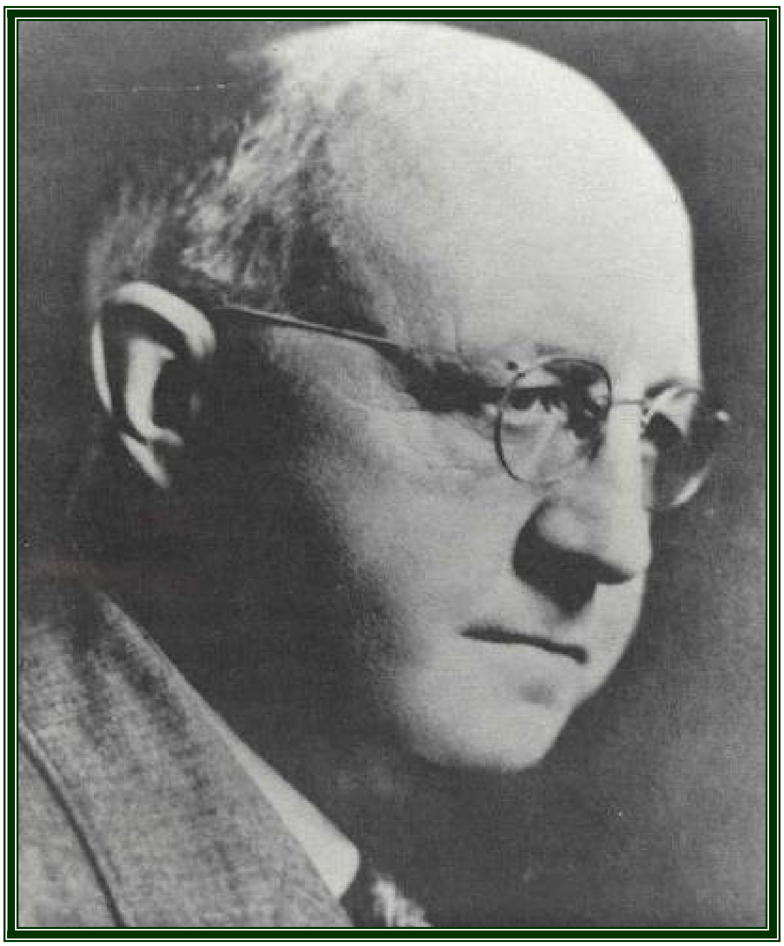
CLARENCE BIRDSEYE
1886-1956



Perfected rapid freezing of foodstuffs

[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.

(Mini-biography from "The Comfort Makers," Brian Roberts, ASHRAE, 2000)

BIRDSEYE Clarence (1886-1956)

Born in Brooklyn, New York. Died in New York.

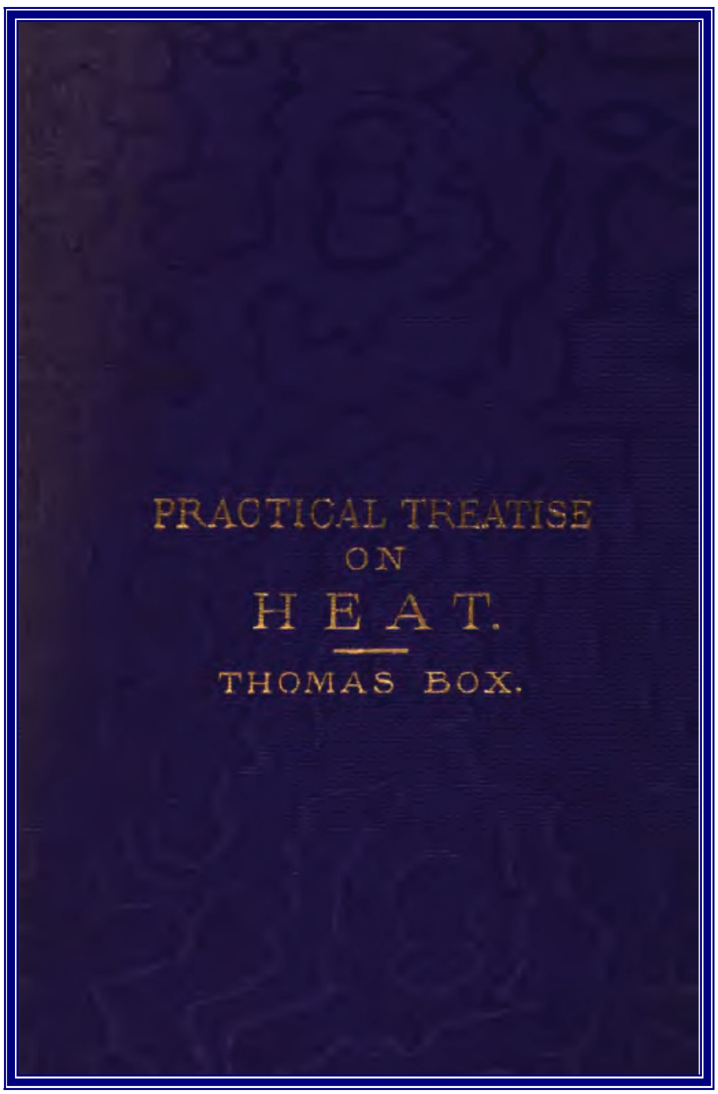
After studying at Amherst College, Birdseye went to Labrador (1912-1915) with the medical missionary Sir Wilfred Grenfell. It was there that he conceived the idea that rapid freezing of foodstuffs could be a commercial proposition, and he did experiments on various products, especially game and fish. He returned to this idea in Gloucester, Massachusetts, and in 1923 founded the "Birdseye Seafoods Co". In 1928, this company froze 400 to 500 t of fruits and vegetables. At the beginning of 1929, the company was taken over by the Postum company (which later became the General Foods Corporation).

In 1929-1930, he invented two types of freezer, one with double belt contact and the other with multiple plates. In 1930, packets of frozen produce with the trademark "Birds Eye" were on sale in several shops in Springfield, Massachusetts.

Birdseye was a fruitful inventor, with patents in many diverse fields, especially: dehydration of foodstuffs, electric lighting, paper making...

