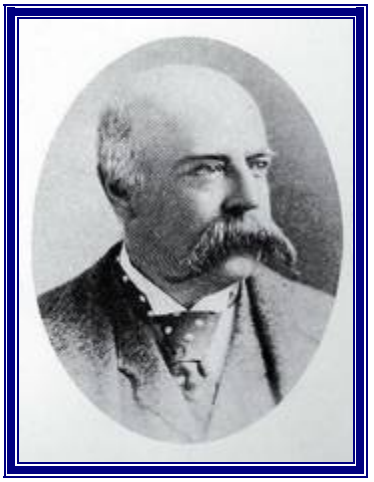
ALFRED WOLFF

& the New York Stock Exchange

By EurIng Brian Roberts, CIBSE Heritage Group



George Browne Post 1837-1913
Architect

Alfred R Wolff 1859-1909
Consulting Engineer

New York Stock Exchange in 1904 (Library of Congress photograph)

New York Stock Exchange, interior of the main floor

George Browne Post

American architect who contributed to the origin and development of the early "skyscraper" in the 1870's, including the Equitable Life Assurance Building in New York, the first office block designed with a passenger lift (by Otis). His best known building is the Stock Exchange. It is said that Post expected Wolff to complete all the ventilation drawings in two weeks but Wolff said that was impossible because the architect's plans were so complex and in the event it took almost a year. (It is not known how Post felt when Wolff refused to accept the normal custom that his fee would be a percentage of what the architect received and instead negotiated a separate agreement).

