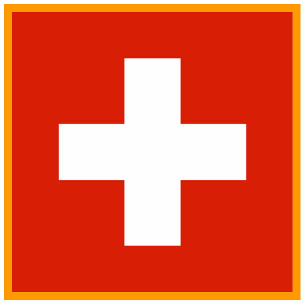
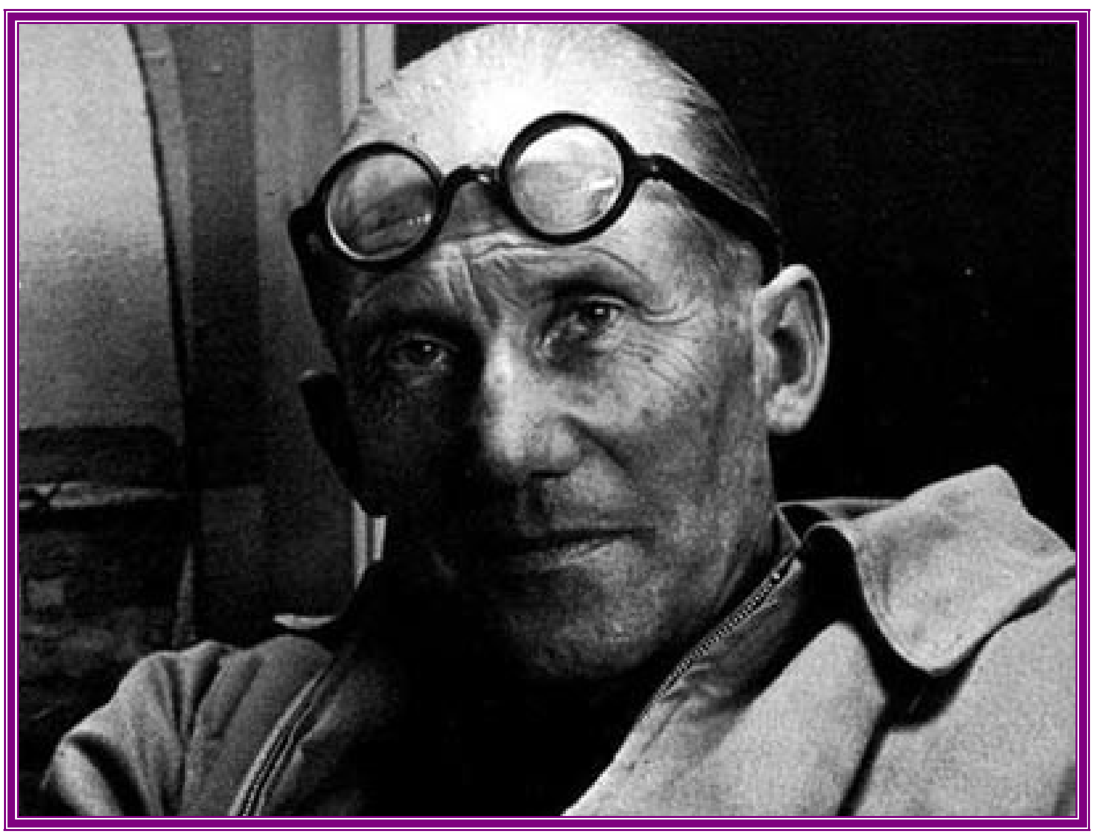


LE CORBUSIER
(CHARLES EDOUARD JEANNERET)
1887-1965

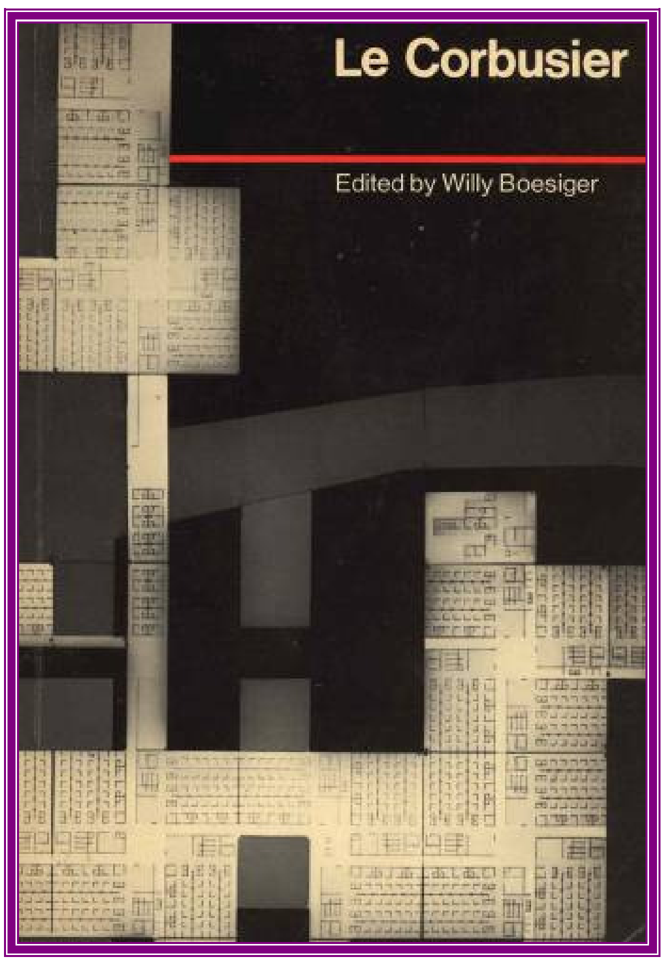


Described Houses as "Machines for Living in"