(From "History of Refrigeration," Roger Thevenot,
International Institute of Refrigeration, Paris, 1979)

THOMAS BOX
About 1821-1855



1868 (No portrait has been discovered so far)

English hydraulic engineer. Specialized in the design of mill-gearing. His interests were widespread and he wrote *Treatises: Hydraulics* (1867), *Heat as Applied to the Useful Arts* (1868), *Mill Gearing* (1869), and *Strength of Materials* (1883). Box wrote about ventilation requirements for life, removal of water vapor, removal of metabolic and other heat, and removal of odors. He discussed the design of aspirating chimneys and proposed a *Chapel System* of ventilation that employed a weight-driven fan. He attempted to calculate intermittent heat flows in buildings and compared fuel usage under continuous and steady-state heating operation. Box gave the symbol *U* to the quantity now termed *thermal transmittance*.

(Mini-biography from "The Comfort Makers," Brian Roberts, ASHRAE, 2000)

Perhaps, not surprisingly, it appears to have been unsuccessful. A more serious endeavour was Thomas Box's "chapel system" of heating and ventilation of about the same period, described by Kell as:

> "a curious system using a fan driven by a weight, impelling air through underground ducts where it encounters hot-water pipes heated by a boiler. The pipes are on rollers. This system is for a chapel, the object being to provide each pew with its due proportion of warmed air. The weight he uses is 27 cwt (1370 kg) with a 30 ft (9 m) drop, used only 3 hours during occupation and taking half an hour during the week to raise by a winch."[36]

It seems that Box was very keen on his weight-driven fan, for he describes it as being suitable for being worked by paupers in the case of workhouses, and in prisons as a task for prisoners.

(Extract from "Building Services Engineering: A Review of its Development," Neville S Billington & Brian M Roberts, 1982)

Box, who was aware of Péclet's work, made some attempt to calculate heat flows during intermittent operation.[12]

In his example (a school) the steady heat loss through the walls and windows was calculated to be 8983 Btu/h, the ventilation loss 11938 Btu/h, giving a total of 20921 Btu/h. The metabolic gain from 100 children was set at 19100 Btu/h, and thus almost enough to maintain the steady temperature rise of 30°F. The quantity of heat needed to raise the wall temperature from an initial 30°F to its steady mean temperature of 41°F is 367420 Btu. Box calculates that each square foot of wall receives from the stove pipe at 800°F an average of 73.1 Btu/ft^{2}h during the heating-up period by radiation and convection, and taking account of the conduction losses, a total of 92815 Btu/h is stored in the walls. Hence 367420/92815 = 4 h, nearly, is required to heat the school from cold. The cooling time is 367420/4492 = 82 h (4492 Btu/h being the *average* loss during cooling).

Box observes that:

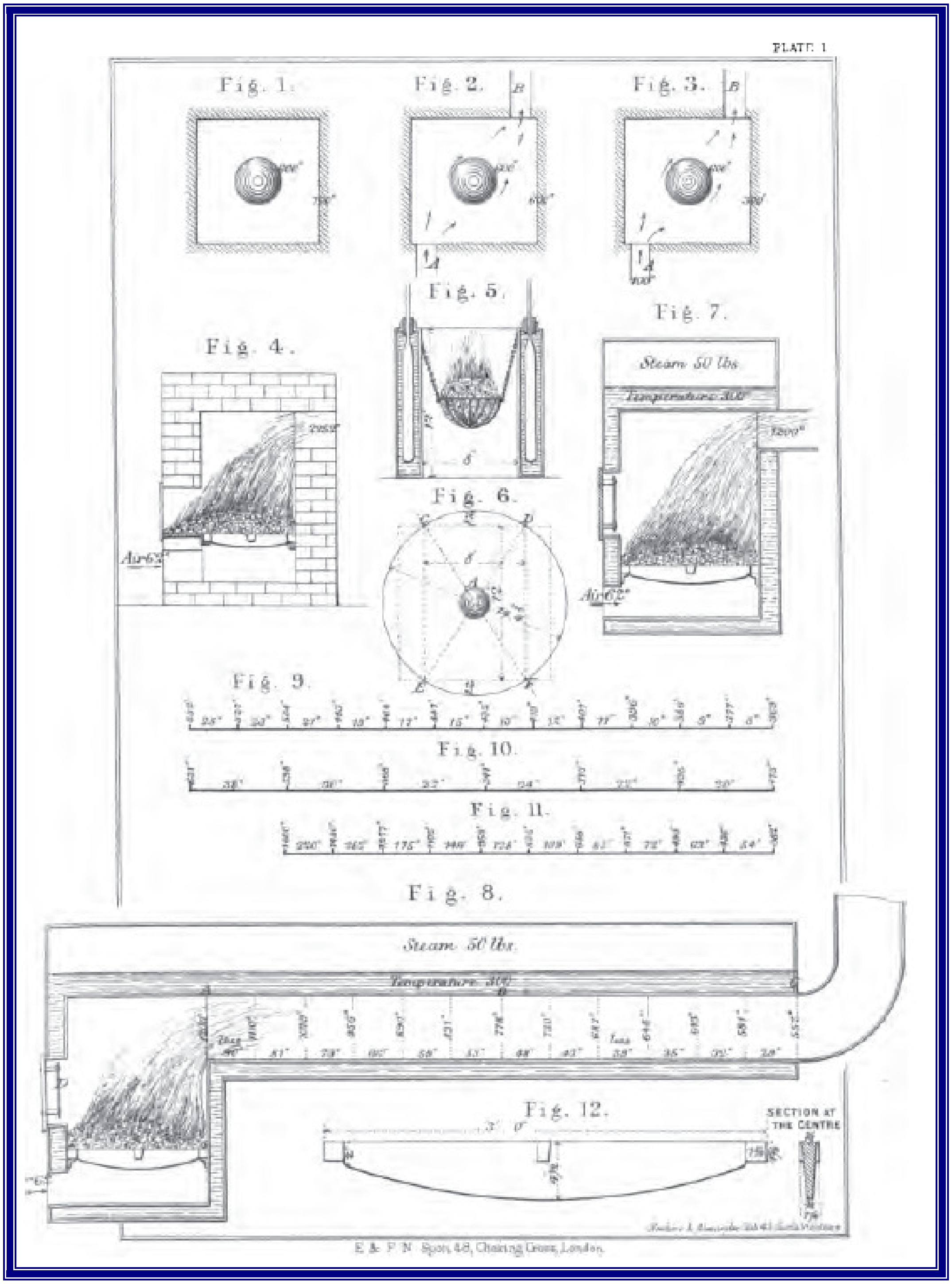
> "This agrees with our experience that in a crowded room artificial heat is not necessary, except to warm the walls etc. beforehand, and in most cases the proportions of the heating apparatus must be fixed with special reference to the preliminary heating of the building, which we have done in this case."