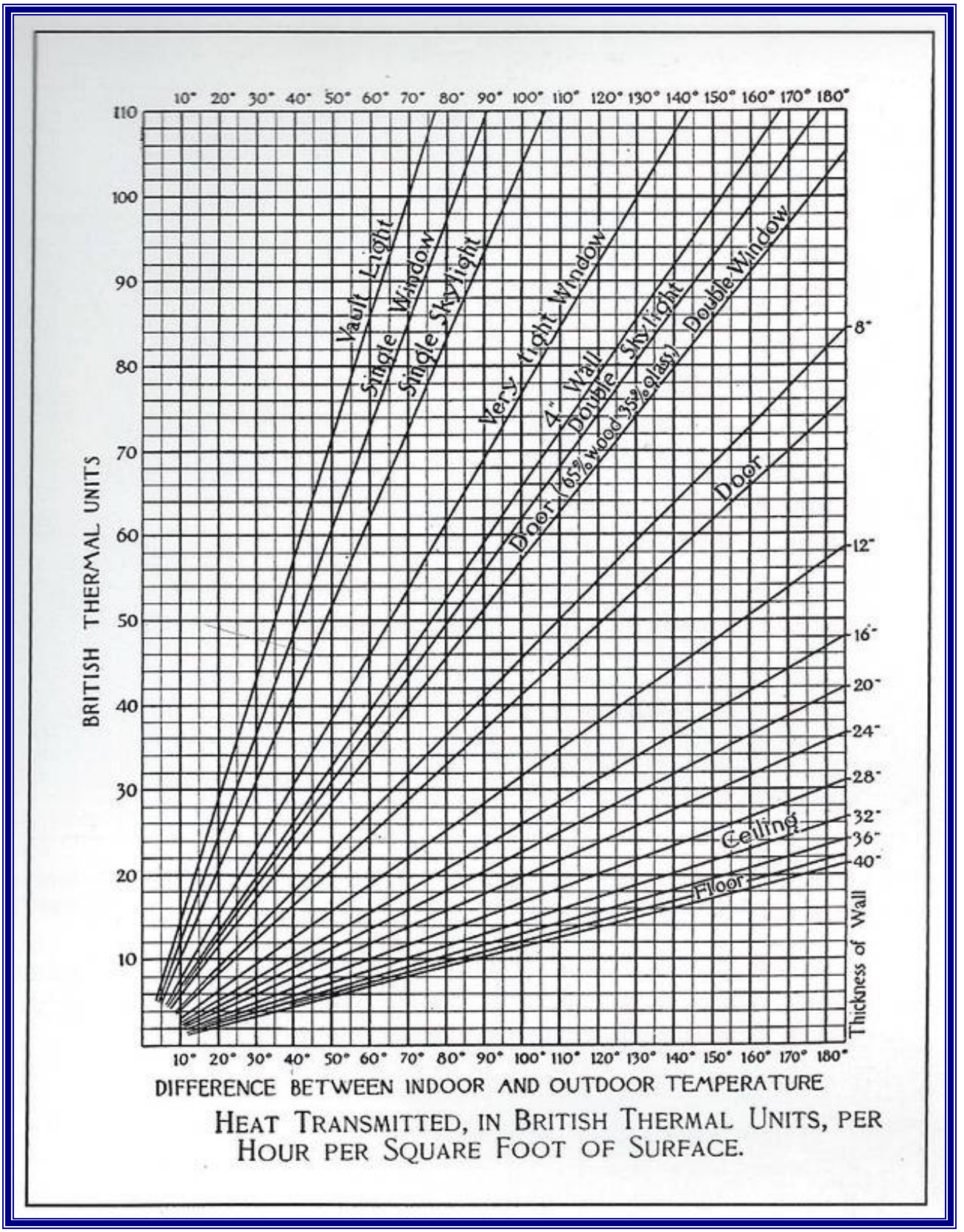
Alfred R Wolff

Wolff was born on 16 March 1859 in Hoboken, New Jersey. At age 13 he entered the Stevens Institute of Technology receiving his Degree in Mechanical Engineering at the age of 17. He then became an apprentice (without pay) at the New York office of Charles Emery, a renowned consulting steam engineer. Later, he formed a consulting engineering partnership with W Weightman. Several years later, Wolff set up his own practice and gave increasing attention to the heating and ventilating of large buildings.

Wolff was considered an eccentric. He refused to get involved with any organisation that advocated secrecy. He refused to join the American Society of Heating and Ventilating Engineers because salesmen were permitted to join. It is said he always impressed upon potential clients that the costs of system operation and maintenance should receive greater consideration than first costs and frequently politely and firmly declined desirable commissions when his view was not accepted. Wolff refused to write letters (except in extreme cases), refused to issue work progress reports and avoided using the telephone, leaving such matters to others. He followed a strict moral code and practised business ethics which forbade bribes or kickbacks.

Wolff believed in using the latest available design information. Electricity was coming into widespread use in the 1890's but it was often more economical to produce on site using steam-engine-driven generators with the large quantity of exhaust steam available to heat the building (co-generation). He also supported the change from steam-driven fans to dc electric drive and was a believer in the use of thermostatic controls favouring the Johnson pneumatic system.

Wolff developed heat loss calculations from German methods using what is now termed *U-values.* He also recognised that internal heat gains, from people and gas or electric lighting contributed to cooling loads and he pioneered the use of air filters. He employed cooling methods on his projects of this time including Carnegie Music Hall in 1889 (ice block cooling) and Cornell Medical College in 1902 (refrigeration by the Carbondale Company).



Alfred Wolff's Design Chart for Determining Heat Transfer Rates for Various Building Materials

When Wolff received the plans for the New York Stock Exchange he was confronted with a design for one of the largest interior spaces (the Trading Floor) in the city “a block long room that would hold 1500 traders, with a skylighted ceiling 72 feet high and an entire wall of windows.” Initially Wolff designed a thermostatically controlled heating and ventilating system but as he developed the scheme for the Trading Floor (also referred to as the Board Room) he concluded that ventilation alone would be unable to control either the temperature or the humidity.

Realising that some form of artificial cooling was necessary, Wolff consulted with Henry Torrance Jr, a well known refrigeration engineer, with whom he had worked before. They designed a mechanical cooling system that Wolff was able to convince the Building Committee was worth an extra cost of $130,000 dollars. The revised mechanical system design employed four high-pressure steam boilers feeding three steam-engine-driven direct current generators with an output of 750 kW for lighting and electric motors. The exhaust steam from the generator engines, supplemented by live steam, was used to supply “13,000 sq ft of direct and 5000 sq ft of indirect radiation,” but perhaps more importantly exhaust steam was used to power the aqua-ammonia absorption refrigerating plant, chilling brine which was pumped to the cooling/dehumidifying coils of the Trading Floor air handling plants. The heating plant was provided with a pneumatic control system.

