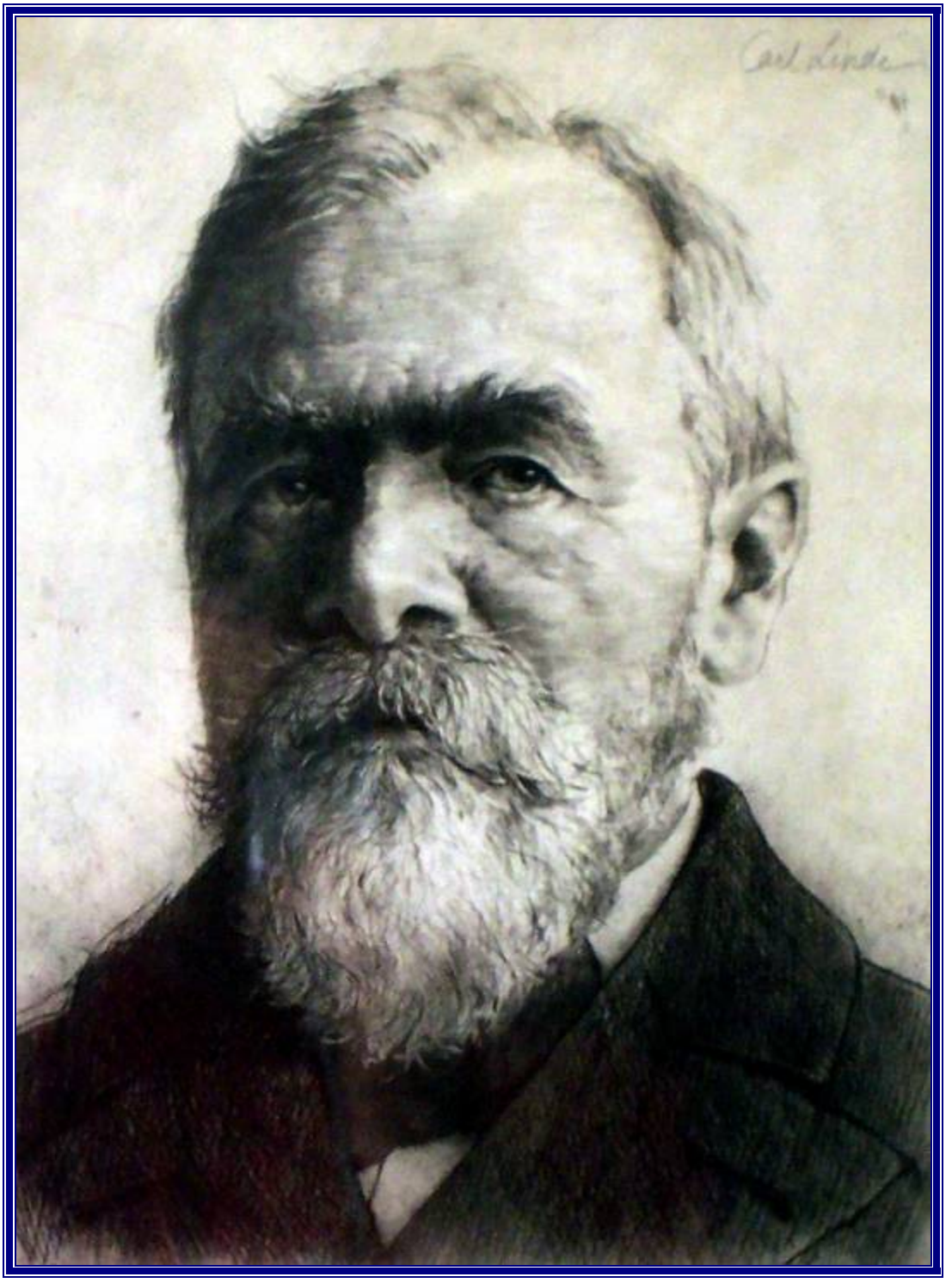
CARL von LINDE

By EurIng Brian Roberts, CIBSE Heritage Group



Carl von Linde, 1842-1934

Carl Paul Gottfried Linde was born in Berndorf, Upper Franconia, in Germany on 11 June, 1842. As the son of a minister it was expected that he would follow in his father's footsteps, but he took an entirely different career path. In 1861, he started a course in engineering at the Swiss Federal Institute of Technology in Zurich, Switzerland. His teachers included Rudolf Clausius who was probably the first person to establish thermodynamics as a science. In 1864, Linde was expelled before graduating for participating in a student protest. He went to work in industry, firstly in a cotton-spinning plant, and finally to the new Kraus locomotive factory in Munich, where he became head of the technical department. He married in 1866.

In 1868, Linde applied for and was accepted as a lecturer at a new Munich University, the *Technische Hochscule*, becoming in 1872, a full Professor of Mechanical Engineering. In 1870 and 1871, Linde published his research findings on refrigeration in the *Bavarian Industry & Trade Journal*. In 1875, he made his first compression refrigerating machine using methyl ether. In 1876, he made his first ammonia compressor with two vertical cylinders, followed in 1877 by a compressor of the double-acting horizontal type. This latter design "was quickly taken up all over the world, with almost immediate manufacture in five countries."

His first refrigerating plants were commercially successful and development work took up so much time, that in 1879, he gave up his Professorship and founded Linde's Ice Machine Company in Wiesbaden, Germany.

In Chicago in 1881, the engineer Fred W Wolf secured rights to manufacture and sell Linde's refrigerating systems in the USA. The Linde British Refrigeration Company was registered in London on 31 October, 1885. The Managing Director was T B Lightfoot (The Company became Lightfoot Refrigeration in 1916). Later, the Linde Canadian Refrigeration Company Ltd was established.

In 1890, Linde moved back to Munich where he took up his Professorship once more and continued to develop new refrigeration cycles. In 1892, he took an order from the Guiness Brewery in Dublin for a carbon dioxide liquefaction plant. From that point on, his career concentrated on very low temperature refrigeration and the liquefaction of gases, including air, oxygen and nitrogen.

"Carl von Linde shone at one and the same time as a scientist, professor, engineer and industrialist, qualities rarely united in one man." Linde was knighted in 1897 as **Ritter von Linde**. He died in Munich in November 1934 at the age of 92

The Swiss Federal Institute of Technology, Zurich

PATENT-URKUNDE

№ 1250.

GESETZ v. 25 MAI 1877

AUF GRUND DER ANGEHEFTETEN BESCHREIBUNG UND ZEICHNUNG IST DURCH BESCHLUSS DES KAISERLICHEN PATENTAMTES

Professor Carl Linde, in München

EIN PATENT ERTHEILT WORDEN.

GEGENSTAND DES PATENTES IST:

Kälteerzeugungsmaschine.

ANFANG DES PATENTES: 9. August 1877.

LÄNGSTE DAUER DES PATENTES: 24. März 1891.

DIE RECHTE UND PFLICHTEN DES PATENT-INHABERS SIND DURCH DAS PATENT-GESETZ VOM 25. MAI 1877 (REICHSGESETZBLATT FÜR 1877 SEITE 501) BESTIMMT.

ZU URKUND DER ERTHEILUNG DES PATENTES IST DIESE AUSFERTIGUNG ERFOLGT.