He goes on to point out that because of the much smaller radiant component from a low temperature source, the heat entering the walls during preheating is less, and the warming-up period correspondingly longer.

In his calculations, he assumed that surface resistance was the only controlling factor, and that the physical properties of the wall (other than the specific heat) had no influence on periodic or transient heat flow into the wall. Yet although his assumptions are suspect, he was able to show that for at least one building (Église St. Roch), theory and experiment agreed in suggesting a preheating period of 8 days. His calculations are noteworthy, too, in that he took account of the thermal capacity of the heating system itself.

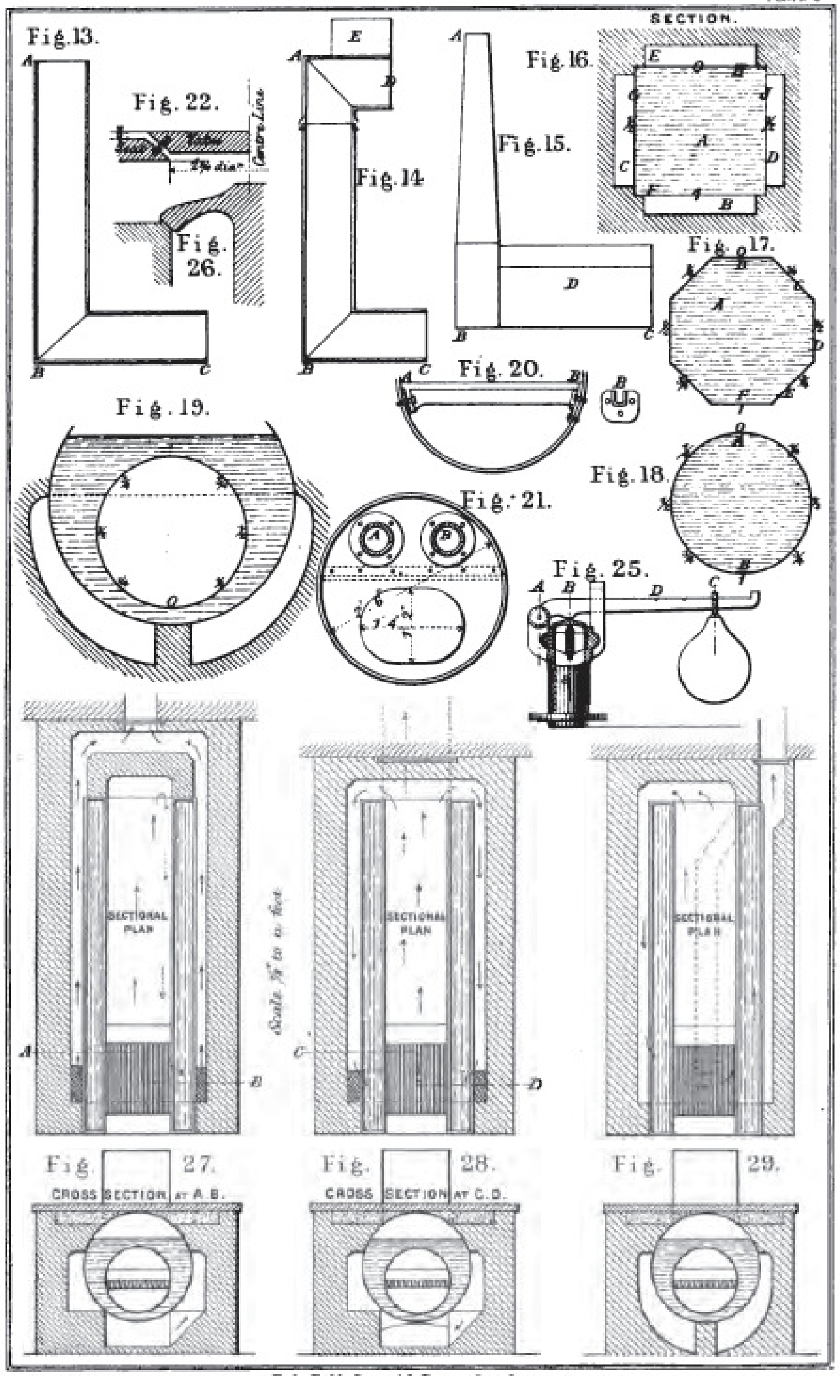
Box goes on to demonstrate for buildings which are used infrequently, continuous heating may use only a little more fuel than intermittent heating. As an example, he takes a church which is used one day a week. With intermittent operation, the weekly fuel use would be 678 lb. On the other hand, continuous firing throughout the week to maintain the steady temperature would consume 940 lb. Box thought that this could be reduced in practice, perhaps to 780 lb, owing to the greater efficiency of regular and slow firing, and "the church would always be ready for week-night or occasional services, and the convenience of this mode of heating are so great that it should become general".

(Extract from "Building Services Engineering: A Review of its Development," Neville S Billington & Brian M Roberts, 1982, Chapter 13 "Heating and Ventilating Design")