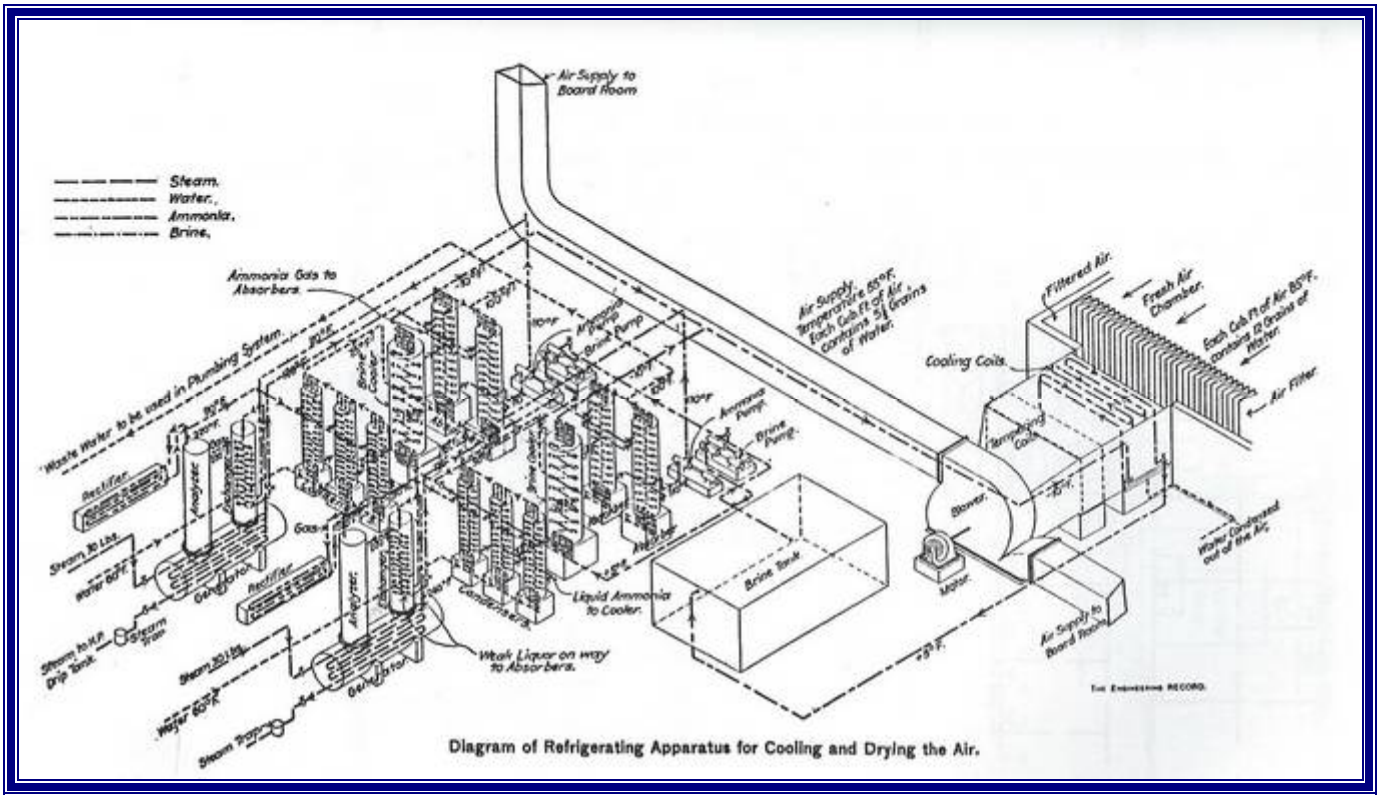


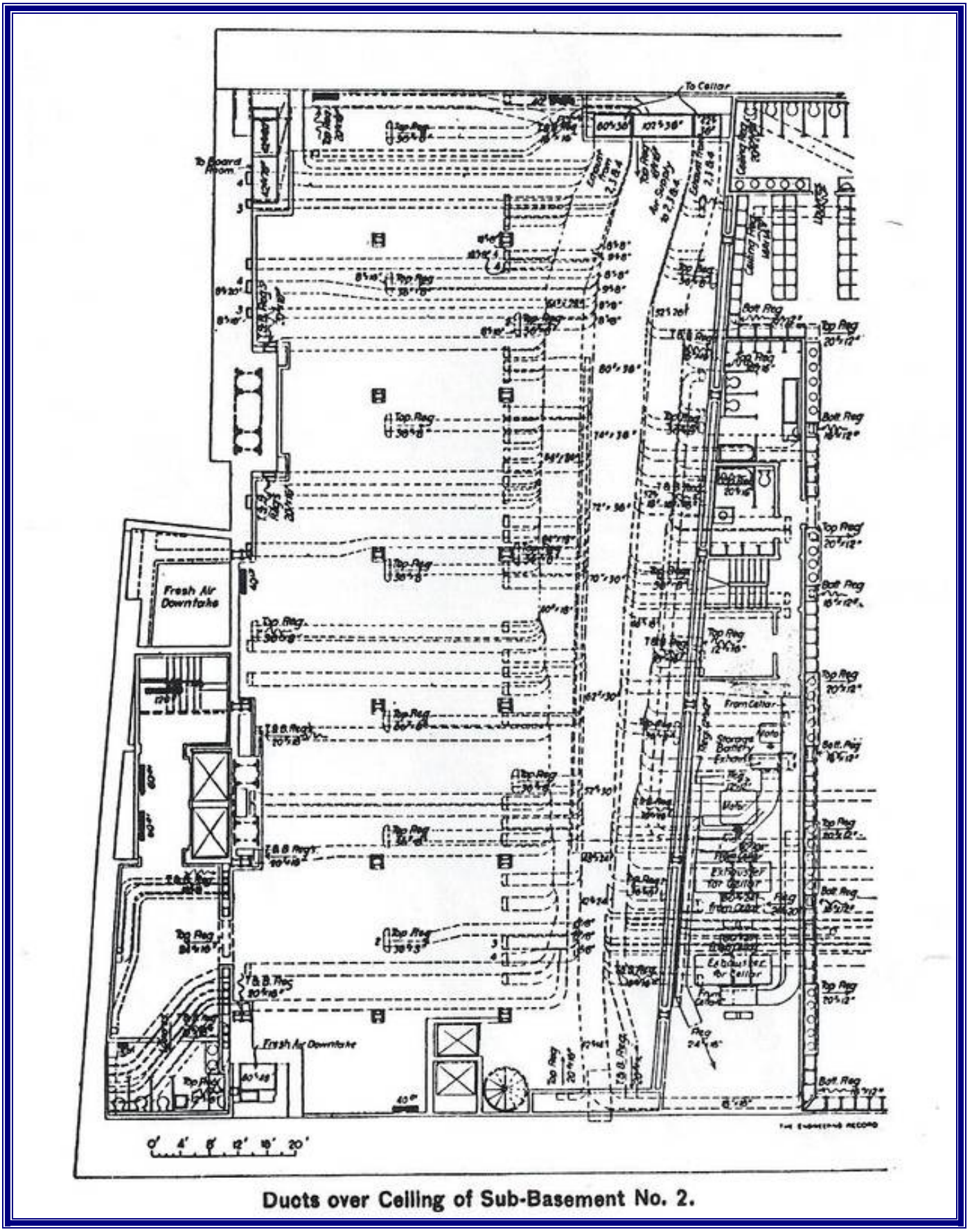
Diagram of Refrigerating Apparatus for Cooling and Drying the Air.

New York Stock Exchange: Refrigerating & Air Conditioning, scheme drawing from 1904

BIG COOLING PLANT IN STOCK EXCHANGE.