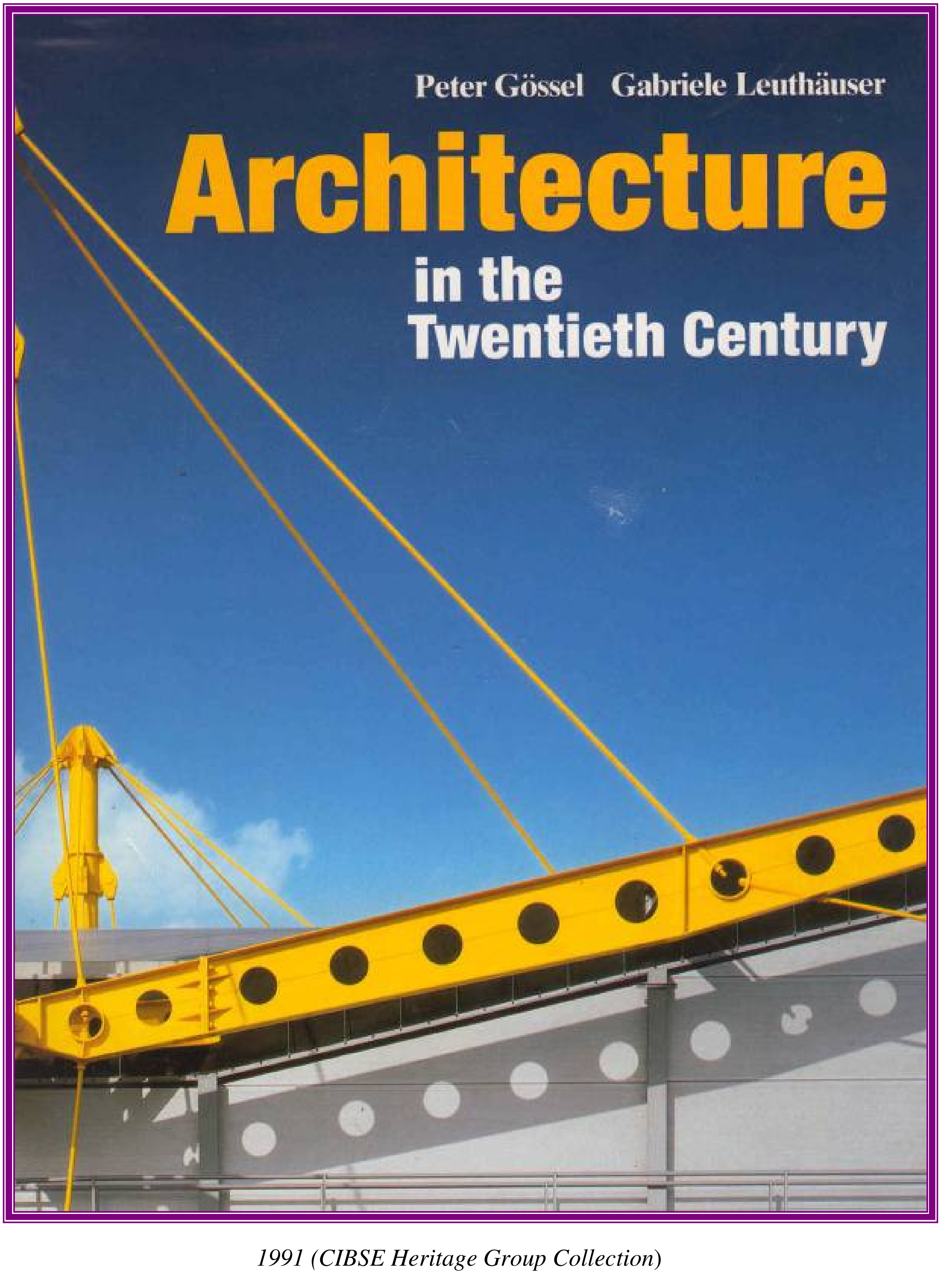
[202] LE CORBUSIER **1887-1965**

Charles Edouard Jeanneret. Swiss born, French architect, town planner, and artist. He designed and spoke of houses as "machines for living in." He sought unorthodox solutions to environmental control involving building orientation, structure, daylighting, and passive solar control; many of his buildings are not considered to be entirely successful in this respect. Le Corbusier claimed to have invented the external sunshade (*brise soleil*), and he developed the neutralizing wall (*mur neutralisant*), to offset the effects of outside conditions on the interior of a room. This involved circulating ventilating air, enclosed between twin walls or membranes, where "is blown scorching hot air, if in Moscow, iced air if in Dakar." Le Corbusier's most famous building is the Unité d'Habitation at Marseilles (1952), a massive housing project of 350 flats in eight double-storys, of which Reyner Banham wrote, "His heroic and sculptured air stacks on the roof...must be acknowledged as historically important if only as the first explicit sign for almost twenty years in his work that mechanical services are an expressible form of a building." Later, in his design for the Supreme Court in Chandigarh in the Punjab (1956), he provided an enormous canopy running the full length of the facade, to protect from wind and rain, combined with vertical wall screens providing natural ventilation of the courtrooms.

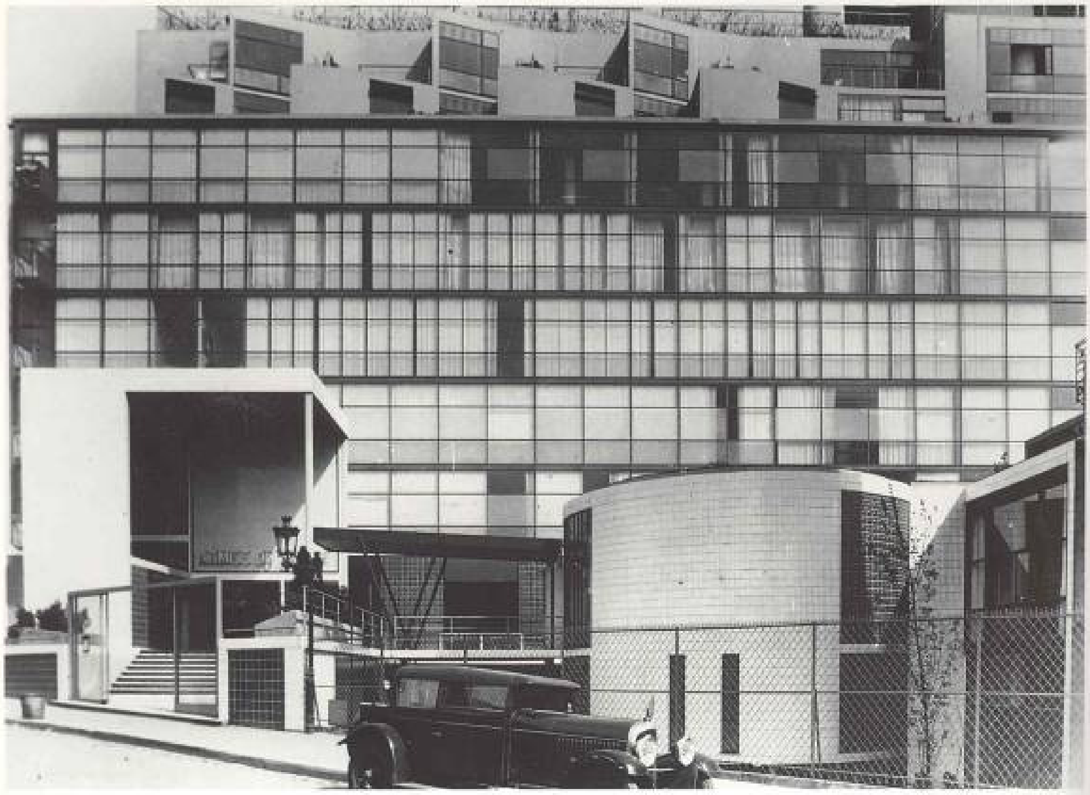
(*Mini-biography from "The Comfort Makers," Brian Roberts, ASHRAE, 2000)*



1972 (CIBSE Heritage Group Collection)

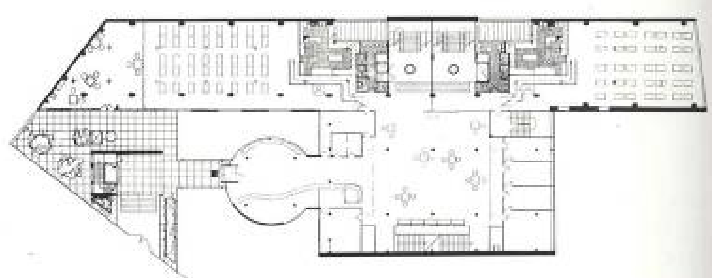


1991 (CIBSE Heritage Group Collection)



Le Corbusier and Pierre Jeanneret
Salvation Army Shelter in Paris, 1929–1933
South front
Fondation Le Corbusier, Paris
Individual stereometric bodies are placed before the long main building. A bridge leads from the open entrance cube to a cylindrical reception building, a sort of outsize concierge's booth with a lounge behind. Dormitories and common rooms initially for 900 and later for up to 1500 homeless lie behind the hermetically-sealed glass façade. A ventilation system was installed which proved wholly unsatisfactory, leaving the rooms to reach hot-house temperatures in summer.

Plan of the ground floor



The Salvation Army Shelter in Paris (from "Gossel & Leuthauser")

Air Conditioning and the International Style

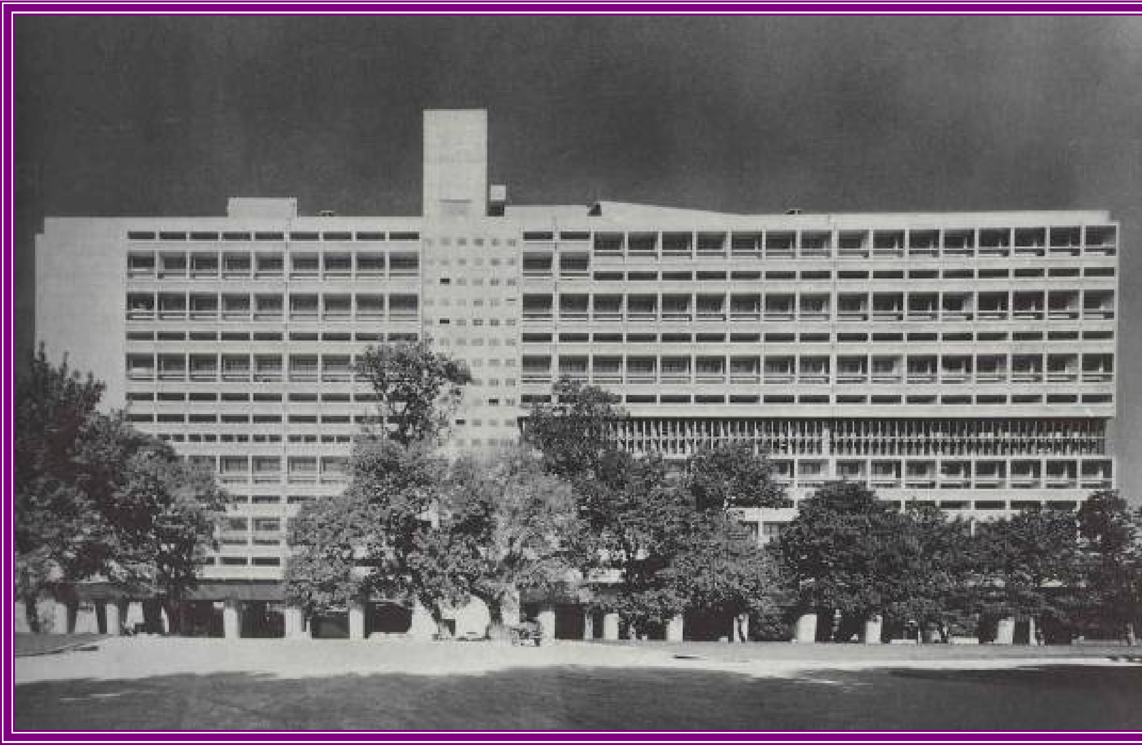
Although the office workers in the Milam Building might not have received the full benefits of air conditioning, they were considerably better off than the people in the Salvation Army Hostel designed by Le Corbusier and Jeanneret at about the same time. Le Corbusier had been collaborating with Gustave Lyon, who was developing air conditioning in Europe independent of the "experiments" in the U.S.[17] Lyon had completed the air conditioning for a 3,000-seat auditorium with his system called *l'air ponctuel,* which loosely translates as "regulated air."

