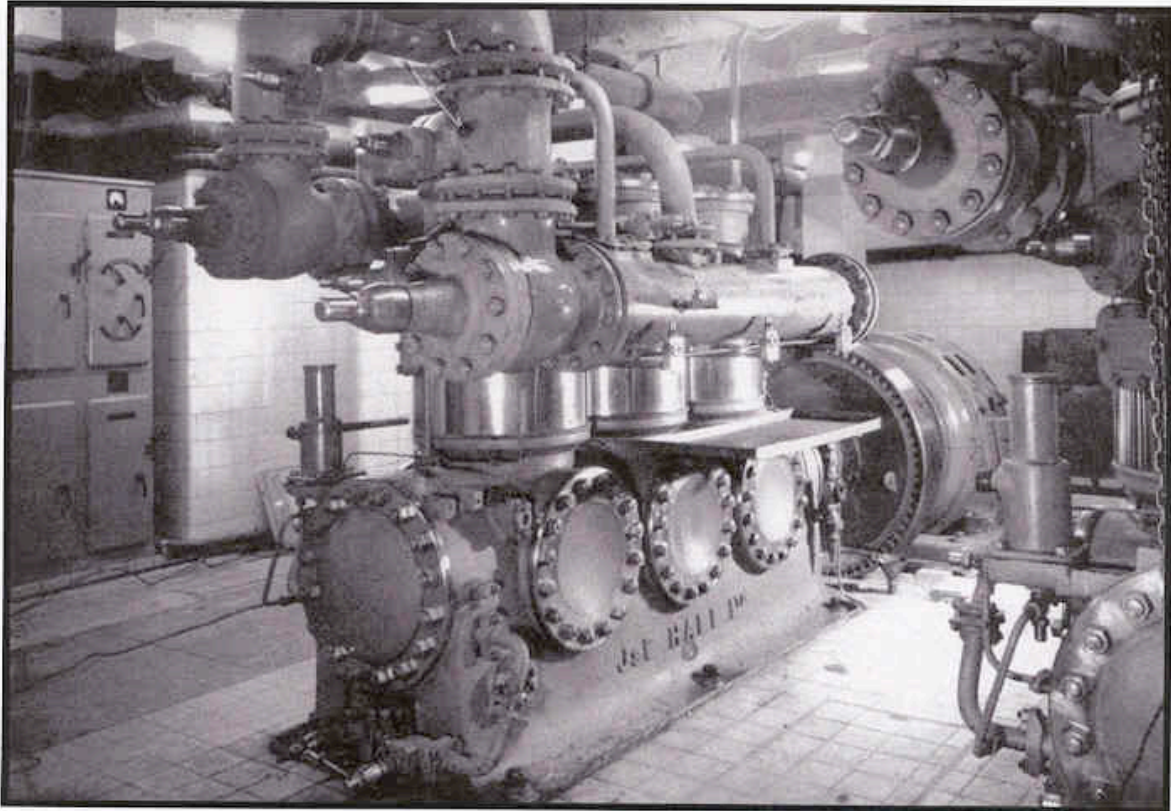


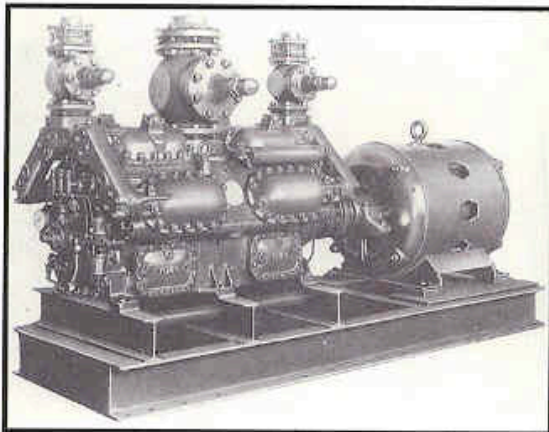
Linde steam engine driven ammonia compressor, early 1900s.

