manufacturers and Mines, *Andrew Ure, 1856.*

[78] Frederic TUDOR **1783-1864**

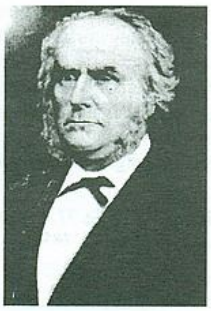
Started the natural ice industry in the United States by harvesting winter ice from ponds and lakes and shipping it to the hot climates of the Caribbean (1805). After many difficult years, he only became financially successful in later years (1849), by which time he was shipping ice to South America and the Far East. He later became known as "Ice King of the World." (In 1872, some 220,000 tons of ice were exported by U.S. firms).

99. *Donaldson and Nagengast, pp.45-46. See also* **105.** *Roberts, figs. 77 and 78. Portrait from Library of the Boston Atheneum, Boston, Massachusetts.*

[79] Alexander Catlin TWINING 1801-1884

American scientist, inventor, and civil engineer. He published a booklet entitled *Manufacture of Ice on a Commercial Scale* (1851). Filed various patents (BP: 1850 and USP: 1853). Designed an experimental ethyl ether freezing machine (1850) with a larger machine constructed at the Cuyahoga Steam Furnace Co. in Cleveland, Ohio (c. 1855), producing about 1700 pounds of ice per day. This latter plant was a forerunner of the "ice-can" system, where water was frozen in metal cans (1862). His system did not see commercial manufacture, largely due to the Civil War, and it would be James Harrison [80] who would succeed where Twining had failed.

99. *Donaldson and Nagengast, pp. 125-127. Portrait from the Twining family.*



[80] James HARRISON 1816-1893

Scotsman who emigrated to Australia and settled in Geelong, near Melbourne. Took a strong interest in mechanical refrigeration for the meat export industry (1852). Made an unsuccessful ethyl ether compressor (1855), apparently unaware of the earlier work of Jacob Perkins [77]. Went to London, where he had an improved machine manufactured by Siebe Bros. Obtained various patents (BP 747: 1856; BP 2362: 1857). First machine of improved design was sold to the Truman, Hanbury & Buxton Brewery in London (1857). Harrison returned to Australia to promote his machine and set up an ice-making plant (1858). More machines were built by Siebe in London and by P.N. Russell & Co. in Sydney. Thus, Harrison has the distinction of being the first mechanical refrigeration pioneer to see actual commercial production of his invention.

28. *Luscombe. Portrait on p. 33, from* **99.** *p. 125.*

[81] Ferdinand CARRÉ 1824-1900

Versatile French engineer with a particular interest in mechanics and thermodynamics. He studied ethyl ether and ammonia refrigeration machines, obtaining a series of patents (1857-1862). But it is his work in absorption refrigeration for which he is famous. Carré built an intermittent aqua-ammonia absorption machine (1859). (Still in use in 1927 as the Crosley "Ice-Ball"). He went on to develop a continuous absorption machine for commercial use (1859), this being manufactured by Mignon & Rouart in Paris in a range of sizes, producing ice at the rate of 12-200 kg/h. Its design was later improved by Holden [89]. Carré left no written records, apart from the details in his patents.

98. *Billington and Roberts, p. 260. See also* **105.** *Roberts, fig. 75. Portrait from the International Institute of Refrigeration.*

[82] Louis Charles Abel TELLIER 1828-1913

Known in his native France as "Père du Froid" (Father of Cold), Tellier had a life-long interest in refrigeration and its application to brewing and food storage. He made a methyl ethyl compressor (1868). The same year, he failed in his attempt to ship refrigerated meat to London aboard the *City of Rio de Janiero*. At Auteil, near Paris, he established what was possibly the first mechanically refrigerated cold storage plant. He disputed the priority of F. Carré's [81] absorption patent, but his own machine was unsuccessful. The ship *Frigorifique*, equipped with a Tellier system, successfully transported chilled meat from Rouen to Beunos Aires (1876). Though honored by the Académie des Sciences (1911), he died in relative poverty.