Le Corbusier claimed to have invented a technique for canceling the cooling effects of the large glazed surfaces characteristic of the new architecture, subsequently called the "International Style." Le Corbusier's idea was to circulate air at a constant temperature of 18°C (64.4°F) between the panes of double glazed windows. He called the technique *le mur neutralisant* (neutralizing wall) and coupled it with Lyon's regulated air for a design of the Centrosoyus Palace in Moscow. The combination was called "conditioned air," which Lyon thought was "an idea of genius." The Russians obviously did not agree. They ignored the proposal and simply placed radiators behind the large opening windows.

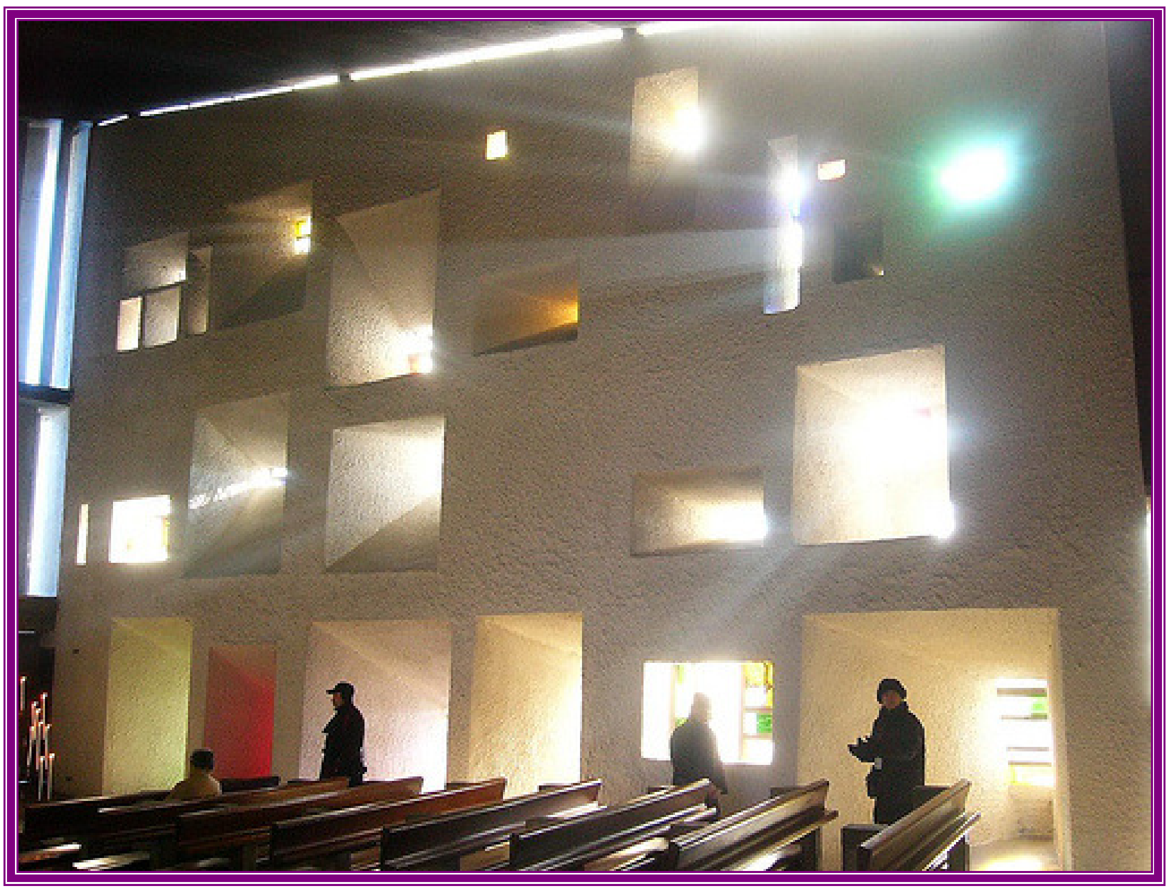
The opportunity to use the concept came with the *Cite de Refuge*, a Salvation Army shelter in Paris. Le Corbusier conceived the idea to hermetically seal the south face of the building from floor to ceiling and wall to wall with 1,000 m² (11,000 ft²) of glass. His view was that the glass could be hermetically sealed as "warm and cleaned air circulated abundantly inside." He was giving the "poor souls" "the free and ineffable joy of full light and the sun."

The building opened late and over budget on Dec. 7, 1933, in one of the coldest periods in memory. The temperature inside on that cold, sunny day was perfect. Unfortunately, the same could not be said during summer. Although the designers had intended to provide their version of air conditioning, the budget did not provide for the cooling plant, and the neutralizing wall had been omitted.[18] Sealed windows did not comply with regulations and ultimately, much to Le Corbusier's displeasure, the windows were changed to opening. It appears that this experience changed Le Corbusier's ideas about glazing. His subsequent buildings featured shading (which was eventually fitted to the hostel), and he is credited with inventing the *brise-soleil*.

(From "The Evolution of Modern Office Buildings and Air Conditioning," David Arnold, ASHRAE, 1999)



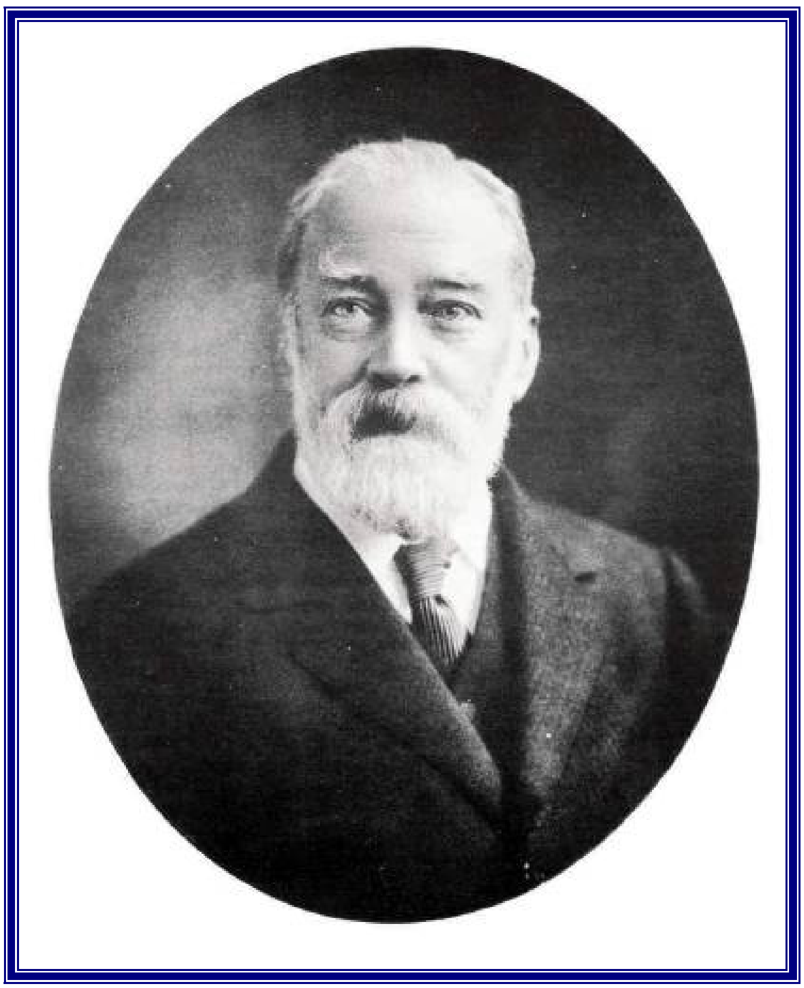
Unite d'Habitation, Marseilles, 1952 with its Ventilation "Sculptured Air Stacks"
(From "Gossel & Leuthauser")