Reciprocating Refrigerating Machines

The prototype machine of Perkins was improved upon by Twining in the USA around 1850, but the first commercially produced machine was that of James Harrison. He was a Scotsman who had emigrated to Australia where he developed a small ice-making machine with a compressor using ethyl ether as the refrigerant. He obtained British patents in 1856 and 1857 and had the firm of Siebe Bros in London construct his machine. Another Scotsman, David Boyle, went to live in the USA where he obtained a patent in 1872 for a compressor using ammonia as the refrigerant. However, it was Professor Carl von Linde who is widely credited as being the inventor to the ammonia compressor, his first machine being constructed in 1876. He made important improvements over the next few years. In 1877, Linde erected a 100 TR plant in England. In 1885 the Linde British Refrigeration Company was set up to manufacture ammonia compression systems and went on to produce machines of different design to the German company.

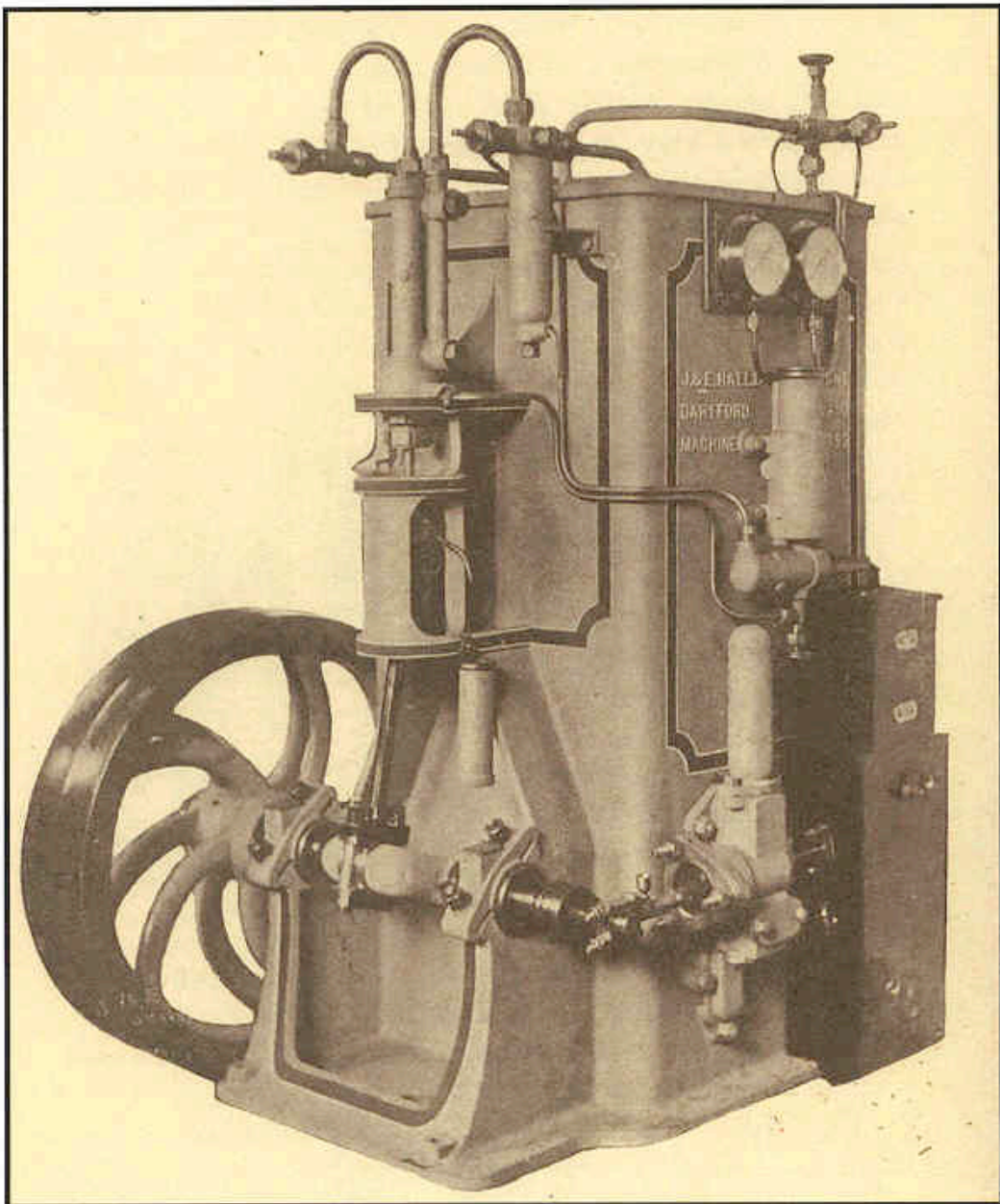


Two 3-cylinder reciprocating refrigerating compressors by J & E Hall, each driven by a 240 hp electric motor. The second machine is partly visible (extreme right). House of Commons air conditioning (Benham & Sons) 1951.