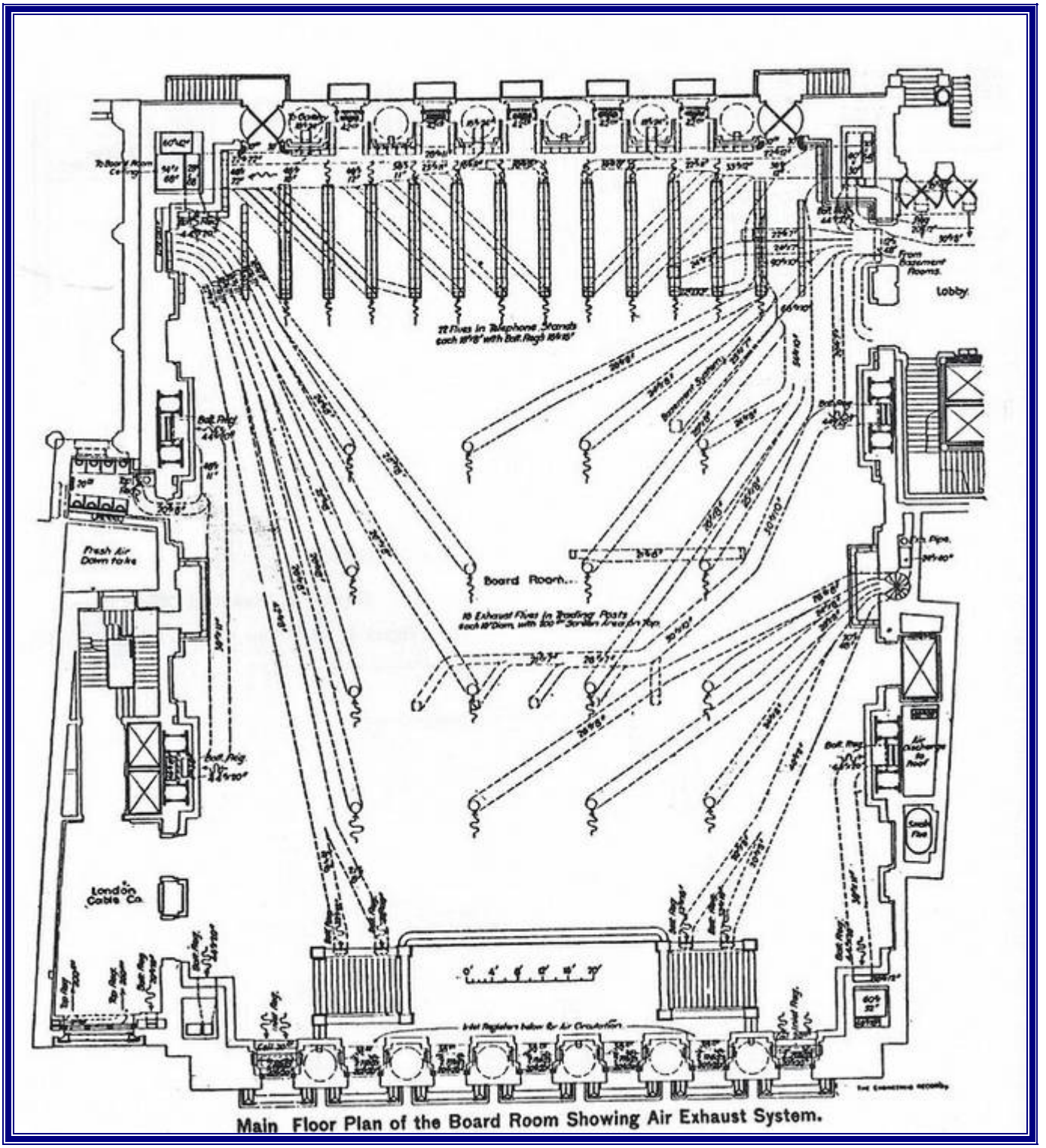
Three 150 Ton Machines Will Try to Keep the Brokers' Tempers Even—This Practically Marks the Opening of a New Era in Refrigeration.

INTERIOR OF THE BOARD ROOM OF THE NEW YORK STOCK EXCHANGE.



Ducts over Ceiling of Sub-Basement No. 2.

New York Stock Exchange: Refrigerating & Air Conditioning, scheme drawing from 1904



New York Stock Exchange: Refrigerating & Air Conditioning, scheme drawing from 1904

Stock Exchange Basement with Sturtevant fans driven by dc electric motors

Wolff's calculations of 1901 reveal that the plant was designed to lower the Trading Floor temperature "from 85 degF to 75 degF and the relative humidity from 85% to 75%" requiring a cooling plant capacity of 420 tons (1477 kW). He told the Building Committee:

> "I would like to say the importance of this plan to the upper portion of the board room is in the abstraction of the moisture and the reduction of humidity. I attach less importance to the reduction of the temperature than to the abstraction of the moisture."

The ventilation systems, serving the Stock Exchange, employed eight centrifugal and three "disk" (propeller) fans, all driven by dc electric motors to deliver five air changes per hour or "200,000 cubic feet per minute of 100% outside air." The supply air was passed through "cheese cloth" filter racks, humidified in winter by steam coil water pans and tempered by steam heating coils. It is recorded that the exhaust air systems had an extract rate of "224,000 cubic feet per minute."

Few comfort cooling systems had been designed before 1901 and the proposed Wolff-Torrance plant was a giant of its time employing three ammonia absorption brine chillers with a cooling capacity of 450 tons of refrigeration (1582 kW). The Trading Floor cooling load was 300 tons (1055 kW). The additional 150 tons was designed to serve the underground basement areas removing machinery and boiler heat with a small amount used to cool drinking water. Waste water from condenser cooling was stored in roof cisterns and used to flush toilets. The capacity of the refrigerating plant was reduced to 300 tons (1055 kW) prior to installation and arranged to serve only the Trading Floor. The refrigeration manufacturer was the Carbondale Machine Company of Pennsylvania using an improvement to the original English Pontifex patents which they had purchased in 1882. The Stock Exchange opened on 22 April 1903.

At the height of his career, Alfred Wolff became ill and died suddenly on 7 January 1909 at the age of 49. Wolff's design for the New York Stock Exchange air conditioning system operated successfully for nearly 20 years before it was modernised. It has greater claim to be the first scientifically designed air conditioning system than Carrier's Sackett-Wilhelms plant of 1902 which was not entirely successful being removed after a few years,

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