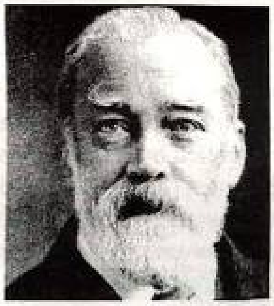
Notre-Dame-du-Hart, Ronchamp, France, 1955
Where natural lighting is used to dramatic effect
(from "Gossel & Leuthauser")

The High Court, Chandigarh, India, 1956, provided with Solar Screens and Natural Ventilation

HENRY LEA
1839-1912



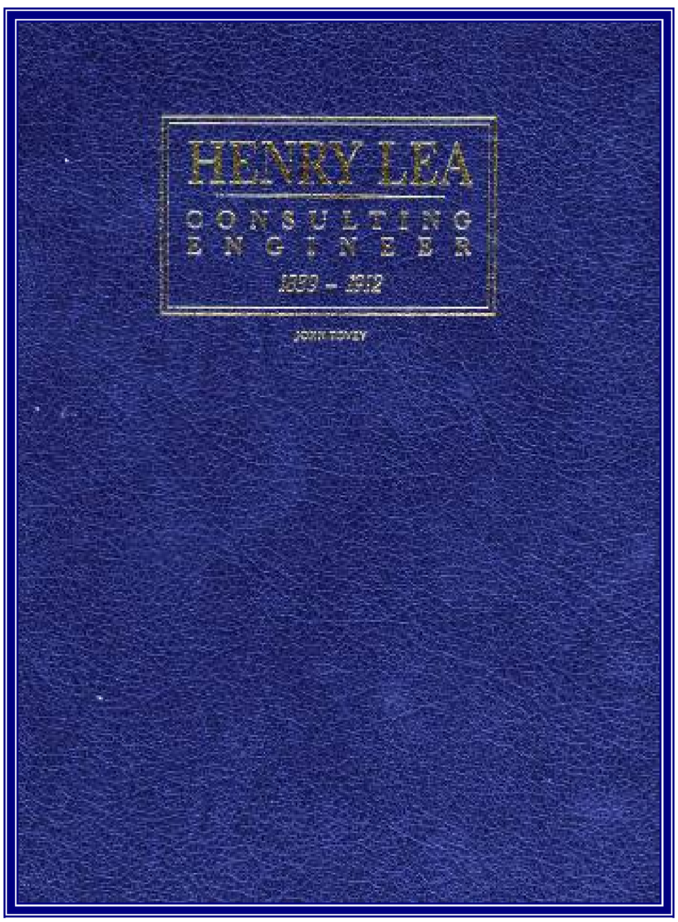
The first Consulting Mechanical Engineer



[208] Henry LEA **1839-1912**

English consulting engineer whose expertise ranged widely over the civil, mechanical, and electrical disciplines. Opened an office in Birmingham (1862) and issued a circular letter, "Henry Lea begs leave respectfully to announce that by the advice of many gentlemen well acquainted with his qualifications and experience, he has commenced practice as a Consulting Mechanical Engineer." He may have been the first in the field to describe himself thus, though Phipson [203] was also active around this time. Lea was a pioneer of electric lighting but also introduced new methods of artificial ventilation based on the plenum system of Key [98]. Used it with notable success at Birmingham General Hospital (1893). Then at the Royal Victoria Hospital, Belfast (1903), where, "A sprinkler system, used to moisten the filters through which the fresh air passed, was regulated on the basis of regular readings of wet- and dry-bulb temperatures. This conscious control of humidity gives the Royal Victoria Hospital a place among pioneering air conditioning systems."

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



(CIBSE Heritage Group Collection)

Offices, 33, Waterloo Street,
Birmingham.

Henry Lea begs leave respectfully to announce that, by the advice of many Gentlemen well acquainted with his qualifications and experience, he has commenced practice as Consulting Mechanical Engineer.

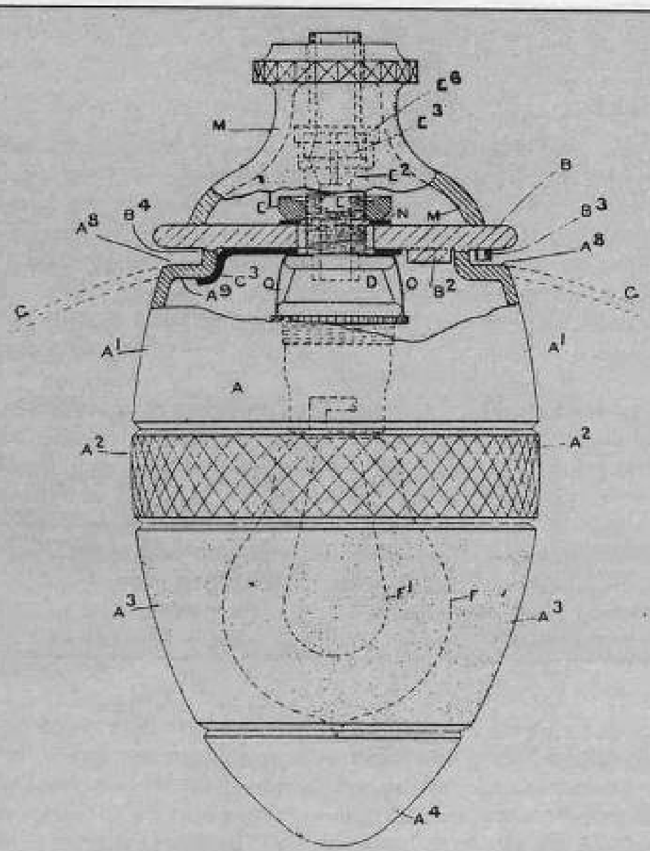
He takes this opportunity to inform his friends and others requiring the services of one of his profession, that he is prepared to undertake to make Drawings and Specifications for Steam Engines, Millwork, general Machinery, Roofing, Bridges, Girders, and Iron Constructions of all descriptions, also the practical Inspection of Contract work, the Valuation of Machinery, and the preparation of Bills of Quantities and of Estimates for Iron work.

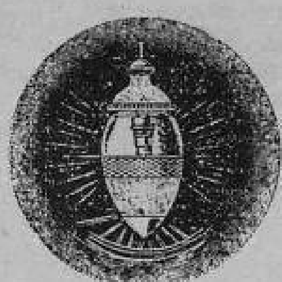
H. L. knowing from experience that very many Steam Engines in Birmingham and the neighbourhood are consuming excessive quantities of Coal, is ready to undertake the examination of Engines by means of the "Indicator," to superintend alterations and repairs, and to furnish designs for Boilers and Boiler settings with a view to ensure the prevention of smoke and a greater economy in the expenditure of fuel.

References — Messrs. Walter May & Co., Engineers, Birmingham, and Westminster, Walter Williams Junr. Esqre., Tipton, William Dredge, Esqre., C. E. Bridge St., Westminster, and Nathaniel Lea, Esqre., Bennetts Hill, Birmingham.

November 1862.

The letter sent out by Henry Lea to announce commencement in practice as a Consulting Mechanical Engineer.

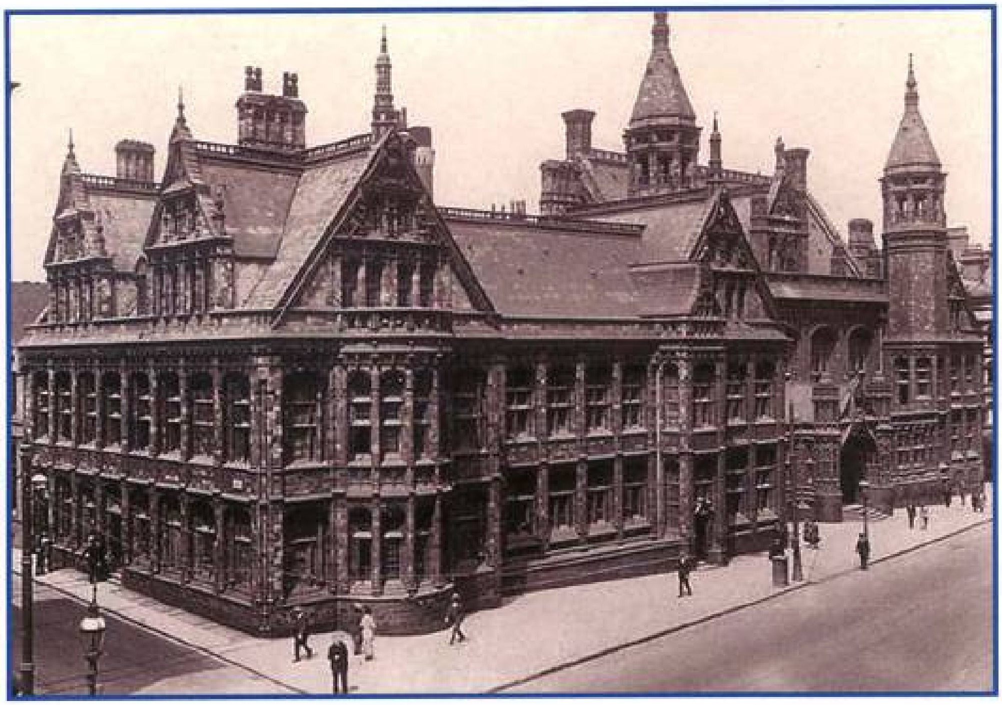




LEA'S ORNAMENTAL GLOBES FOR INCANDESCENT LAMPS.