Combustion and heat transfer

PLATE 2

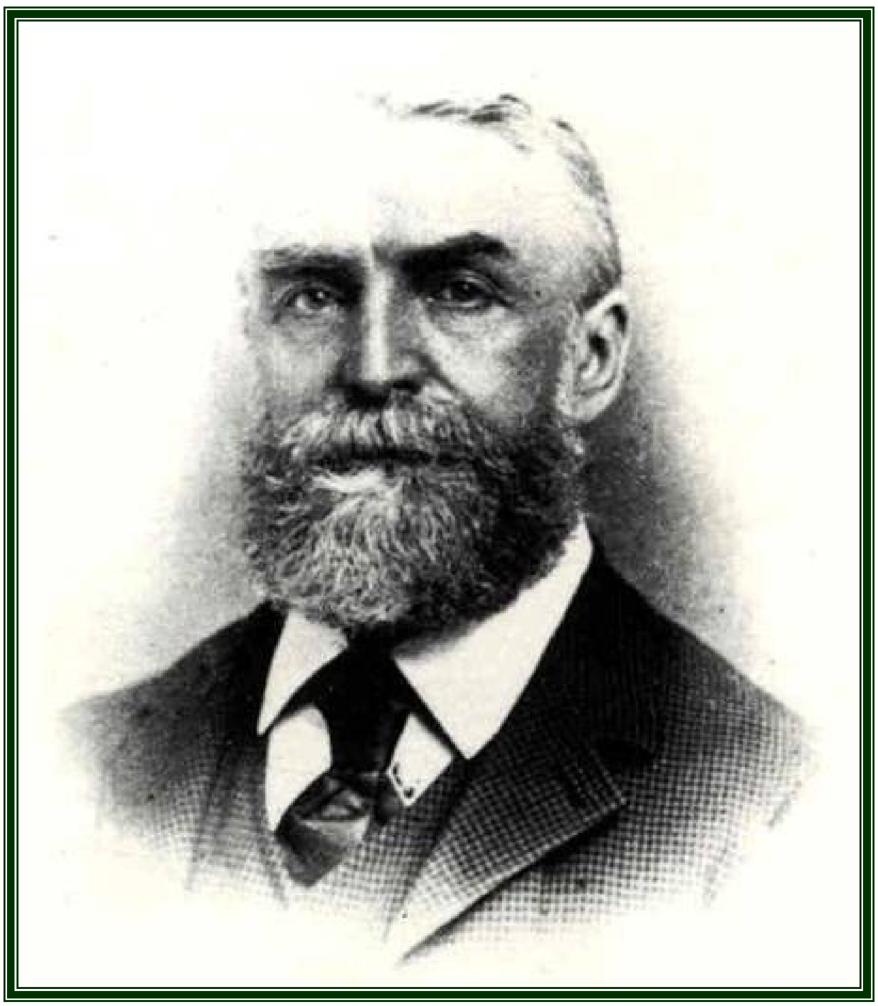


E & F. N. Spon, 48, Charing Cross, London

Effects of boiler shape and length upon efficiency

DAVID BOYLE
1837-1891



Father of ammonia compression refrigeration in the USA

[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."

(Mini-biography from "The Comfort Makers," Brian Roberts, ASHRAE, 2000)

BOYLE David (1837-1891)

Born in Johnston, Scotland, he emigrated to Mobile, Alabama, United States in 1859. Settling in California from 1869 to 1872, he designed an ammonia refrigerating compressor (patented in 1872). At the end of 1872 he built the first ammonia compressor (3000 kcal/h) in New Orleans. This machine was transferred to Jefferson, Texas, where it was used to make ice at the end of 1873; it was destroyed in a fire in the following year. Four compressors of his design were made in 1875-1876 in Illinois (notably by Crane, Chicago). In 1877, a Boyle machine of 60 000 kcal/h was in use in a Chicago brewery.

In 1878, he founded the "Boyle Ice Machine Co." in Chicago; this company produced about 200 machines up to 1884. He was a genial mechanic.

(From "A History of Refrigeration," Roger Thevenot, International Institute of Refrigeration, Paris, 1979)

David Boyle (Figure 8-31) is probably the best known of the early U.S. refrigeration entrepreneurs. He is often credited, along with Carl Linde, as "the inventor of the ammonia compressor"; however, neither Boyle nor Linde was the first to propose use of ammonia or construct compressors for its use.[61] David Boyle began his refrigeration work in 1865 at Demopolis, Alabama. Boyle recounted his experience, saying:

> I was keeping store and making and selling ice cream and lemonaid. A brigade of Federal troops were stationed there, and it were a bonanza to me. I had a shipment of ice from New Orleans delayed in transit three or four days, and when it reached Demopolis its actual cost was about seventy-five cents per pound. The weather was hot, and it did not take long to get rid of it. I used it to cool lemonaid, 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.[62]

Hearing of an ice-making machine backed by parties in New Orleans, he went there only to conclude that the machine (which was probably a Carré apparatus) was too expensive for commercial use. During the next several years, he searched for information on availability of refrigerating machines, finally hearing of a Van der Weyde machine being set up in New Orleans (probably by

Holden). Boyle sold most of his assets and purchased a machine, which was a total failure. In 1869 he took his family to San Francisco and spent a year going through the library of the Mechanics' Institute there. During that time, he learned of Harrison's machine and purchased one from Seibe in London but had to sue to recover his money since the machine was never shipped. Frustrated at his attempts to find a satisfactory machine made by others, he moved back to New Orleans, constructed a one-ton machine, and then went to Jefferson, Texas (probably to the Louisiana Ice Manufacturing Co.), with the half-done machine and only $175 to his name. Upon completing the machine, Boyle found that "it leaked like a sieve" and he had to completely remake it.

> My brother and I sat down in the wood pile to cool off. We were worn out with the worry and disappointment, and the machine was a wreck. All was gone, and I was at the end of my tether. I had success within reach, but lacked the means to secure it. My wife joined us, and, after listening to any complaints, made a most astounding statement. She could furnish me with money—money that she (cramped financially as we were) had managed to lay by for darker days. The amount was not large, but it was enough to start me on the final success.[63]

It was not until 1874 that the system was satisfactory in producing ice. Receiving offers of financial backing, Boyle moved to Quincy and then Chicago, Illinois. The Boyle Ice Machine Co. was organized about 1877, after Boyle contracted with Crane Brothers in Chicago to manufacture his ammonia vapor-compression systems. His earlier attempts had been ice-making plants of the "plate" type, but Boyle expanded his horizons to general refrigerating purposes with the sale of a refrigerating plant to the Bemis & McAvoy Brewing Co. in Chicago in 1877.[64] Boyle's systems were manufactured by his and successor companies until 1905[65] (Figures 8-32 through 8-34).