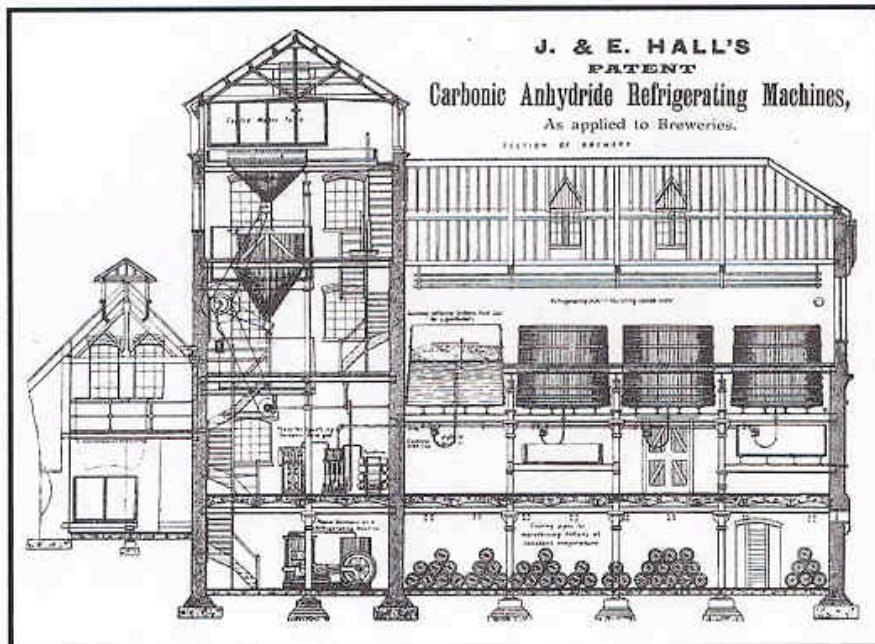


16-cylinder V/W arrangement, direct-drive reciprocating compressor (100 TR), York, 1956.

*A mechanical compression machine utilises the evaporation of a liquid refrigerant to absorb heat and lower the temperature of its surroundings at the **evaporator**. The **compressor** pumps this gas at high pressure to the **condenser** where the refrigerant vapour is liquefied and rejects heat to raise the temperature of its surroundings. A throttling device or **expansion valve** meters the flow of refrigerant to the evaporator.*

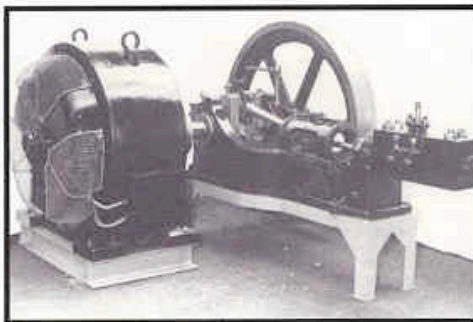


*Carbonic Anhydride (carbon-dioxide) belt-driven land type compressor
with the steam engine part of the machine itself.
J & E Hall of Dartford c.1900*