Messrs. Fowler, Lancaster and Co. are introducing a globe for enclosing incandescent lamps, which is represented in the adjoining figure. Of course, the object of such an attachment is to conceal the filament itself from the eye, while intercepting the light as little as possible. Both the globe and its cover are made entirely of glass, and there are no metallic rims or screws to work loose, the connection being of an elastic character. The method of attachment adopted relieves the electrical connections of the lamp-holder from the weight of the globe. So far as can be judged from the figure, this globe will probably strike most of our readers as being particularly well designed from the æsthetic point of view.

Globe designed by Henry Lea for enclosing incandescent lamps. Apart from concealing the filament itself from the eye whilst refracting the light for distribution effect, the globe received universal acclaim as being particularly well designed from a aesthetic point of view.



Victoria Law Courts, Corporation Street, Birmingham 1886-91.
Designed by the architects Aston Webb and Ingress Bell.
Henry Lea's appointment covered the installation of the dynamos, the boilers and engines.

P. 30th November 1898.

Dr. Fergusson
Hydropathic Establishment
Gt. Malvern.

Dear Sir,

Confirming our conversation with you on the 24th inst, we beg to say that we will examine, test, and report upon your electric light installation on the terms of One Guinea per hour for Mr Henry Lea, Five Shillings per hour for Mr Fred M. Lea, and assistants at our usual rates.

We are

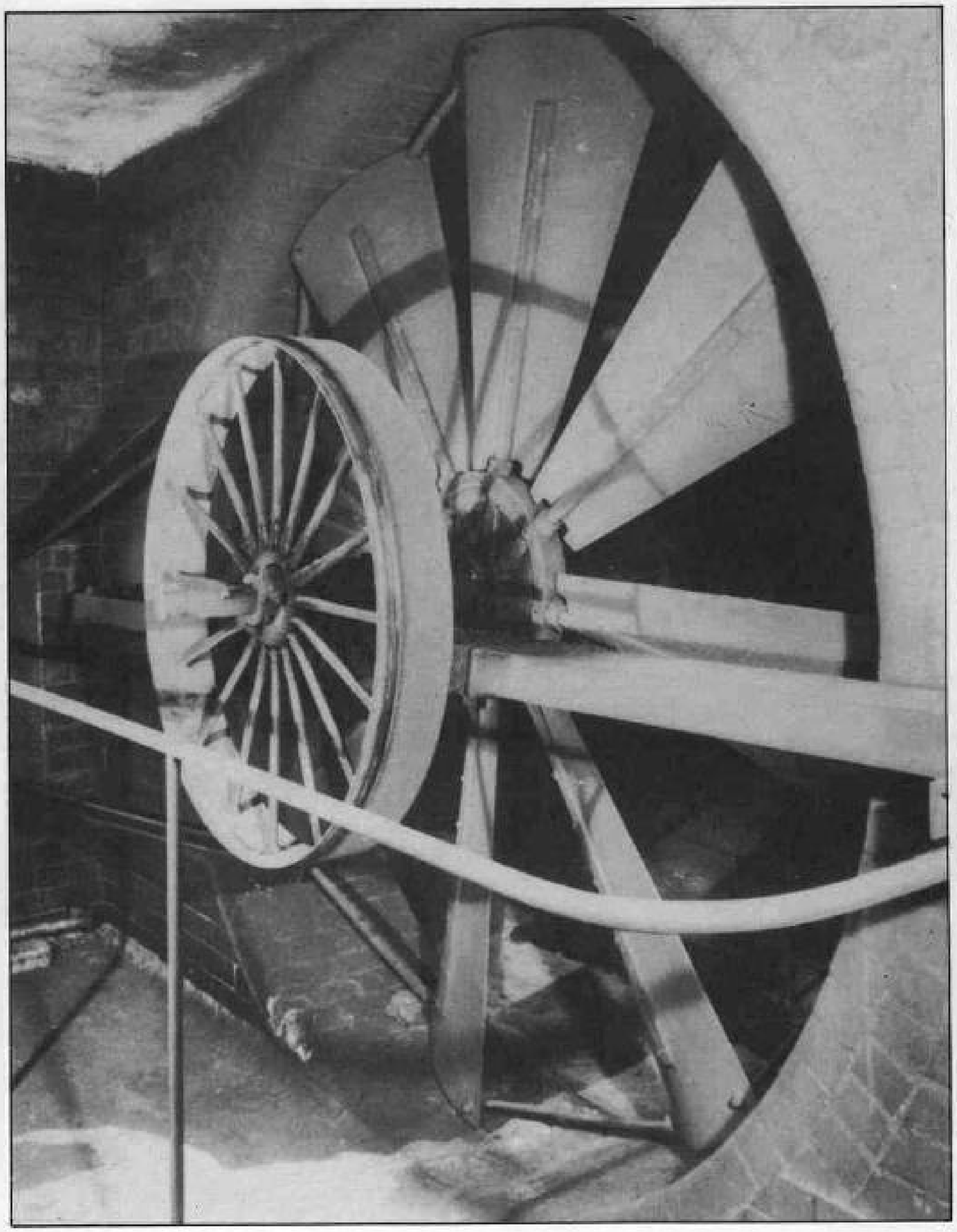
Yours faithfully,

Henry Lea

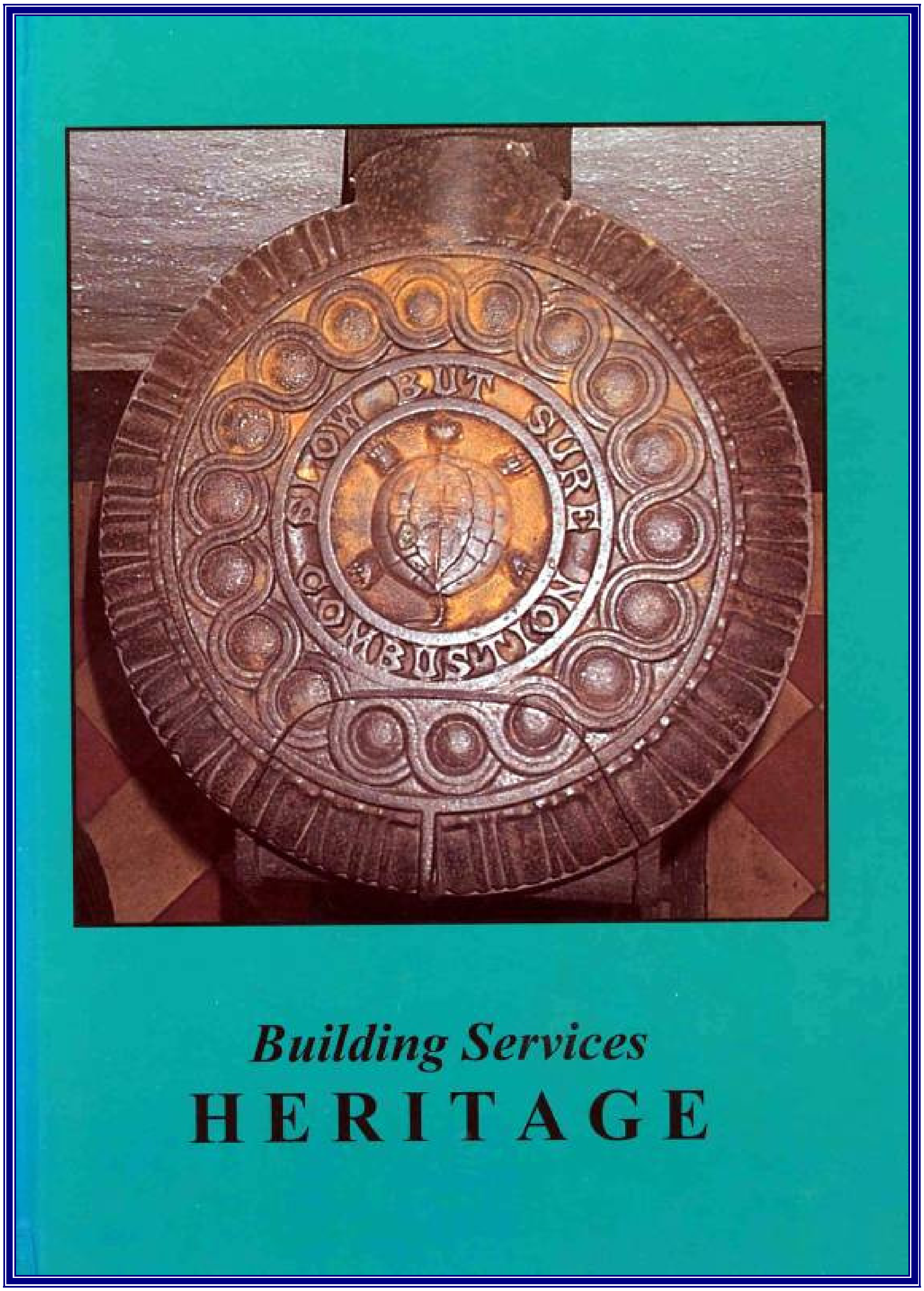
Letter from Henry Lea dated 30 November 1898 to a Dr Fergusson of the Hydropathic Establishment at Great Malvern in which he sets out his rates for carrying out tests on the electric lighting installation.