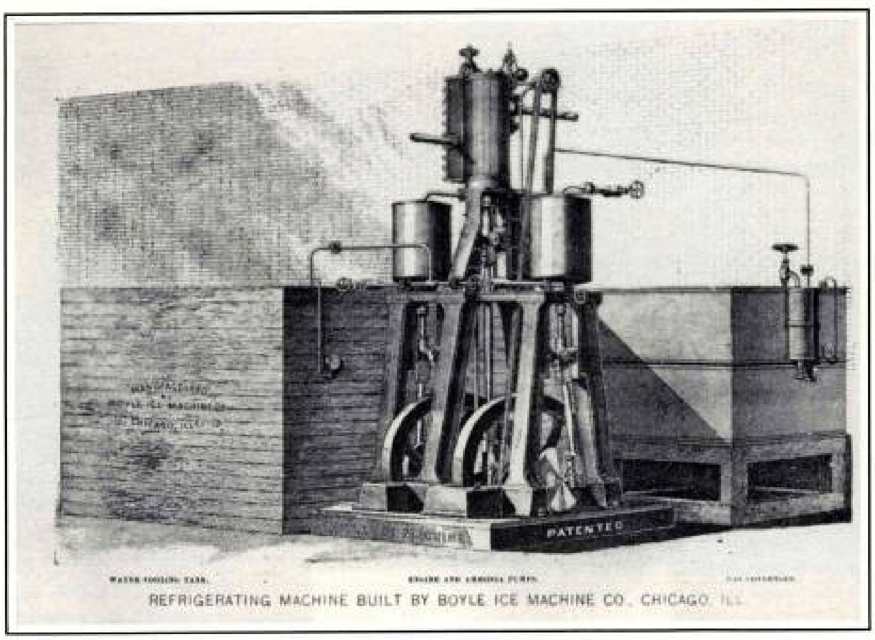


Figure 8-33 *Refrigeration machine for breweries, etc., as manufactured by the Boyle Ice Machine Co. in the 1880s (from catalog,* Boyle Ice Machine Co. Patentees and Manufacturers of Refrigerating Apparatus and Ice Machines, *Chicago, c. 1881).*

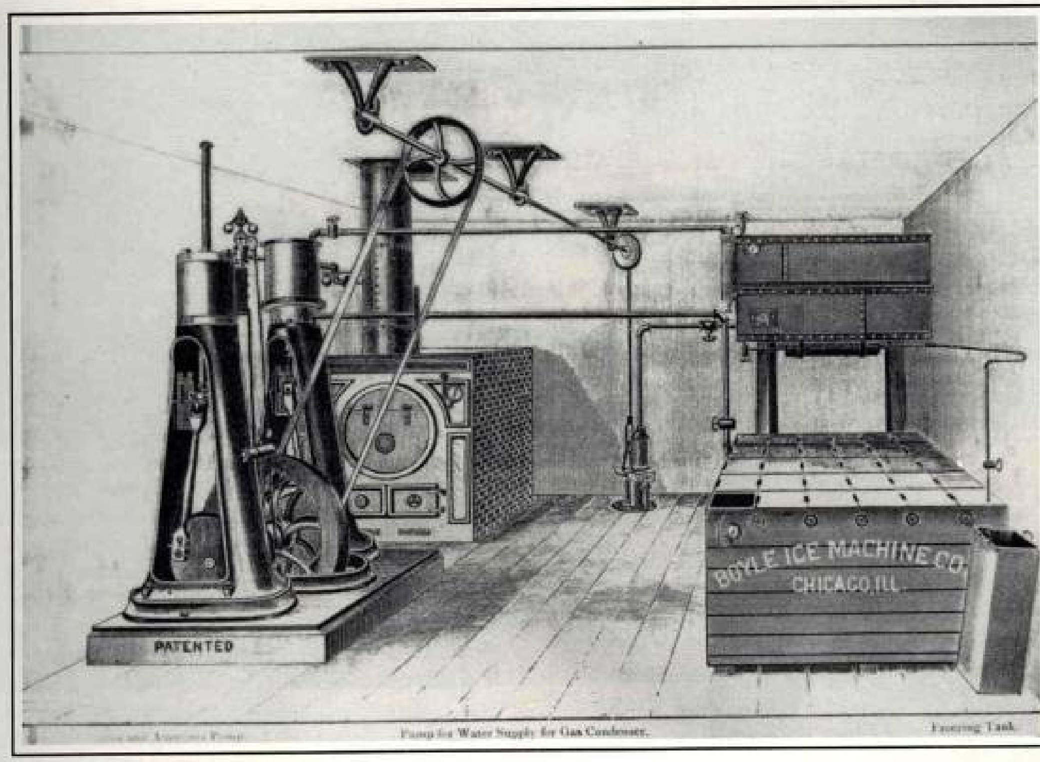


Figure 8-34 *Ice-making plant by Boyle Ice Machine Co., 1879. It appears that Boyle had abandoned his "plate ice" plants of earlier years in favor of the "can ice" type of system. Early ice plants did not always perform up to expectations. "When the machine started, our troubles began. It made ice, all right, but such ice! Not being lasting, it could not be utilized for tomb stones. Being made from hard limestone water, over-ripe hen fruit was its only competitor in smell and taste" (W.J. Rushton, 1916, "Early days of the manufacture of ice,"* Ice and Refrigeration, *November, p. 152) (from catalog,* The Boyle Ice Machine and Refrigerating Apparatus as manufactured by the Boyle Ice Machine Co., *Chicago, 1879).*

(Text and pictures from "Heat & Cold: Mastering the Great Indoors," Barry Donaldson & Bernard Nagengast, ASHRAE, 1994)

David Boyle, a Scotsman who went to America, took out USP 128448 in 1872 for a refrigerating machine. In 1873, he built a 1-tr (3.5 kW) ammonia plant which he installed in Jefferson, Texas, and produced the first ice in October of that year (Fig. 5.7). In the spring of 1874, after several improvements, Boyle was able to make clear ice, but his machine was destroyed by fire in the summer. He went to Chicago, where he formed a partnership with W.B. Bushnell to build ammonia compressors. In 1875 Boyle and Bushnell moved to Chicago and made arrangements for Boyle compressors to be built by the Crane Company. One of these machines was displayed at the 1876 Centennial Exposition in Philadelphia. Woolrich[39][40] considers that "the verified dates of Boyle's accomplishments indicate that David Boyle deserves much of the recognition that too often is accorded

Professor Linde of Germany". While others might disagree, certainly Boyle has a strong claim to be considered the father of ammonia compression refrigeration in America. A Boyle plant in a Chicago brewery had a capacity of 20 tr (70 kW) (1877); it consisted of a twin-cylinder single-acting vertical compressor, the cylinders being 254 mm bore and 457 mm stoke. 30-tr (105kW) machines were considered large up to about 1890. A complete ice-making plant of this size could be purchased for $40000; a 1-tr (3.5 kW) plant cost $4000. In 1891, the Frick Co. installed a 125-tr (440 kW) plant for the East St. Louis Ice and Cold Storage Co. – "the largest sum ever invested in ice-making and refrigerating plant up to that time."