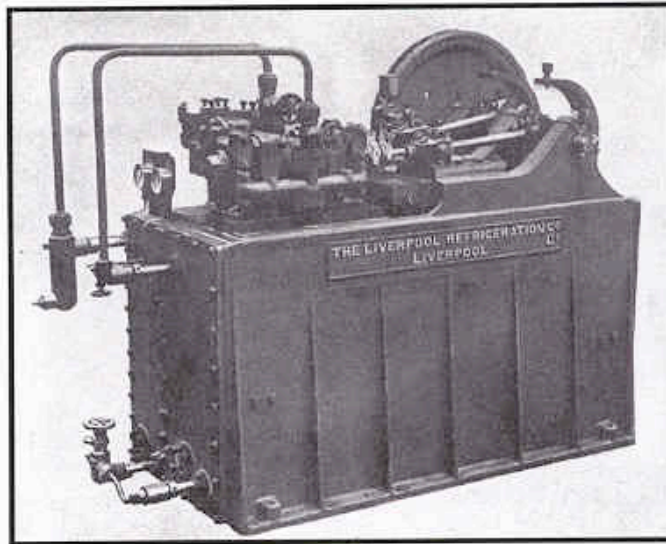


J & E Hall's carbon dioxide machines (lower left) used in a brewery

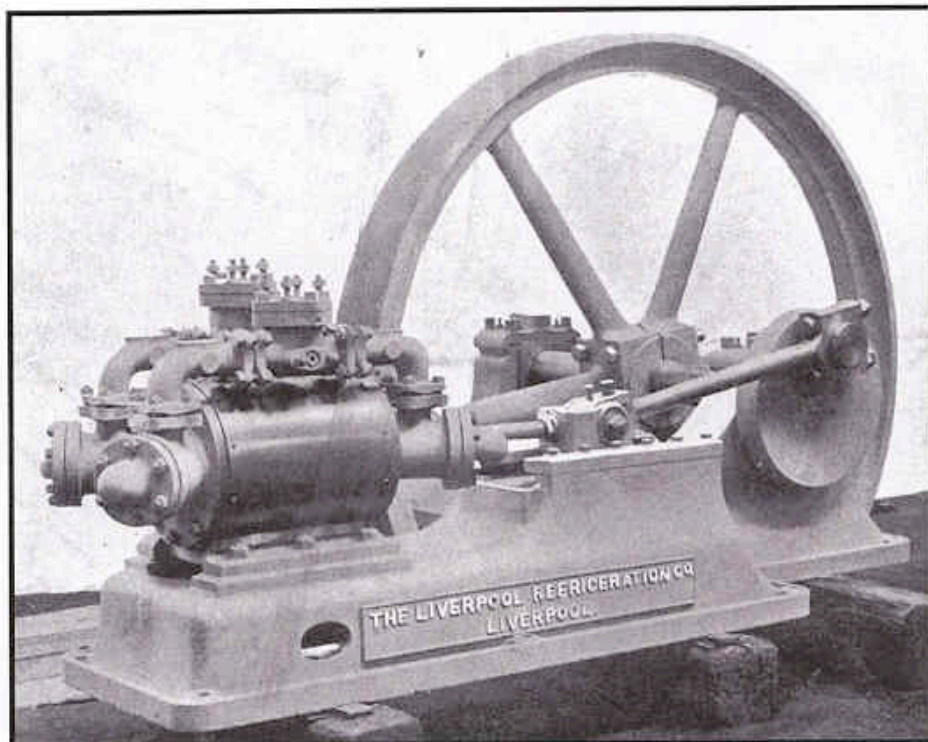
In 1887 J & E Hall acquired the manufacturing rights to the German carbon dioxide refrigerating compressor patents of Franz Windhausen. In 1889 a machine of this type was installed in a frozen meat store in Smithfield Market. On test it exploded. To avoid future accidents Halls invented a safety valve and modified the compressor design. This machine of Halls went on to dominate the refrigerated shipping market and found extensive use on land, particularly in breweries.



Single cylinder electric motor driven carbon dioxide compressor installed in a cold store in London's dockside Tooley Street, J & E Hall 1914.