The Town Hall, Victoria Square, Birmingham, built 1831-49.
The architect was Joseph Hansom (inventor of the Hansom Patent Safety Cab), but the financial arrangements led his bankruptcy. In 1835 Charles Edge took over as architect and construction continued until about 1849.

Opening of the new buildings of Birmingham General Hospital in 1897 by HRH Princess Helena of Schlesweig-Holstein



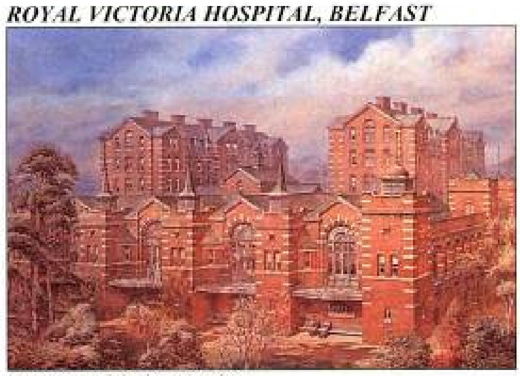
The 8ft. fan for plenum ventilation at Birmingham General Hospital 1893.



"Building Services Heritage," Brian Roberts, CIBSE Heritage Group, 2003
(CIBSE Heritage Group Collection)

ROYAL VICTORIA HOSPITAL, BELFAST

Henry Lea



Henman's original perspective

Branch duct to ward

Louvered extract lantern

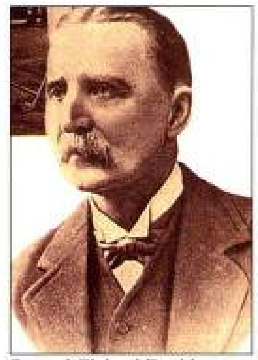
Royal Victoria Hospital, Belfast, 1898-1903

The architect and engineer for the Birmingham General Hospital of 1893-97 were William Henman and Henry Lea, assisted by the Glasgow engineer William Key, a pioneer of plenum ventilation. In 1898, Henman and Lea were appointed for the new Royal Victoria Hospital in Belfast. Both knew there was scope for the improvement of environmental systems. Operating theatres and 17 wards were provided under a continuous roof. A very large brick lined air duct 9 ft wide and 433 ft long ran beneath the main corridor. Lea determined this size was necessary to provide 7 air changes/h in winter and 10 in summer. Two fans, each of 9 ft 2 in diameter were provided, driven by a steam engine, with the exhaust steam used to heat domestic hot water. The local engineer Samuel Cleland Davidson played an important role. The Davidson Works was producing some of the world's most advanced centrifugal fans and was responsible for designing, installing and maintaining much of the central plant. A sprinkler system, used to moisten the fresh air filters, was regulated on the basis of regular readings of wet and dry-bulb temperatures, a very early example of the conscious control of humidity. Much of the central plant remains in place, including the steam engine which is still operational.

More information is contained in "Henry Lea, Consulting Engineer, 1839-1912," Henry Tovey, Hoare Lea & Partners, undated.

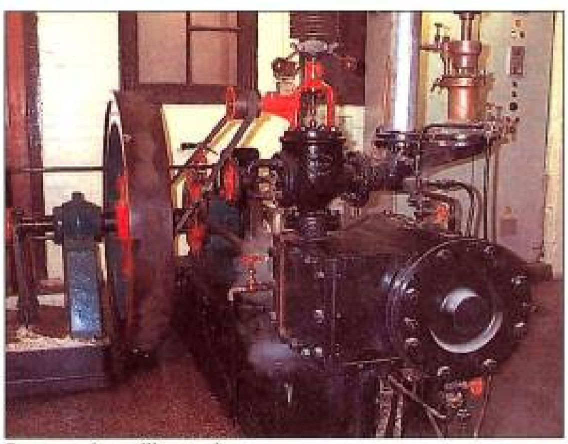
Davidson fan

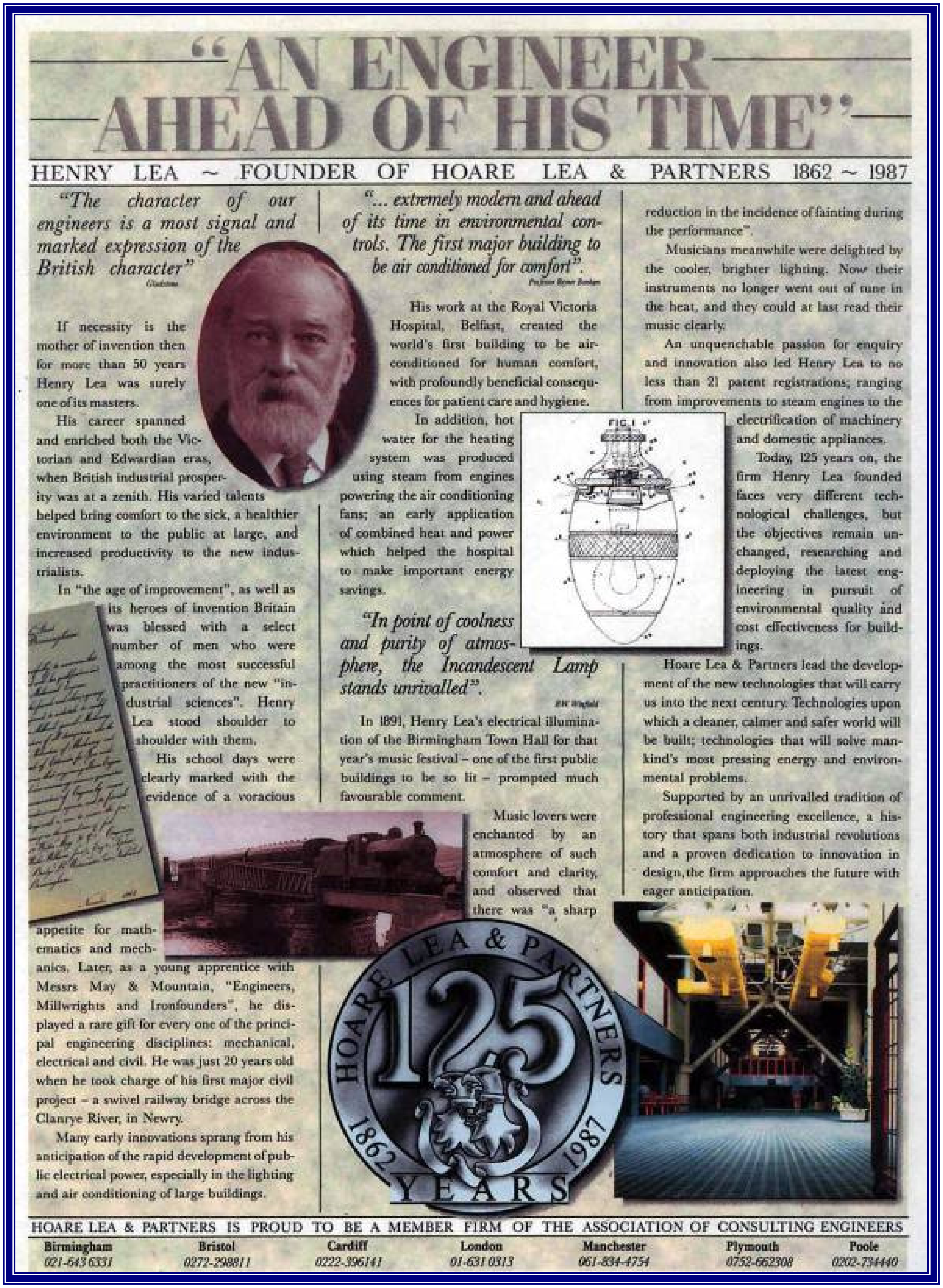

South side of ward block 1903


Samuel Cleland Davidson


One of the Wards


Coconut fibre rope filter wetted by sprinklers


Steam engine, still operating



"AN ENGINEER AHEAD OF HIS TIME"

HENRY LEA ~ FOUNDER OF HOARE LEA & PARTNERS 1862 ~ 1987

"The character of our engineers is a most signal and marked expression of the British character"

If necessity is the mother of invention then for more than 50 years Henry Lea was surely one of its masters.