Berlin, den 29. Mai 1878.

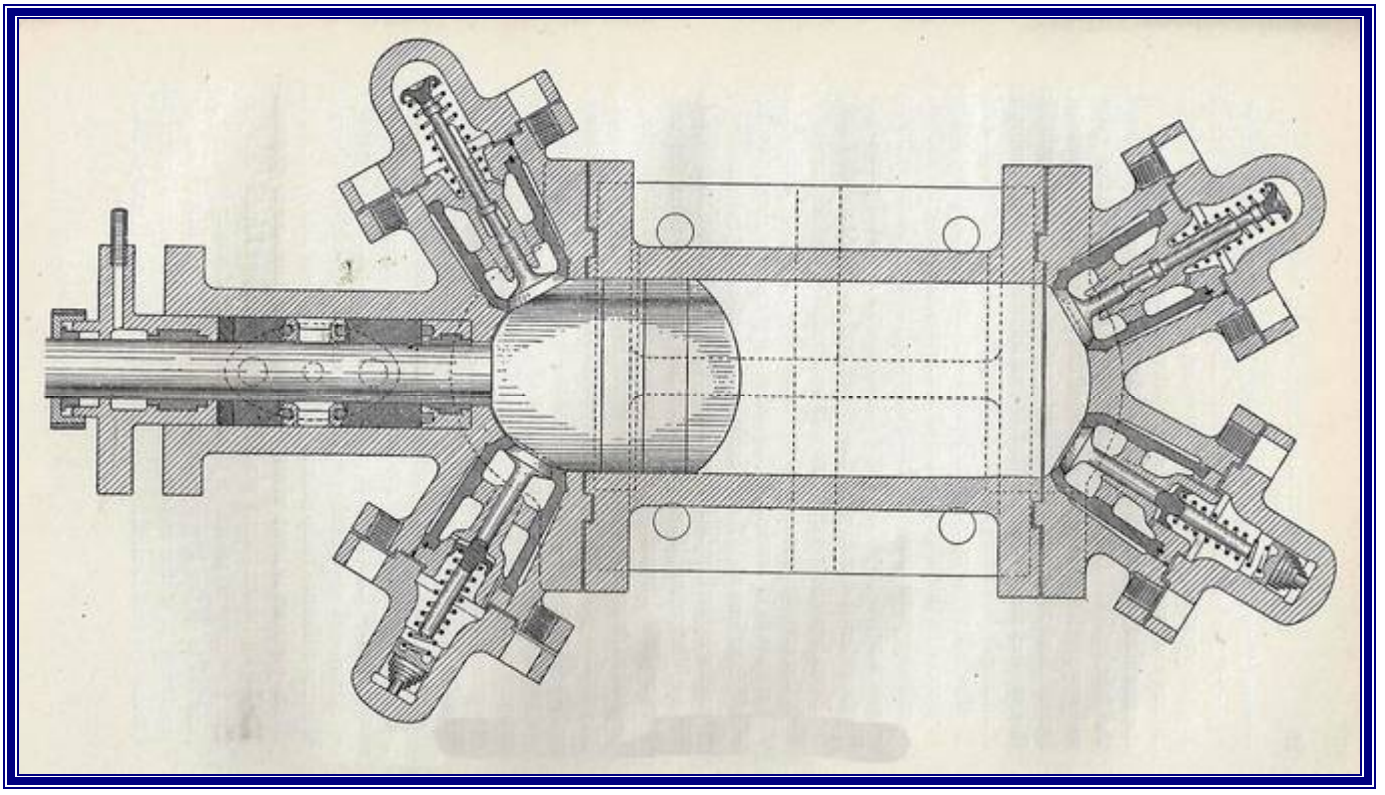
KAISERLICHES PATENTAMT.

Beglaubigt durch Schmidt

Sekretär des Kaiserlichen Patentamtes.

Linde's Imperial Patent No. 1250 of 9 August, 1877 for his first refrigerating machine

Model of Linde's first ammonia refrigerating system which had been installed in a Brewery in Trieste in 1877



Compressing cylinder of Linde's improved horizontal ammonia compressor

C. P. G. LINDE.

Refrigerating and Ice-Making Apparatus.

No. 228,364. Patented June 1, 1880.