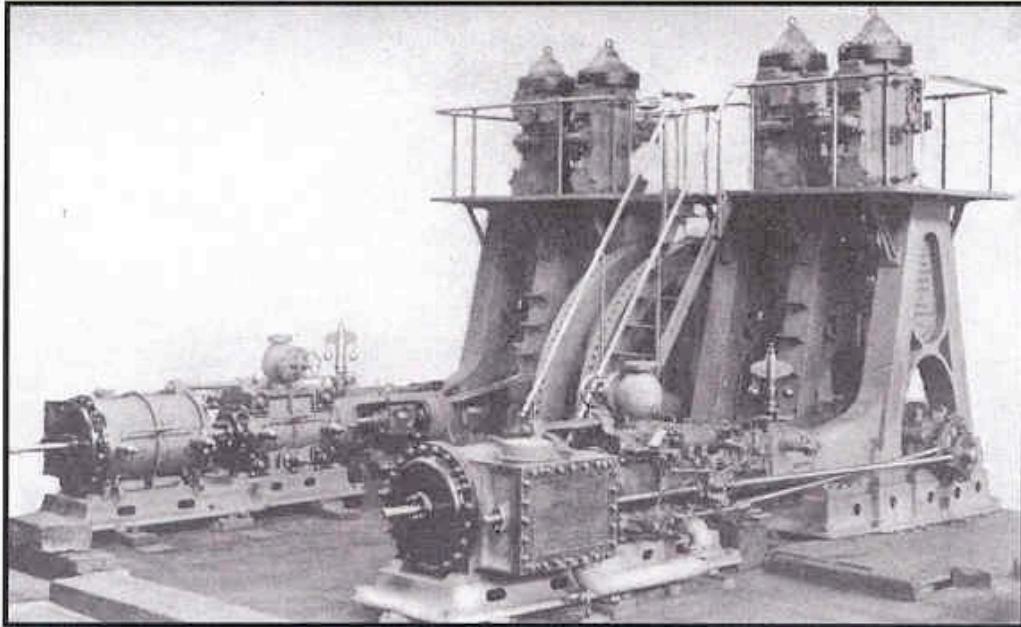
Submerged condenser unit (refrigerant coils in water tank), Liverpool Refrigeration 1908.



Belt-driven compressor, Liverpool Refrigeration 1908

In 1874 Raoul Pictet of Switzerland designed the first sulphur dioxide refrigerating compressor. This type of machine proved popular in continental Europe. In England it was made by William Douglas & Sons from 1899 to 1926. (This firm later used compressors from the Vilter, the American manufacturer).

Another British manufacturer, from before 1890, was Louis Sterne in Glasgow, who initially used De La Vergne ammonia compressors in some designs. In the early 1900s, compressors were also manufactured by Haslam & Company in Derby, and by Liverpool Refrigeration.



Two compound horizontal steam engines, each driving 2-vertical double acting De La Vergne ammonia compressors, L Sterne c.1900.

Early British compressors had horizontal cylinders while vertical cylinders were common in the USA. The first large compressors, driven by steam engines, operated at very low speeds, about 60 rev/min in 1900. They occupied considerable space but often lasted for fifty years or more. Gradually speeds increased, reaching over 200 rev/min by 1916. By the 1920s the steam engine drive had largely given way to electric motors and belt drive gave way to direct drive.

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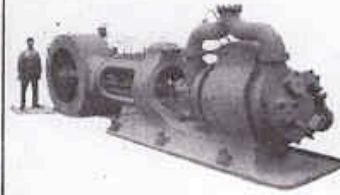
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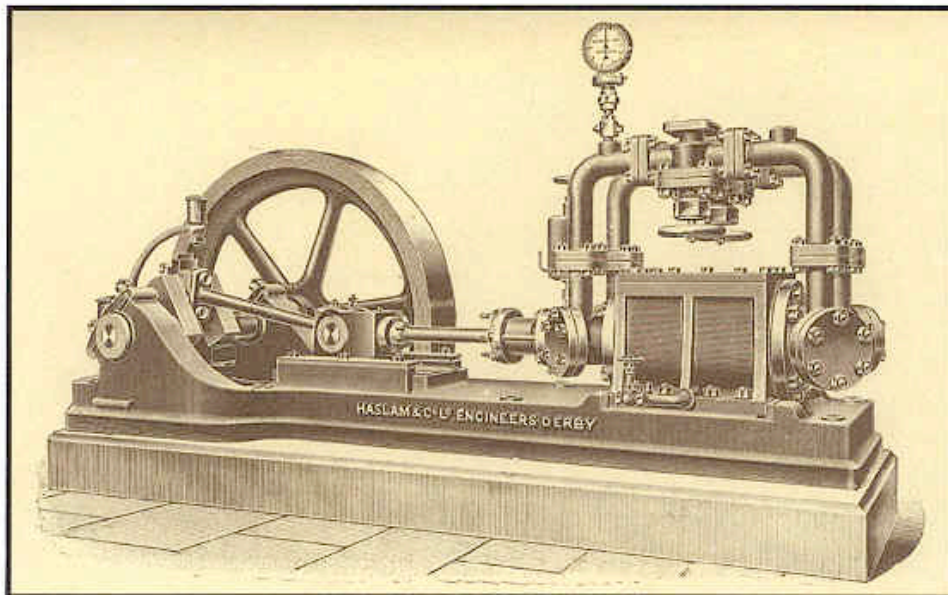