His career spanned and enriched both the Victorian and Edwardian eras, when British industrial prosperity was at a zenith. His varied talents helped bring comfort to the sick, a healthier environment to the public at large, and increased productivity to the new industrialists.

In "the age of improvement", as well as its heroes of invention Britain was blessed with a select number of men who were among the most successful practitioners of the new "industrial sciences". Henry Lea stood shoulder to shoulder with them.

His school days were clearly marked with the evidence of a voracious appetite for mathematics and mechanics. Later, as a young apprentice with Messrs May & Mountain, "Engineers, Millwrights and Ironfounders", he displayed a rare gift for every one of the principal engineering disciplines: mechanical, electrical and civil. He was just 20 years old when he took charge of his first major civil project – a swivel railway bridge across the Clanrye River, in Newry.

Many early innovations sprang from his anticipation of the rapid development of public electrical power, especially in the lighting and air conditioning of large buildings.

"... extremely modern and ahead of its time in environmental controls. The first major building to be air conditioned for comfort".

His work at the Royal Victoria Hospital, Belfast, created the world's first building to be air-conditioned for human comfort, with profoundly beneficial consequences for patient care and hygiene.

In addition, hot water for the heating system was produced using steam from engines powering the air conditioning fans; an early application of combined heat and power which helped the hospital to make important energy savings.

"In point of coolness and purity of atmosphere, the Incandescent Lamp stands unrivalled".

In 1891, Henry Lea's electrical illumination of the Birmingham Town Hall for that year's music festival – one of the first public buildings to be so lit – prompted much favourable comment.

Music lovers were enchanted by an atmosphere of such comfort and clarity, and observed that there was "a sharp reduction in the incidence of fainting during the performance".

Musicians meanwhile were delighted by the cooler, brighter lighting. Now their instruments no longer went out of tune in the heat, and they could at last read their music clearly.

An unquenchable passion for enquiry and innovation also led Henry Lea to no less than 21 patent registrations; ranging from improvements to steam engines to the electrification of machinery and domestic appliances.

Today, 125 years on, the firm Henry Lea founded faces very different technological challenges, but the objectives remain unchanged, researching and deploying the latest engineering in pursuit of environmental quality and cost effectiveness for buildings.

Hoare Lea & Partners lead the development of the new technologies that will carry us into the next century. Technologies upon which a cleaner, calmer and safer world will be built; technologies that will solve mankind's most pressing energy and environmental problems.

Supported by an unrivalled tradition of professional engineering excellence, a history that spans both industrial revolutions and a proven dedication to innovation in design, the firm approaches the future with eager anticipation.

HOARE LEA & PARTNERS IS PROUD TO BE A MEMBER FIRM OF THE ASSOCIATION OF CONSULTING ENGINEERS

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1987 Advertisement

MAURICE LEBLANC
1857-1923

Designed the first steam-jet refrigerating machine and patented the concept of the centrifugal compressor

[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.

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

3.16. THE STEAM JET REFRIGERATING MACHINE

3.161. The novelty in the preceding period had been the steam jet machine of Maurice Leblanc *, first made by Westinghouse, in Paris. In 1926, R. Follain, an engineer of SCAM (Paris) improved the machine and increased its output by introducing multiple stages of vaporisation and condensation of the suction steam. The first industrial realisation was in 1928, when the machines were used in the chemical industry, and in breweries.

LEBLANC Maurice (1857-1923)

French engineer.

Ecole Polytechnique. Career on the railways, and then in several industries. Work and research on electric motors and transformers, on brakes, and on hydraulic machines.

In 1907-1908, he designed the first steam jet refrigerating machine, which was made in Paris by the Westinghouse company in 1909 (his steam ejector had been conceived in 1903). In 1908 he read a paper to the 1st International Congress of Refrigeration on standardising methods of testing refrigerating machines.

He was a member of the Académie des Sciences.

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

5.12 TURBO-COMPRESSORS*

Turbo-compressors for air have been in use for over 60 years, their development being largely due to Rateau. The first attempt to use them for refrigerating machinery was made by Lorenz and Elgenfeld in 1910-11. Lorenz computed the lower limit of size and came to the conclusion that these were 165 tr (580 kW) for SO_2, 414 tr (1450 kW) for ammonia and 215 tr (754 kW) for CO_2.

At about the same time, in France, Leblanc obtained a broad patent for his centrifugal compressor and built a workable experimental machine, using water vapour as the refrigerant. Water vapour has a low molecular weight and Leblanc was unable to design an impeller of sufficient mechanical strength for the necessary high rotating speeds. Leblanc also experimented with carbon tetrachloride and here he was on the right track, for carbon tetrachloride has most of the desirable properties, including a high molecular weight, of a refrigerant suitable for use in centrifugal compressors. But carbon tetrachloride was unstable and dissociated to form decomposition products which ruined the compressor. Leblanc also had other problems, notably with shaft seals, and he was unable to keep air out of the refrigerating system.(16)

5.16 JET MACHINES

The possibility of using jets for the production of cold was envisaged in a patent of 1884. In about 1902, Charles Parsons worked on steam-jet cooling; and independently, Leblanc invented the steam ejector refrigerating apparatus in 1905 (USP 1005851 of 1911), and, with Westinghouse, built the first successful machine in Paris in 1910. The steam was used to speed the evaporation in Cullen's process of 1755. Steam at high pressure was ejected from nozzles over a tank of water, and thus maintained the partial vacuum needed for high evaporation rates.(33) This type of plant found its chief use in air-conditioning on account of its relative safety and low first cost. These machines need substantial quantities of cooling water, and this limits their applications. By using multi-stage evaporation and compression, Follain (1928) succeeded in making significant economies in both steam and cooling water. The liners *Queen Mary* and *Queen Elizabeth* were among the first ships to be fitted with steam-jet refrigeration. Small steam-jet units were later used in the USA for the air conditioning of railway passenger coaches, having been first introduced by Carrier in 1931.

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

The steam jet machine, invented by Maurice LeBlanc in France, and used to a considerable extent on French battleships, appeared to have attractive possibilities. It was not until a little more than a decade ago, however, that it was perfected sufficiently to gain commercial importance, and of course its inherent limitations — the necessity of a cheap source of steam and copious condensing water—were recognized at that time. For a refrigerating machine to fill the economic need in the broadest possible way, it was essential that it could use any of the available important primary sources of energy.

Early Investigations and Inventions

ALTHOUGH the idea of applying centrifugal compression is probably fairly old, the first competent analysis and experimental groundwork was not done until between 1910 and 1915. This pioneering was likewise done by Maurice LeBlanc, who not only made quite a thorough study but built a workable experimental machine and obtained a broad patent on the centrifugal idea.[1]

LeBlanc experimented with two refrigerants — carbon tetrachloride and water vapor. Carbon tetrachloride was not a satisfactory refrigerant because it was unstable and dissociated sufficiently to form decomposition products which ruined the compressor. He was on the proper trail, however, because CCl_4 has thermodynamic properties (including a high molecular weight) which would otherwise have made it a suitable refrigerant for centrifugal compression. LeBlanc's work with water vapor (Fig. 1) did not bear fruit largely because of his inability to design an impeller of sufficient mechanical strength for the high rotative speeds necessary with a refrigerant of such low molecular weight. A secondary reason for his failure to build a practical machine was his lack of a satisfactory shaft seal to keep air out of the system.