Fig 1

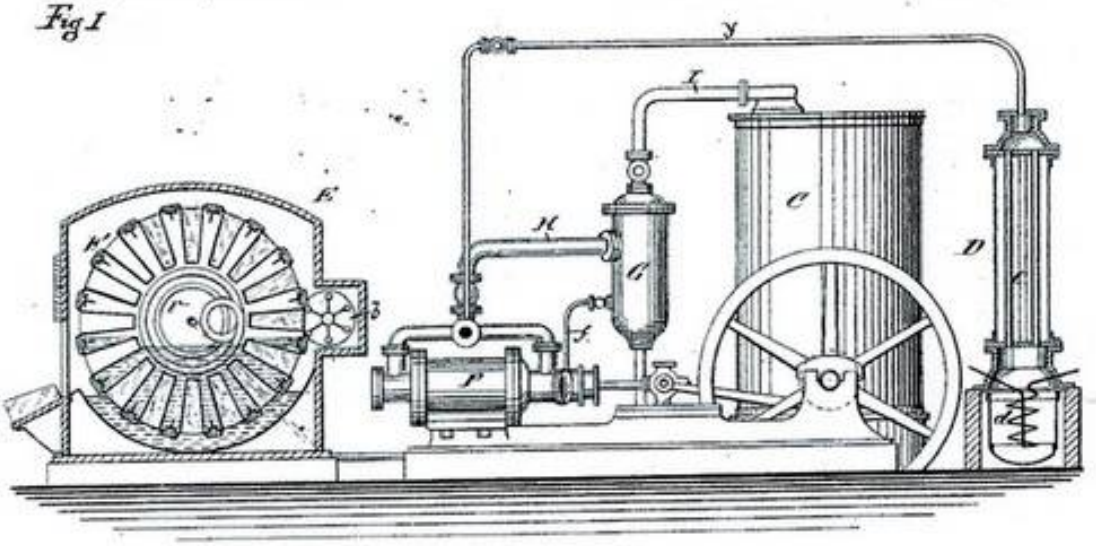


fig. 2

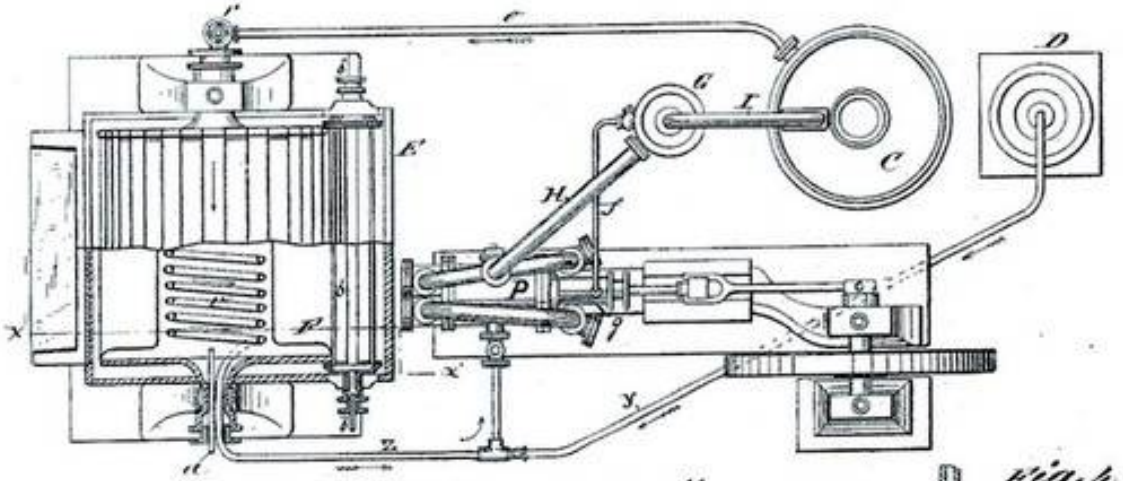
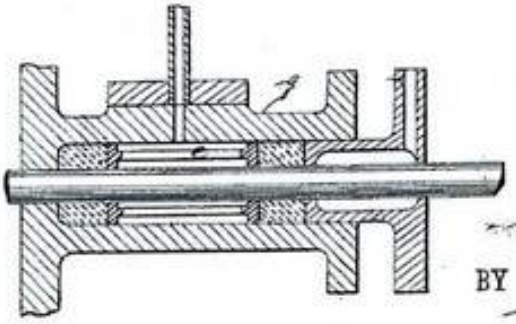


fig. 3.

fig. 4



WITNESSES:

C. Neveux

C. Sedgwick

INVENTOR:

C. P. G. Linde

BY Munn & Co.

Linde's US Patent No.228,364 of 1 June, 1880 for Refrigerating and Ice-Making Apparatus

UNITED STATES PATENT OFFICE.

CHARLES P. G. LINDE, OF MUNICH, GERMANY.

REFRIGERATING AND ICE-MAKING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 228,364, dated June 1, 1880.

Application filed July 14, 1879.

To all whom it may concern:

Be it known that I, CHARLES P. G. LINDE, of Munich, Germany, have invented a new and Improved Refrigerating and Ice-Making Apparatus; and I do hereby declare that the following is a full, clear, and exact description of the same.

My improvements relate to that class of refrigerating or ice-making apparatuses in which the refrigerating effect is obtained by the evaporation of a volatile liquid, the vapors of which are compressed by a pump into a condenser, and then liquefied ready to be again subjected to the process of evaporation.

The object of this invention is the following: first, to prevent overheating of the pump, which overheating has been the cause of loss of motive power and rendered artificial heating necessary; second, to effect a more perfect packing of the stuffing-box of the pump, and the employment of the stuffing medium for the lubrication of the points of contact of the working parts; third, to provide means for replenishing the apparatus with pure liquid ammonia while in operation; fourth, to provide means for the production of transparent ice and the means for discharging the same from the carriers.

The invention consists, first, in preventing the overheating of the pump by causing a portion of the liquid ammonia to be carried along with the vapors to the pump, to be evaporated by the heat generated by the compression action of the pump; second, in a glycerine-chamber placed in the delivery-pipe, and connected by a pipe to a glycerine-chamber in the stuffing-box of the pump, whereby the said stuffing-box will be tightly packed and the internal parts lubricated; third, in connecting the distilling apparatus directly with the exhaust-pipe of the pump; fourth, in a revolving drum provided with radial ice-collecting cells, to enable the ice to be formed in thin films or layers, and thereby rendered transparent; and, fifth, in a revolving device for pressing heated tubes in contact with the ice on the face of the drum, to facilitate its removal, all as hereinafter described.

In the drawings, Figure 1 is an elevation of the apparatus with the freezing-chamber in section. Fig. 2 is a plan view with the freezing-chamber partially broken open. Fig. 3 is an enlarged longitudinal section of the stuffing-box. Fig. 4 is a cross-section of the same.

C is the condenser, E the refrigerating or freezing chamber, and P the pump.

To obviate the loss of power resulting from the heat caused by the compression of the vapors, the volatile liquid and its vapors are conducted to the pump in a mixture of such proportions that the state of saturation is just attained at the end of compression. This is accomplished by causing the ammoniacal vapors to be conducted from the condenser through the refrigerating-chamber up to the pump in a continuous circuit through the conduit *o*, refrigerating-coil *v*, and the exhaust-pipe *z*, whose areas are less than that of the pipes H I, which deliver the vapors from the pump to the condenser. By this means the velocity of the vapors will be so increased that a certain amount of liquid ammonia will be carried along with the vapors to the pump and there evaporated by the heat generated by the compression action of the said pump. Thus all overheating of the pump is prevented, all the heat being consumed in the evaporation of the liquid, which passes through the pump with the vapors.

In order that the quantity of liquid ammonia to be carried to the pump be properly regulated, a valve, *r*, is arranged in the conduit *o*, whereby more or less liquid ammonia may be admitted, as may be required, and the temperature of the delivery-pipes H I will be a precise guide for the operator in regulating the valve.

To pack the stuffing-box tightly a chamber, *e*, is formed in the stuffing-box around the piston by two india-rubber rings, (see Figs. 3 and 4,) which chamber is connected by a small pipe, *f*, with the glycerine-vessel G, arranged in the delivery-pipe H I in open connection with the condenser, so that the pressure in the condenser will force the glycerine into the stuffing-chamber. The pressure in the condenser, never being lower than the highest pressure in the pump, will force the glycerine into the stuffing-chamber under great pressure, and if any leakage should occur in the said stuffing-box, it—that is, the glycerine—will be forced on one side into the open air and on the other into the pump-cylinder. By this

Description of Linde's US Patent No. 228,364 though strangely his Christian name is given as Charles, not Carl

means an exit of the ammoniacal vapors or the admission of air to the same is prevented, and the glycerine entering the pump-cylinder will be carried along with the ammoniacal vapors, lubricating the parts through which it passes, and be returned to the glycerine-vessel G.

In order to replenish the machine with ammonia nearly devoid of moisture during its operation, I make use of the distilling apparatus D, which has in its lower part the vessel *d*, for containing the commercial liquid ammonia to be vaporized by the application of heat or other suitable means. Above this vessel I arrange a tube-condenser, *c*, which is kept cool on the exterior by water. These vapors pass through the said condenser-tube, thus depositing the aqueous vapors generated by distillation, and are conducted by a pipe, *g*, directly to the exhaust *z*, and thence to the pump in a thoroughly-pure state.

The next feature of my improvement relates to the production of transparent ice, which is obtained by a revolving drum, F, provided with radiating cells, and arranged in the refrigerating-chamber E, which contains water, from which the ice is to be frozen. The drum is partially filled with a non-freezing liquid, such as brine intensely refrigerated by the evaporation of the volatile liquid in the stationary coil *e*, arranged in the said drum. The ends of this coil pass through the hollow journals of the said drum, and are connected at one side with the conduit *o* and at the other with the exhaust *z*. During the rotation of the drum the cells will be alternately immersed in the water, which will be congealed in thin films or layers therein until the said cells are entirely filled with ice, which latter, owing to the gradual freezing of the successive water-films and the movement of the water with reference to the ice surface, will be clear and entirely free from the milky appearance usual in ice formed by the apparatus in general use.