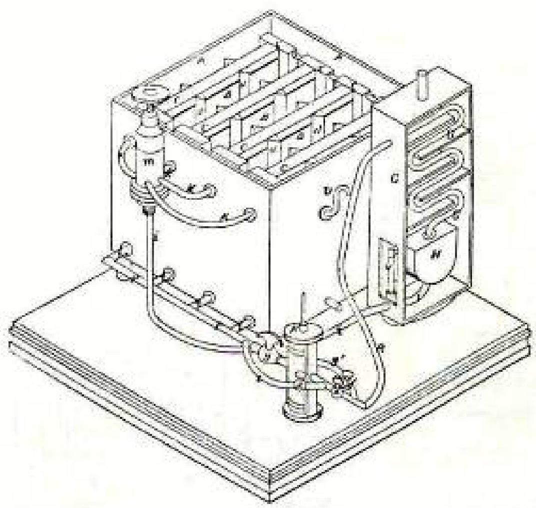


Fig. 5.7. Patent drawing of refrigerating machine developed by David Boyle in 1872 during his stay in California.

*(From "Building Services Engineering,"
Neville S Billington & Brian M Roberts, 1982)*

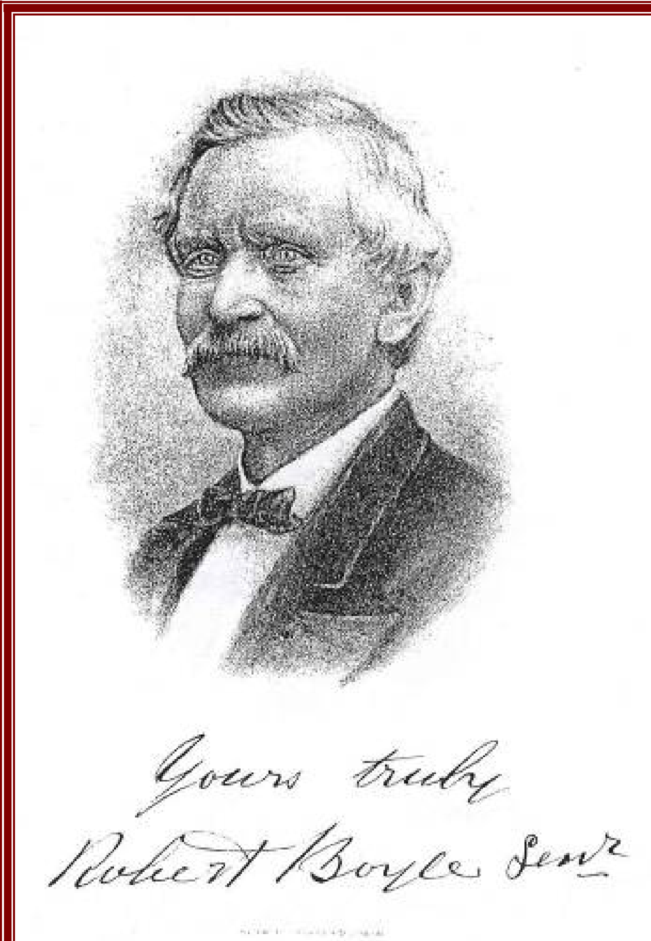
ROBERT BOYLE Jr
Born c.1850

Passionate advocate of natural ventilation

[69] Robert BOYLE, Jr. **active 1898**

Ventilating engineer. Not to be confused with his illustrious namesake [142]. Carried on the engineering work of his father Robert Boyle, Sr. (1821-1878). Boyle Jr. was a passionate advocate of natural ventilation and strongly opposed to mechanical methods. Robert Boyle & Son published *Natural & Artificial Methods of Ventilation* (1899), which refers to the work of many pioneer ventilators and hygienists, including Billings [73] and Galton [171]. Boyle refers to "the evils of forced down-draught ventilation and of hot-air heating (he believed heating and ventilation should be separate) and the dangers of open-window ventilation in cold weather." The company also published *Ventilation of Public Buildings* (1923) with many detailed examples.

(Mini-biography from "The Comfort Makers," Brian Roberts, ASHRAE, 2000)