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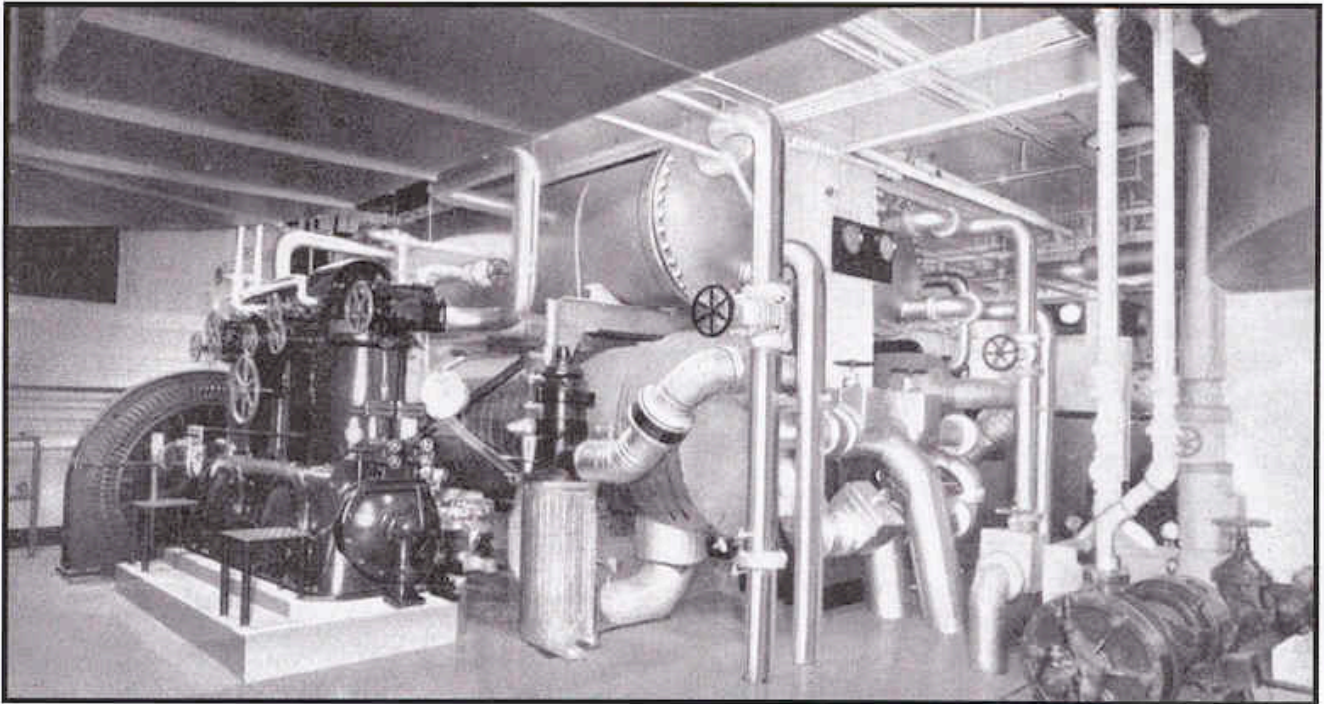
Ammonia compressor, Sulzer (410 TR) 1921



Belt-driven compressor, Haslam & Company, Derby 1908

Other makers providing reciprocating compressor equipment for the UK market post World War II include Lightfoot Refrigeration at Wembley, Sulzer Bros of Switzerland and York Shipley, London (York Corp, USA).

After the War reciprocating compressor design improvements and mass production methods, similar to those in motorcar engine manufacture, were introduced. Units became available with from 1 to 16 cylinders, the larger numbers being arranged in V, W or radial formation. Compressors used direct drive motors running at 1450 or even 2800 rev/min. York Shipley manufactured equipment in the UK. A number of American air conditioning manufacturers marketed refrigerating equipment, particularly packaged water chillers, in the UK. Firms included Carlyle (US Carrier), American Standard, Trane Company, Chrysler and Dunham-Bush.



Reciprocating water-chilling unit for air conditioning, York-Shipley 1936