The ice having attained a proper thickness, the cold brine is drawn off by the tube *a*, and warm water, brine, or steam is introduced into the drum while still turning, by which the ice will be loosened in the cells. If, however, the blocks of ice should be frozen together on the surface, it will become necessary to separate them before they can be removed. To accomplish this I arrange a shaft parallel to the axis of the drum, provided with radiating arms which carry steam-pipes, to which steam is admitted from a steam-vessel. These tubes, coming in contact with the ice by the rotation of the drum and being heated, will make incisions in the ice, thus separating the blocks of ice contained in the cells of the drum from the wood blocks between the said cells and allow the said blocks of ice to fall out during the rotation of the drum.

If the machine is to be used simply for refrigerating purposes without the production of ice, the drum will be dispensed with and the coil *e* be placed in the refrigerating-space in contact with such bodies as are to be cooled.

I am aware that the piston and internal parts of a pump of an ice-machine have been lubricated with glycerine, and I am also aware that a drip cup or trap has been placed in the pipe leading from the pump to the condenser, and connected with the induction-pipe by a small pipe provided with a cock, so that when the said cock is opened the glycerine in the drip cup or trap will be forced back into the induction, to be again utilized by the pressure of the gas on its passage to the condenser; but

What I claim, and desire to secure by Letters Patent, is—

1. In combination with the pump P, the delivery-pipe H I, and the refrigerating-chamber E, the conduit *o* and the exhaust *z*, having smaller areas than the delivery-pipe H I, substantially as and for the purpose set forth.

2. In a refrigerating or ice-making apparatus, the combination, with the pump P and the condenser C, of the glycerine-chamber G, placed in the delivery-pipe H I and connected directly with the stuffing-box of the pump, whereby the glycerine is held under pressure in the said stuffing-box, to pack the same and to lubricate the piston, substantially as described.

3. The revolving drum F, provided with radiating cells, in combination with the refrigerating-chamber E and the evaporating-coil *e* of an ice-machine, substantially as and for the purpose set forth.

4. The revolving device *b*, consisting of a shaft provided with radial arms, carrying steam or hot-water pipes, in combination with the revolving drum F and the chamber E, substantially as and for the purpose set forth.

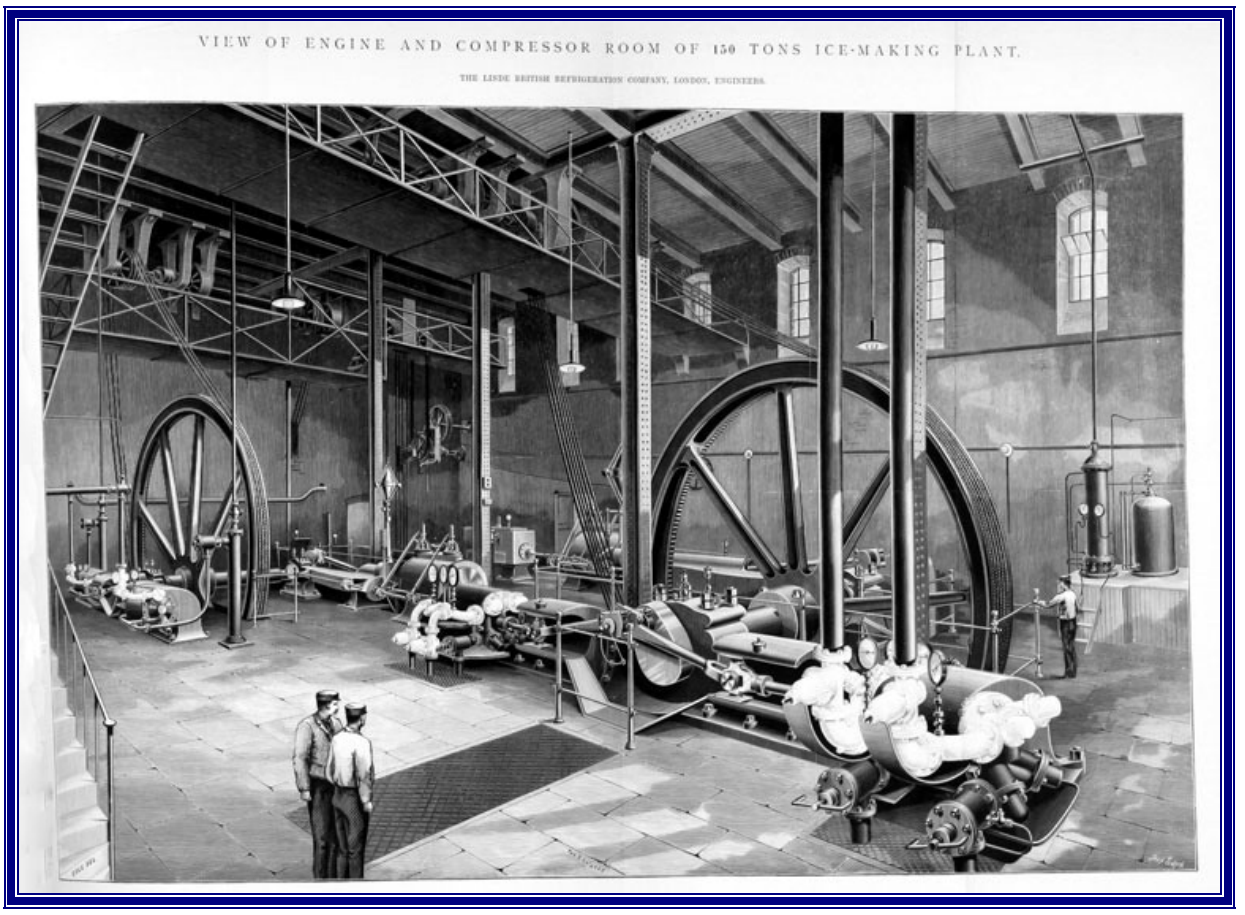
In testimony that I claim the foregoing I have hereunto set my hand this 27th day of May, 1879.

CHARLES LINDE.