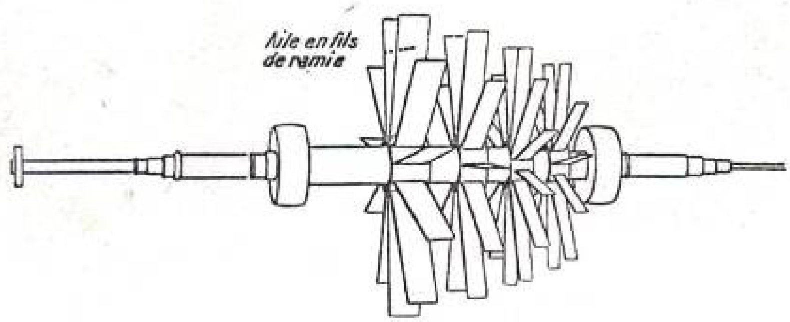
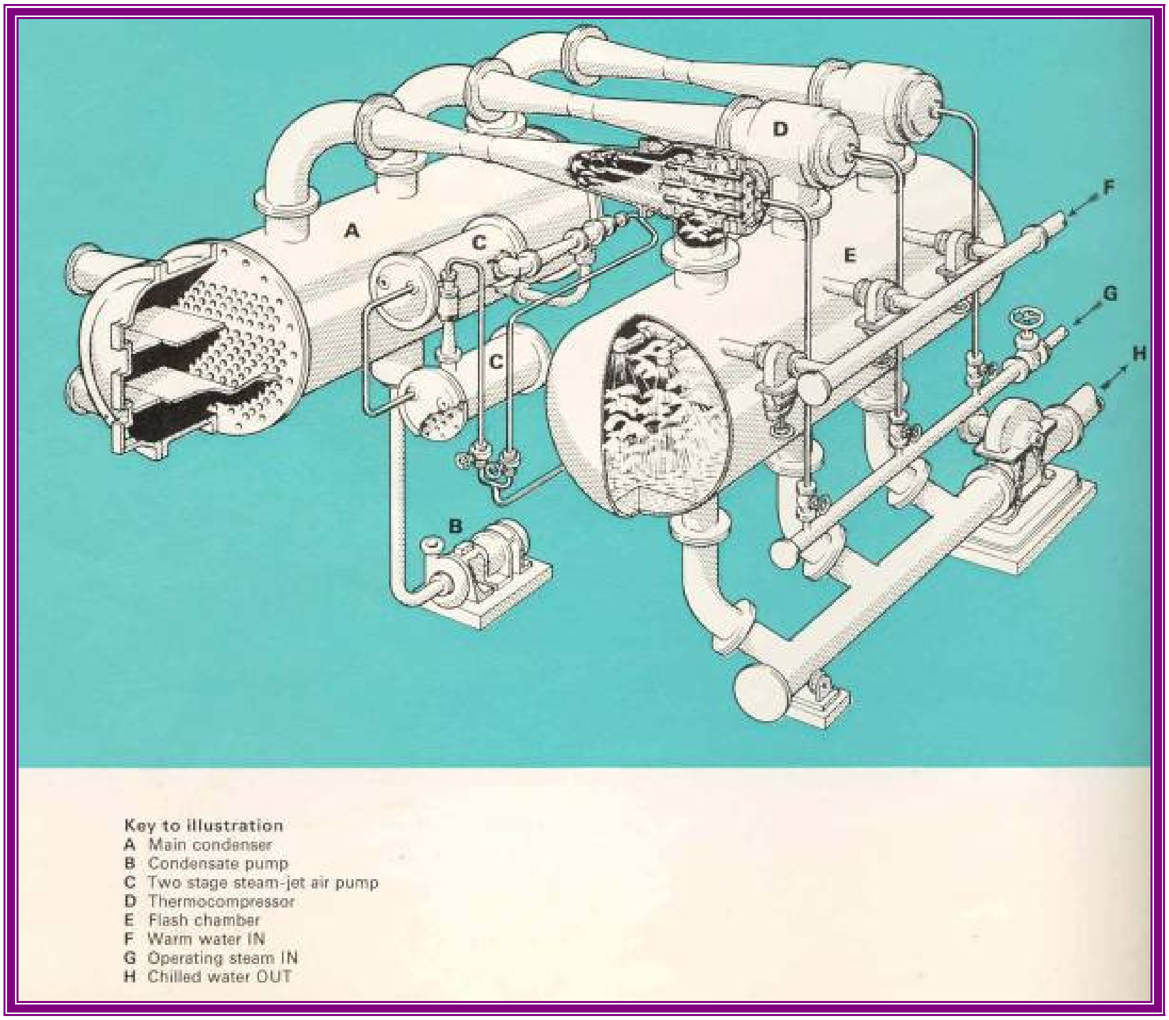


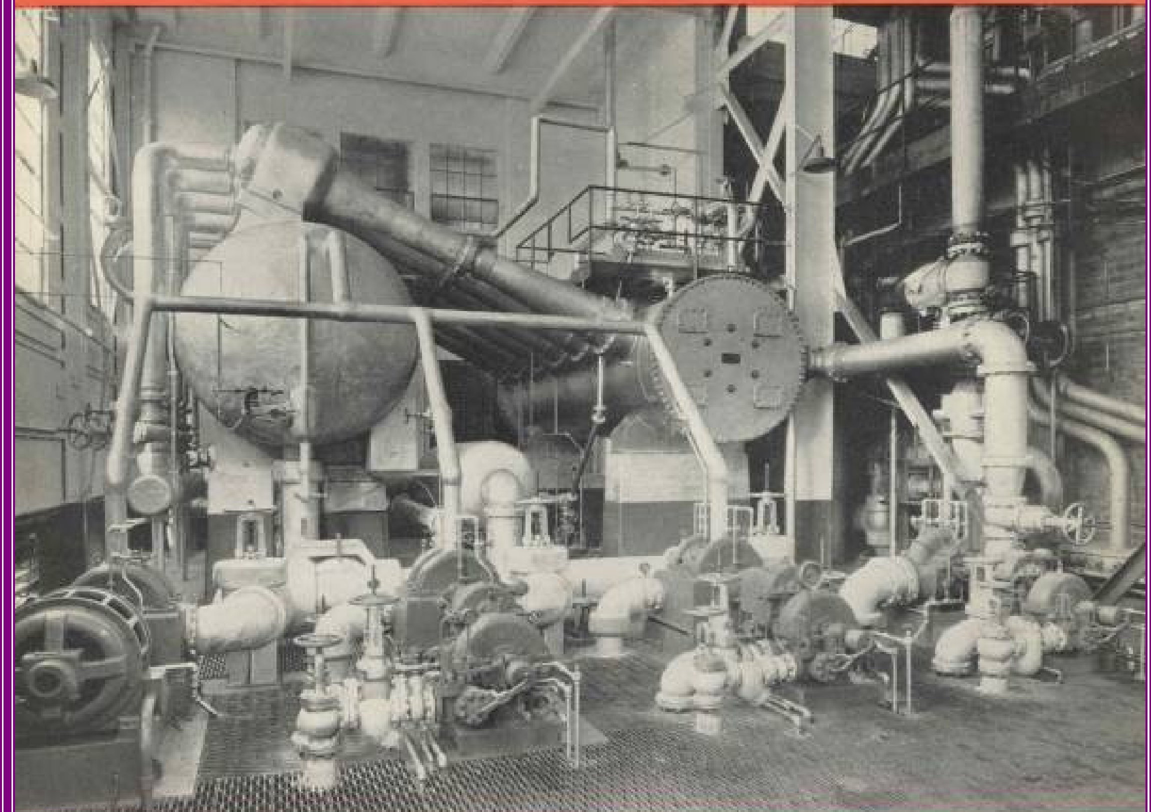
Fig. 1. LeBlanc centrifugal rotor.

(From "A History of the Centrifugal Refrigeration Machine," Walter A Grant, Refrigerating Engineering, February 1942)



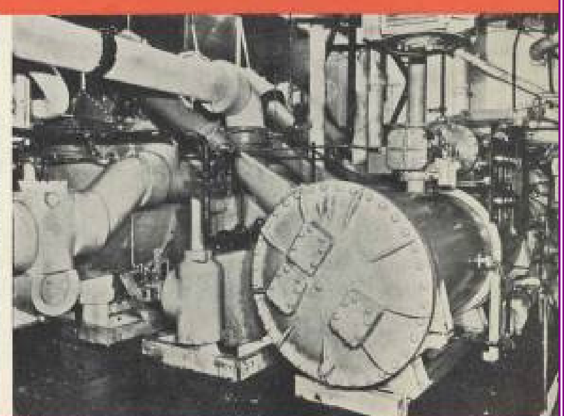
Schematic of Steam-Jet (or Vacuum) Refrigerating Machine
(Foster Wheeler leaflet 1969, CIBSE Heritage Group Collection)

FOSTER WHEELER VACUUM REFRIGERATION PLANTS



This large land unit cools 1666 gallons of water per minute from 70°F. to 60°F.

Testing a plant of 500,000 B.T.U. per hour at Foster Wheeler's Works



Marine unit installed in the Cunard-White Star R.M.S. "Queen Mary"

Photographs of Steam-Jet (Vacuum) Refrigerating Plant, including RMS "Queen Mary" (CIBSE Heritage Group Collection)