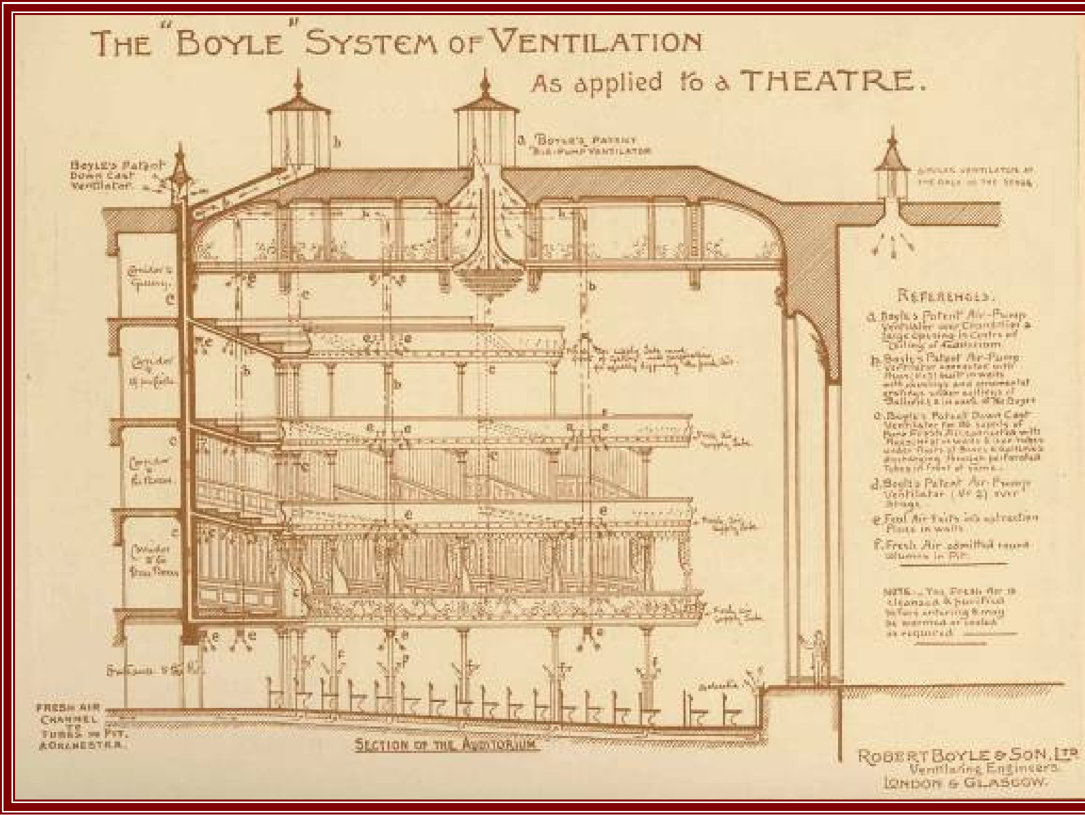


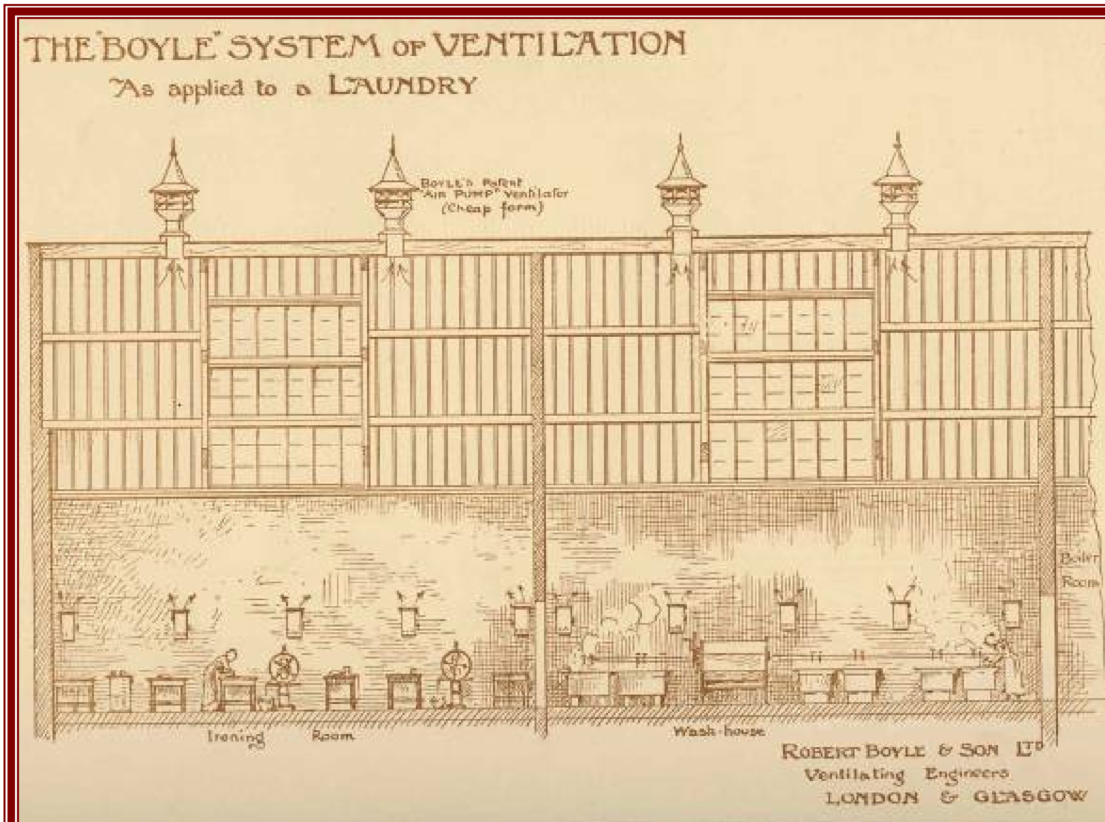
Robert Boyle Sr, 1821-1878

Robert Boyle was born in Hamilton, North Britain (Scotland) in 1821. His first business venture appears to have been around the age of 20, when he opened a bakery in Glasgow to make "unadulterated" bread. He developed a strong interest in religion, missionary work (he was a friend of Dr Livingstone) and scientific studies and lectured extensively on all these topics. In 1854 he was jointly responsible for the establishment of an Industrial Museum in Glasgow. He invented many things, including a device for preventing theft from letter boxes, a "safe" explosive and a substitute for Indian ink, but none of these was taken up.

His son, also named Robert Boyle, seems to have been born around 1850. At some point in time they jointly developed "The Air Pump Ventilator." The first reference to ventilation by Boyle in "The Builder" magazine is in 1880 and to the Company of Robert Boyle & Son in 1881. However, the Father died in 1878 and commercial exploitation of the "Ventilator" appears to have been almost entirely due to the efforts of Robert Boyle Junior. The ventilator won a prize at the London International Medical & Sanitary Exhibition of 1881. Over the next few years Boyle Junior elicited testimonials from various Royal Commissions, Select Committees of the Houses of Parliament and many eminent persons, including Lord Kelvin, Captain Douglas Galton and Sir Gilbert Scott.

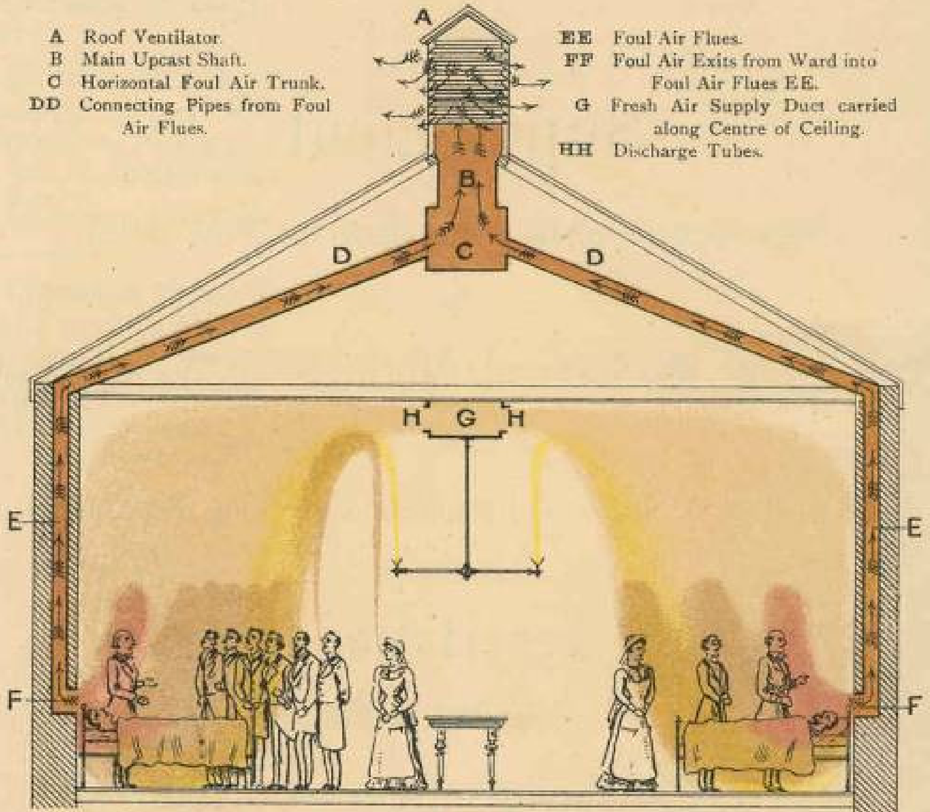
Robert Boyle Junior produced numerous books on the merits of natural ventilation and was a fierce opponent of all forms of mechanical ventilation. The examples in the following sections of this electronic book are from the Company catalogue of about 1899. The last publication so far discovered is "The Ventilation of Public Buildings" of 1923 which re-uses the illustrations from the 1899 catalogue and updates some of the text.