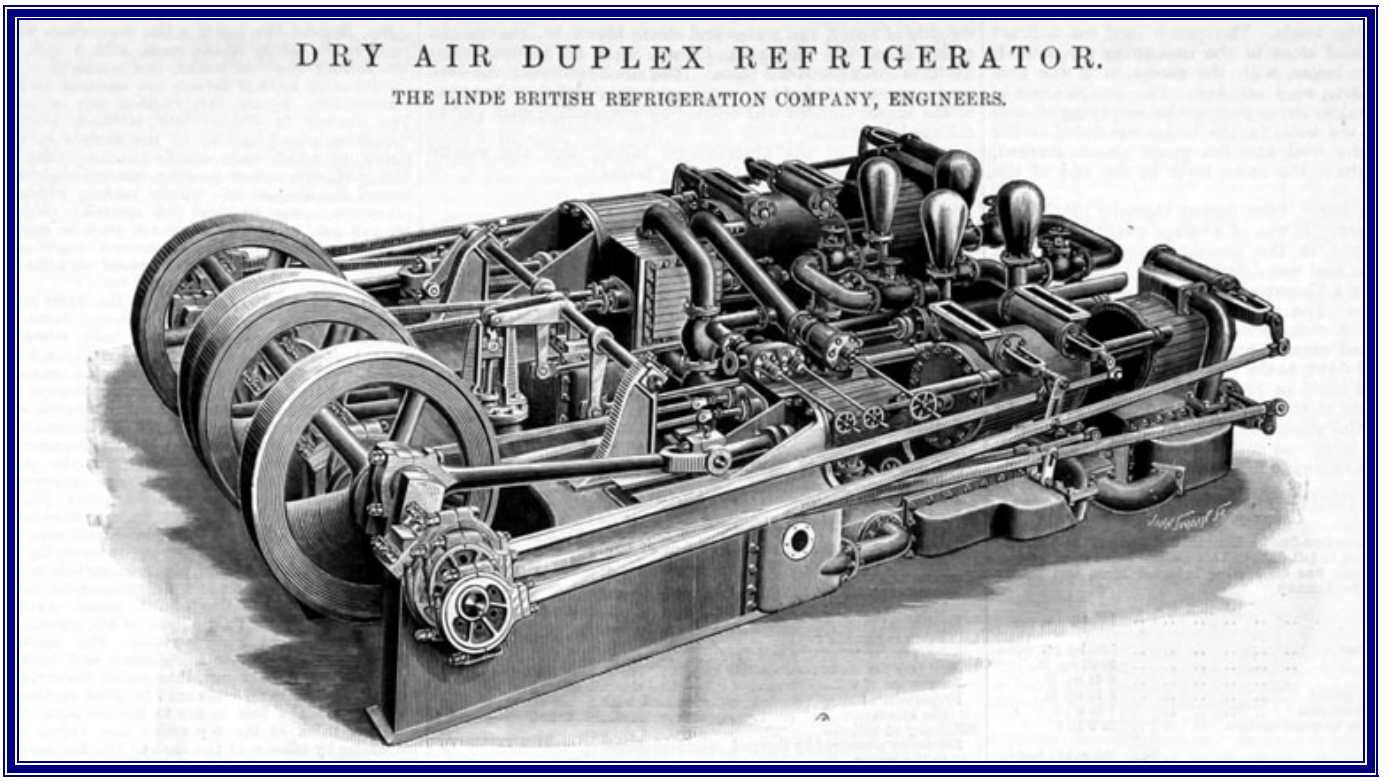
Witnesses:
FRANZ MARSCHALL,
FRANZ WIRTH.