99. *Donaldson and Nagengast, p. 130.*

[83] Franz WINDHAUSEN 1829-1904

Distinguished German engineer who made significant contributions to the development of three types of refrigerating machines. Perfected (1868-1869) the air cycle machine of Kirk [84]. Later, Windhausen produced an industrial continuous absorption machine that relied on the evaporation of water under a vacuum, the water vapor being absorbed in sulfuric acid and the diluted acid reconcentrated (USP 236,471: 1881). However, he was particularly successful with the commercial development of CO_2 compressors (1886). The firm of J & E Hall took up the English rights to his patent, and Hall CO_2 machines became virtually standard for marine work.

98. *Billington and Roberts, p. 253.*

[84] Alexander Carnegie KIRK 1830-1892

Scottish mechanical engineer. Having studied William Siemen's analysis of the cold air machine of John Gorrie [96], Kirk was able to perfect a closed-cycle air machine (1862).

98. *Billington and Roberts, pp. 267-268.*

[85] Thaddeus Sobieski Coulincourt LOWE 1832-1913

American constructor of balloons for the army, he made one of the earliest CO_2 compressors (USP 63,413: 1867) and used it to manufacture ice, first in Texas, later in Mississippi.

17. *Thévenot, p. 445. Portrait from* 119. *p. 393 (Courtesy Library of Congress, Brady-Handy Collection).*

[86] Edmund CARRÉ 1833-1894

Younger brother of Ferdinand Carré [81]. Building on the earlier observations of Nairne [145] and Leslie [150], he developed a sulfuric acid/water cooling machine with a glass water holder, an acid container of lead, and a hand pump that found some use in Paris cafés (1850-1866).

98. *Billington and Roberts, p. 259.*

[87] David BOYLE 1837-1891

Emigrated to the USA from Scotland. Working in California, he designed an ammonia refrigerating compressor (USP 128,448: 1872). He built a number of machines before establishing the Boyle Ice Machine Co. in Chicago (1878) and is often credited along with Carl Linde [90] as the inventor of the ammonia compressor. Tellier [82] also experimented with ammonia as a refrigerant (1862). Other pioneers include Eugene Nicolle (1863), R.A. Brookman (BP 3062: 1864), and John Beath (USP 127,180: 1872). Boyle is generally regarded as the "Father of Ammonia Compression Refrigeration in America."

99. *Donaldson and Nagengast, pp. 134-136. Portrait from* Ice and Refrigeration, *July 1891, p. 24.*

[88] Paul GIFFARD 1837-1897

French engineer. Perfected the first open-cycle air refrigerating machine to be a commercial success (1873). It was exhibited in Paris (1878) where it came to the attention of E. Hesketh of the British firm of J & E Hall. The machine had an important refinement, the "cut-snow" valve that prevented the outlet valves from becoming blocked with snow. The cold air machine was developed by J & E Hall for frozen meat ships but was rapidly supplanted by improvements to the CO_2 compressor of Lowe [85]. Giffard's work was also developed by Bells of Glasgow, Coleman, and the firm of Lightfoot.

98. *Billington and Roberts, pp. 268-269.*

[89] Daniel Livingstone HOLDEN 1837-1924

Born in Kentucky, USA. He purchased a Carré [81] absorption machine (c. 1865) that had been smuggled into the Confederacy during the Civil War when the Union had denied supplies of natural ice to the South. He put it to work in San Antonio, but dissatisfied with the off-color ice, he placed steam coils in the generator to heat the aqua-ammonia and substituted distilled water. These changes quickly led to public acceptance of machine-made ice. Later, Holden worked on improving the "chimogene" (petroleum distillation mixture) compressor of P.H. Van der Weyde (USP 87,084: 1867); he also produced his "Regealed" freezing machine (USP 95,347: 1869), which was manufactured for some years in Philadelphia.