THE "BOYLE" SYSTEM OF VENTILATION
As applied to a THEATRE.
a. Boyle's Patent "Air-Pump" Ventilator
Boyle's Patent Down Cast Ventilator
References.
f. Fresh Air admitted round columns in Pit.
Fresh Air Channel
Section of the Auditorium
Robert Boyle & Son, Ltd.
Ventilating Engineers.
London & Glasgow.


THE "BOYLE" SYSTEM OF VENTILATION
As applied to a LAUNDRY
Boyle's Patent "Air Pump" Ventilator (Cheap form)
Boiler Room
Ironing Room
Wash-house
Robert Boyle & Son Ltd
Ventilating Engineers
London & Glasgow

"MECHANICAL VENTILATION ON THE DOWNDRAUGHT PRINCIPLE, BY IMPULSION, OR THE PLENUM SYSTEM, APPLIED TO A HOSPITAL WARD.

A Roof Ventilator.
B Main Upcast Shaft.
C Horizontal Foul Air Trunk.
DD Connecting Pipes from Foul Air Flues.
EE Foul Air Flues.
FF Foul Air Exits from Ward into Foul Air Flues EE.
G Fresh Air Supply Duct carried along Centre of Ceiling.
HH Discharge Tubes.



BLUE—Fresh air supply.
YELLOW—Products of combustion.
BROWN—Products of respiration.
RED—Products of respiration from patient.

"Downward ventilation returns the vitiated respired air to be rebreathed, also the poisonous products of combustion. Only an unendurable and highly dangerous downdraught could prevent the hot respired air ascending to a height sufficient to ensure its rebreathal. With this system the patients in a hospital inhale foul air only. If the foul air exits are placed either above, below, or at the side of the bed, the results are the same, also when the fresh air is forced in at the upper parts of the side or end walls, or is projected up on to the ceiling."

Since Mr. Robert Boyle made London his headquarters, his business has developed to an extent which clearly indicates the real progress made in popularizing sanitary appliances. The offices in Mansion House Buildings, where the London business had been carried on for nearly ten years, afforded insufficient accommodation for the rapidly increasing connections, and the firm was consequently induced to remove to the extensive and handsome premises on Holborn Viaduct. But the requirements quickly outgrew the capacity of even that spacious establishment, and it became necessary to take in equally extensive premises adjoining. At the same time the firm established London works to relieve the increased pressure on the Glasgow manufactory, and suitable buildings were found and fitted for the purpose in the neighbourhood

(Text extract from "Robert Boyle: Inventor and Sanatarian," Lawrence Saunders; notes relating to Boyle Jr: CIBSE Heritage Group Collection)

of Euston Road. Still the business grew apace, orders multiplied, from every part of the world the mails brought fresh commissions, the owners of mansions, churches, factories, and workshops anxiously sought the firm to rescue them from the miseries of bad ventilation, and thus the resources of the works were in time insufficient to meet the growing strain, and a more spacious factory has now been provided, the Glasgow works being also enlarged four times its former capacity.

Such an extraordinary development demonstrates beyond all question a steady improvement in sanitary matters, and at the same time reflects great credit on Mr. Robert Boyle's administration. The welfare of his business means the welfare of the public, and its practical development means the overthrow of that subtle destroyer—vitiated and poisoned air. For this reason, many distinguished persons in this and other countries, anxious to encourage the movement, have honoured Mr. Boyle with special marks of approval. Quite recently, we understand, H.R.H. the Crown Prince of Sweden has expressed great interest in the inventions; and during his visit to this country, the Prince of Montenegro also evinced his gratification at their ingenuity, having made an examination of them with a view to their adoption in his own country.

It is satisfactory to learn that Mr. Robert Boyle has no intention of resting content with this most encouraging success, but proposes to avail himself of his professional influence and admirably-organized business to extend his sphere of sanitary work. He is making arrangements to deal with the more general and complete sanitation of dwellings, and drainage of towns on improved lines. The question of regulating the temperature of air in buildings is one of great importance to health, and, at the urgent request of architects, he is now engaged in the preparation of a scheme for efficiently combining heating and ventilation in a scientific and practical form, which will insure greater economy and, by the application of heat to the proper parts of the building, effectually prevent the cold draughts which are experienced in most public edifices. The chilling currents which have a deadly effect on delicate people are chiefly caused by the defective methods of heating at present in use. Mr. Boyle's plan will save architects the trouble and inconvenience of calling in a separate firm to do the heating, and better results must necessarily follow from the harmony and comprehensiveness of the arrangements. We may safely predict in this department a most extensive and profitable business. Ventilating and sanitary engineering is now only in its infancy, but it is undoubtedly destined to become one of the most important professions.

Mr. Boyle has recently invented an ingenious system of ventilation adapted to the peculiar requirements of prisons. This system is called the "silent" system of ventilation for prisons, being devised to meet the necessity of isolating the cells from each other, and yet providing a continuous change of air. The advantage of this system is that every cell is separately and equally ventilated, perfect isolation being at the same time secured; for no sound can possibly be conveyed from one cell into another through the ventilating openings, though as many as from ten to twenty cells are ventilated with the one pipe, and three or four of these lead into one upcast shaft, there also being no valves whatever used.

Notwithstanding the complete success of the Air Pump Ventilator, the innate restlessness of inventive genius has led Mr. Boyle to discover an improvement, which he has recently patented, and which is said to surpass the present ventilator both in efficiency and simplicity. The improved form of ventilator will, we understand, entirely supersede that hitherto supplied, as it is not considered desirable to submit to the public apparatus of this kind, however efficient, while better results are attainable. In the course of time it is very probable that even the new and improved form will in its turn be superseded, for Mr. Boyle refuses to sit down with self-satisfied triumph.