January, 1888

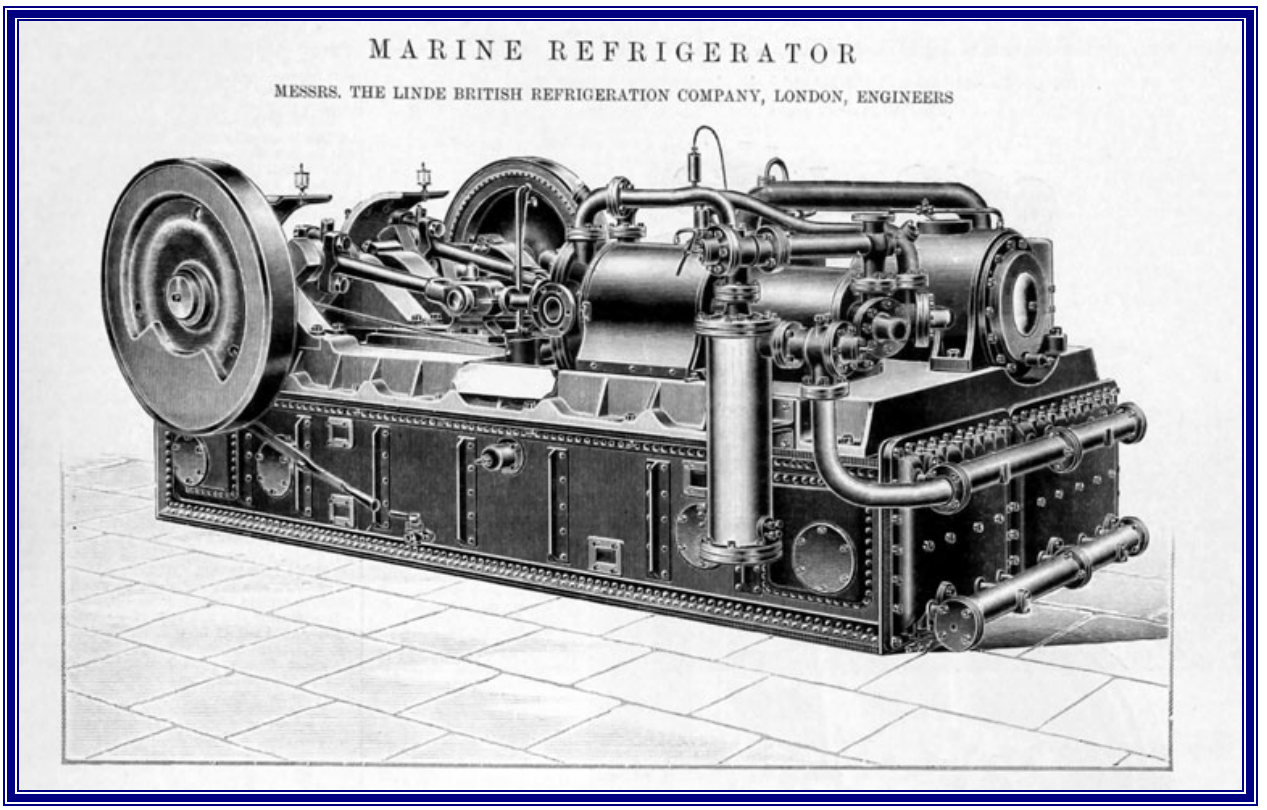
June, 1888



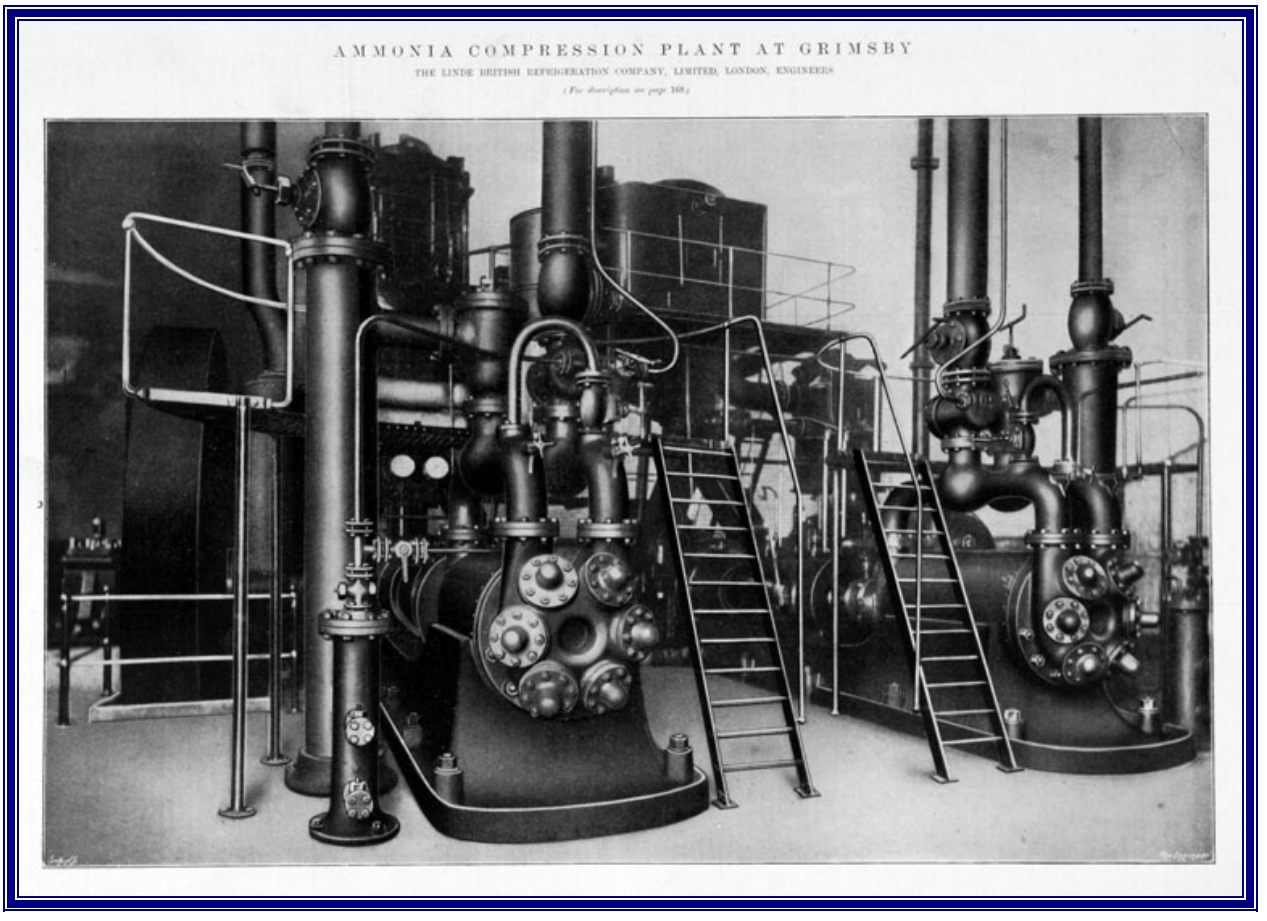
Linde Engine & Compressor Room of 150 ton ice-making plant, 1890