25. *Woolrich. See also* **105.** *Roberts, fig. 73. Portrait from* **99.** *p. 133.*

[90] Carl von LINDE 1842-1934

German scientist, professor, engineer, and industrialist. Studied under Clausius [167]. Wrote his classic paper *The Extraction of Heat at Low Temperature by Mechanical Methods* (1870), in which he compared the efficiency of cold air, compression, and absorption machines. Linde was possibly the first to use a rigorous thermodynamic approach to refrigeration design. Built a methyl ether compressor (1875), following with ammonia compressors (1876) and his successful double-acting design (1877). He established commercial production of the latter by forming his own company at Weisbaden (1879). The Chicago engineer, Fred W. Wolf, secured the rights (USP 228,364: 1880) to manufacture and sell Linde's machines in the USA (1881). The Linde ammonia compressor and refrigerating system was widely used throughout the world.

98. *Billington and Roberts, pp. 249-251.*

[91] Raoul Pierre PICTET 1846-1929

Swiss professor of physics. Began a study of refrigerants (1872), particularly SO_2, which had earlier been considered by A.H. Tait (USP 94,450: 1869) and possibly by Holden [89] (c. 1870). Pictet designed an SO_2 compressor (1874), which was built and worked in the following year (BP 2727: 1875). His machine was manufactured in Switzerland, and later in France, but not much used elsewhere. SO_2 was used by Audiffren [94] and later by the early U.S. domestic refrigerator industry.

98. *Billington and Roberts, p. 252. See* **105.** *Roberts, fig. 76. Portrait from Pioneers in Cryogenics,* ASHRAE Journal *feature, 1984.*

[92] Maurice LEBLANC 1857-1923

French railway and electrical engineer. Conceived the steam injector (1904) independently of Sir Charles Parsons. Designed the first steam jet refrigerating machine (1908), which was constructed by Westinghouse (1909), (USP 1,005,851: 1911). (The liners *Queen Mary* and *Queen Elizabeth* were both fitted with steam jet refrigeration, serving air conditioning of public rooms.) Later (1910-1915), Leblanc also made a detailed study of centrifugal compression, built a working experimental machine, and obtained a broad patent on the idea (1913). This later prevented Willis Carrier [101] from securing a basic patent for the centrifugal compression of refrigerants.

18. *Grant.*

[93] Clarence BIRDSEYE **1886-1956**

American businessman and inventor who, while living in Labrador, decided that rapid freezing of foodstuffs could be a commercial proposition. He experimented with game and fish. Founded the Birdseye Seafood Co. (1923), later part of the General Foods Corp. Developed two types of freezers (1929-1930), one of which was of multi-plate design. Although earlier patented by A.H. Cooke (1925), it was Birdseye who perfected a commercial machine and went on to sell "Birds Eye" frozen food products.

17. *Thévenot, p. 438. Portrait from* 99. *p. 240.*

[94] Rev. Marcel Antoine AUDIFFREN **active 1895**

French abbot and physics teacher. Developed a hermetically sealed refrigerating system (1890s), said to have been conceived to cool the wine made by the monks. His unit, in appearance like a dumb bell, employed a stationary compressor and used SO_2 as the refrigerant (USP 551,107: 1895). Produced commercially by the French industrialist H.A. Singrun. The Audiffren- Singrun was later built in the USA by General Electric and its design improved (USP 1,555,780: 1915).

99. *Donaldson and Nagengast, pp. 222-225. Portrait from* Audiffren Drinking Water Systems, *Bulletin D-201, 1921, H.W. Johns-Manville Co.*

[95] Thomas MIDGLEY, Jr. **1889-1944**

American chemist. Discovered that tetraethyl lead was an effective anti-knock agent for fuel (1921). Turned his attention to discovering a suitable refrigerant for use in domestic refrigerators (late 1920s), since ammonia, methyl chloride, and sulphur dioxide were all poisonous. Much earlier (1893-1907), Swarts of Ghent had published his work on the production of fluorinated and chlorinated hydrocarbons. Midgley, with associates Albert Henne and Robert McNary, recognized their potential as refrigerants and successfully developed the first CFC refrigerant (R-12) under the trade name "Freon" (1930). Later, Midgley was struck down by polio (1940) and tragically strangled himself in a special support harness that he had devised (1944).

22. *and* 160. *Nagengast. Portrait of Midgley (left) from General Motors Institute, Collections of Industrial History, Flint, Michigan.*