Linde Dry Air Duplex refrigerating machine, 1891



Linde marine refrigerating machine, 1899

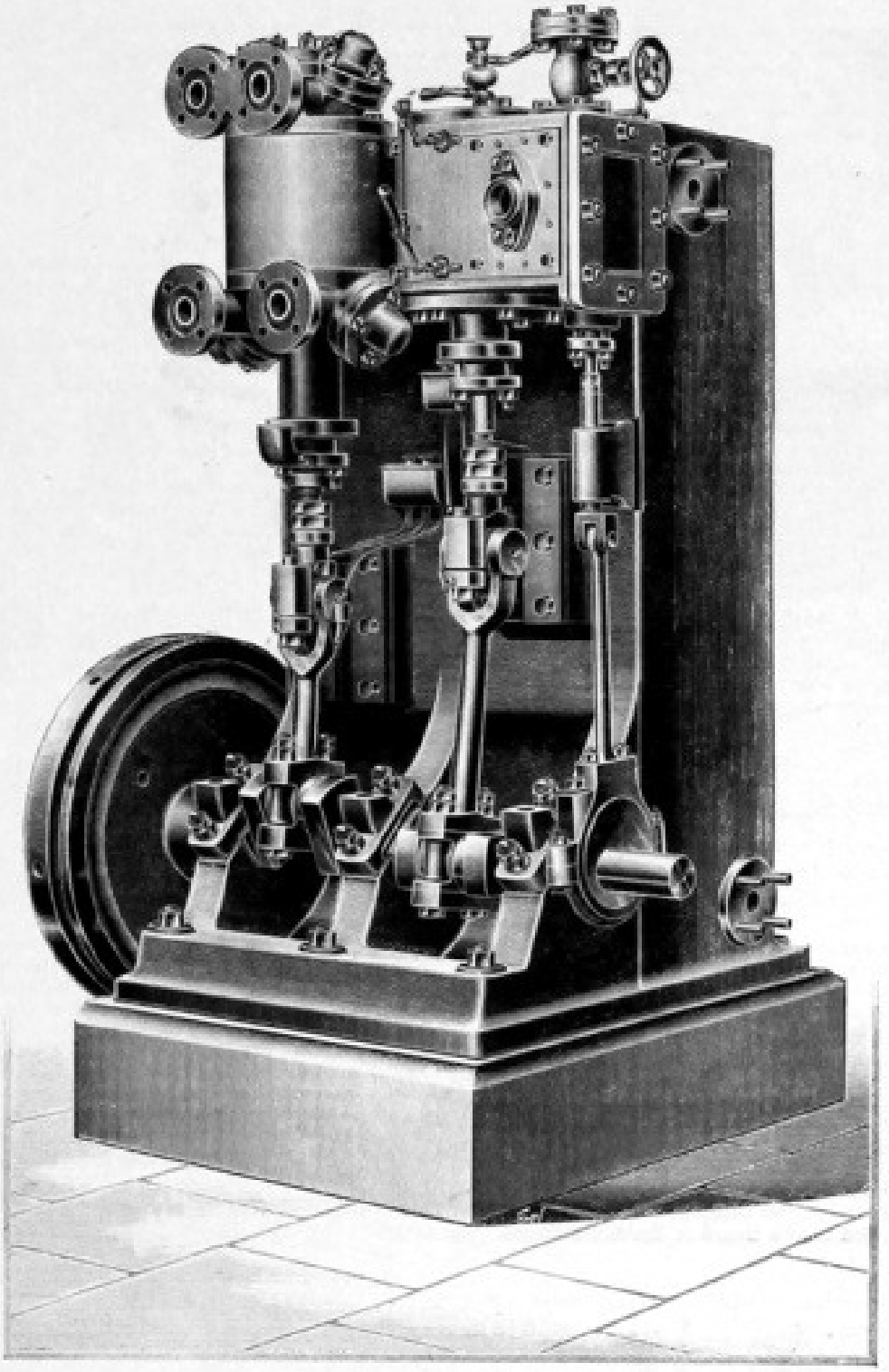


Linde ammonia compressor installation at Grimsby, 1910

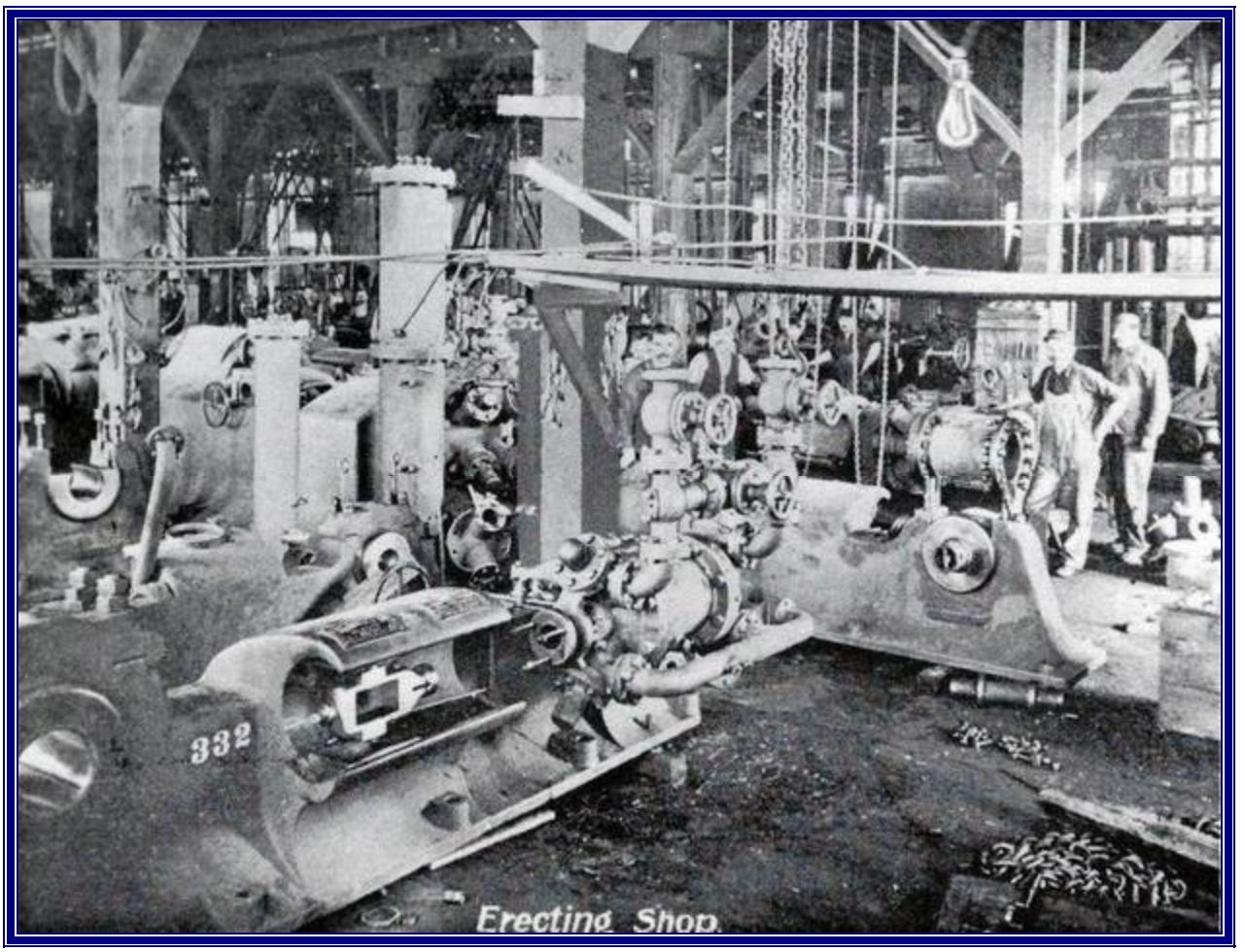
MARINE REFRIGERATOR FOR PASSENGER VESSELS

MESSRS. THE LINDE BRITISH REFRIGERATION CO., LONDON, ENGINEERS

(*For description see page 65*)

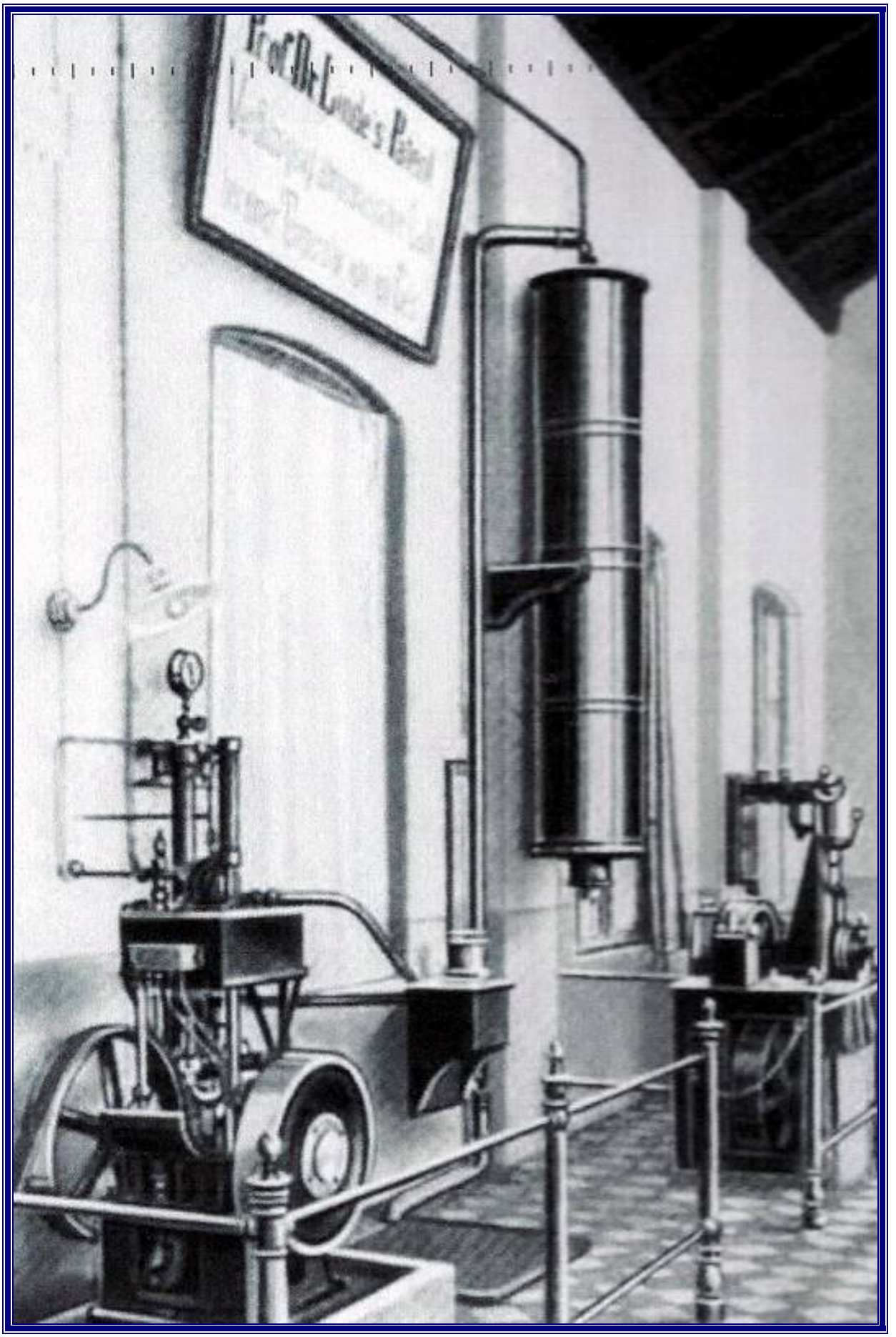


Linde marine refrigerating machine for passenger vessels, 1899

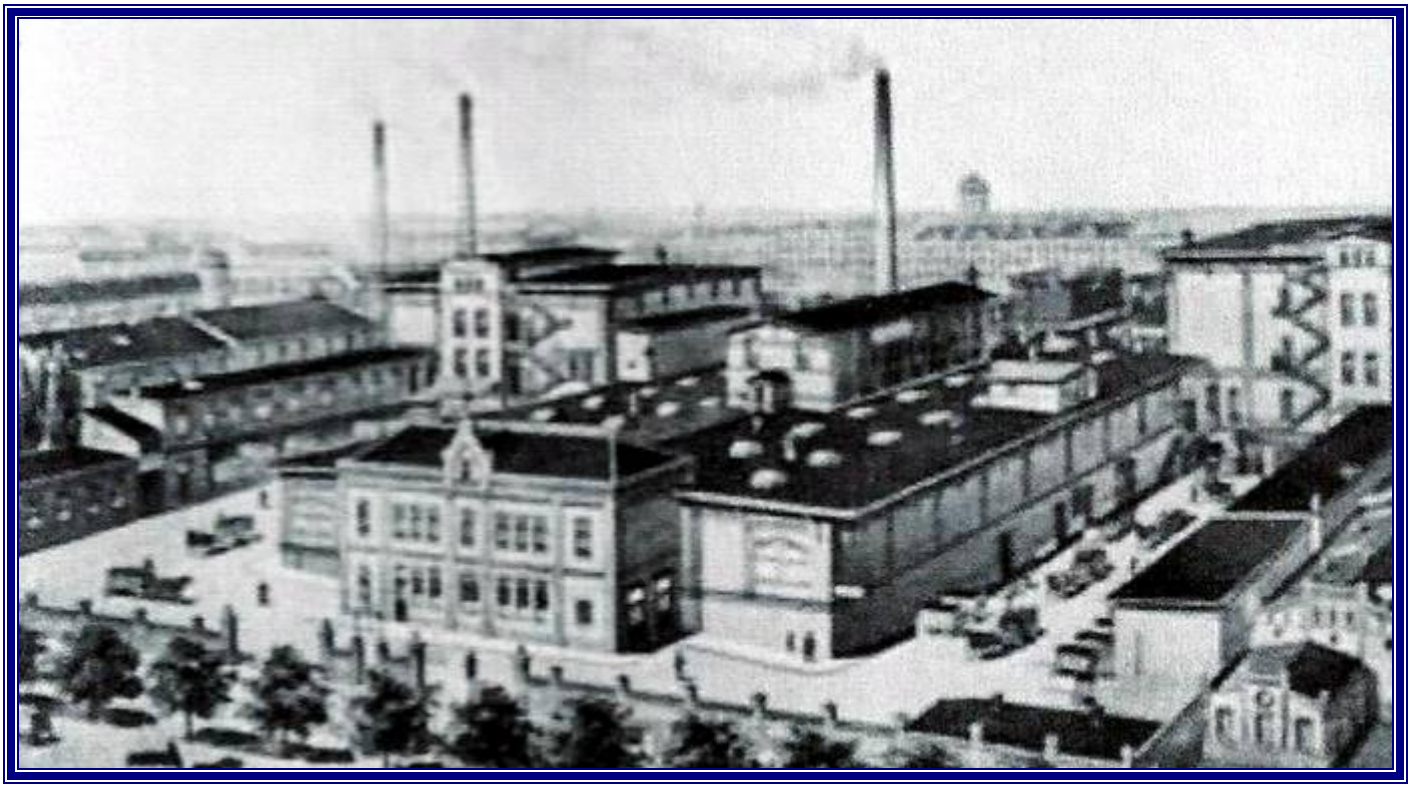


Assembly of Linde horizontal compressors at Fred R Wolf Company in Chicago, 1900

Advertisement of 1923



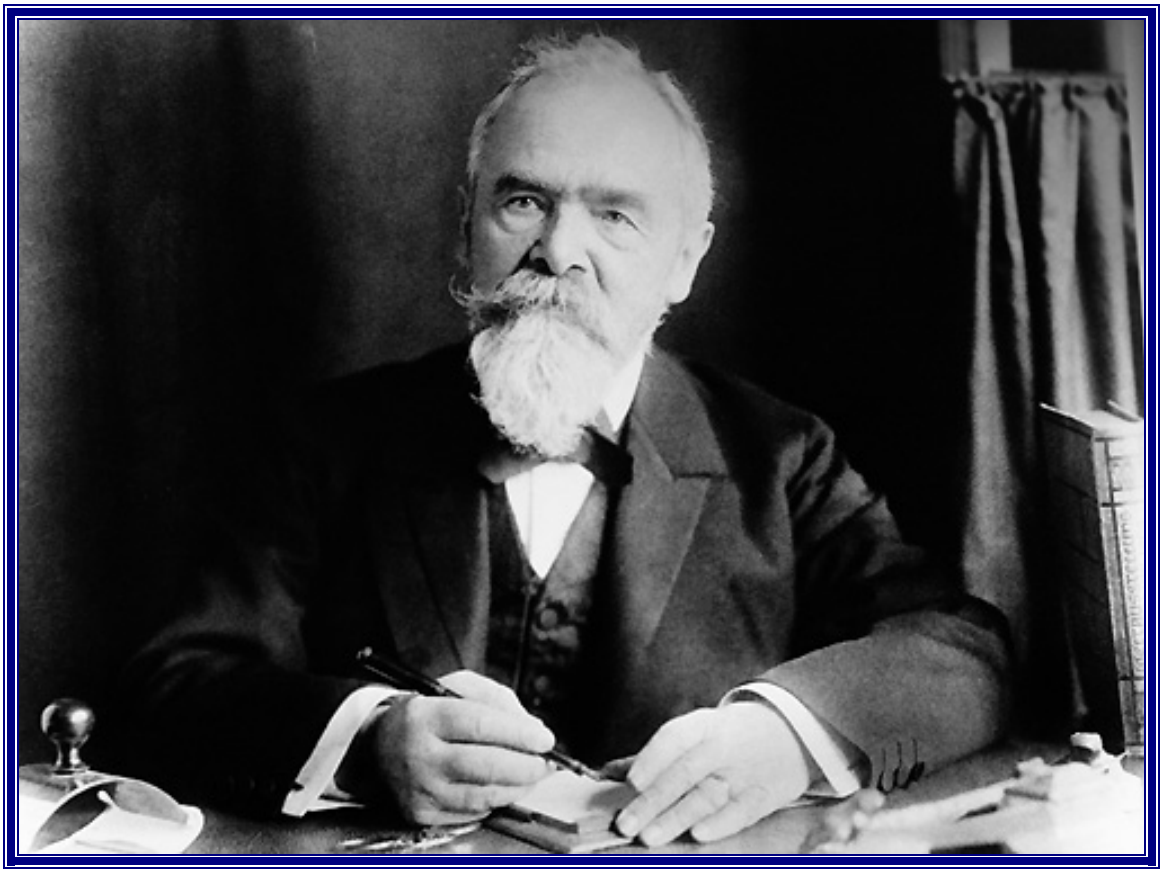
Linde Air Liquefaction Plant, Bavarian Industrial & Commercial Exhibition, Nuremberg, 1896



Linde Plant for Chilling Food & Ice-Making, Hamburg, 1892

A Linde Engineering Office in 1910

The Linde Family with Carl seated in the front row



Carl von Linde

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