Refrigeration in American Breweries 1860-1920

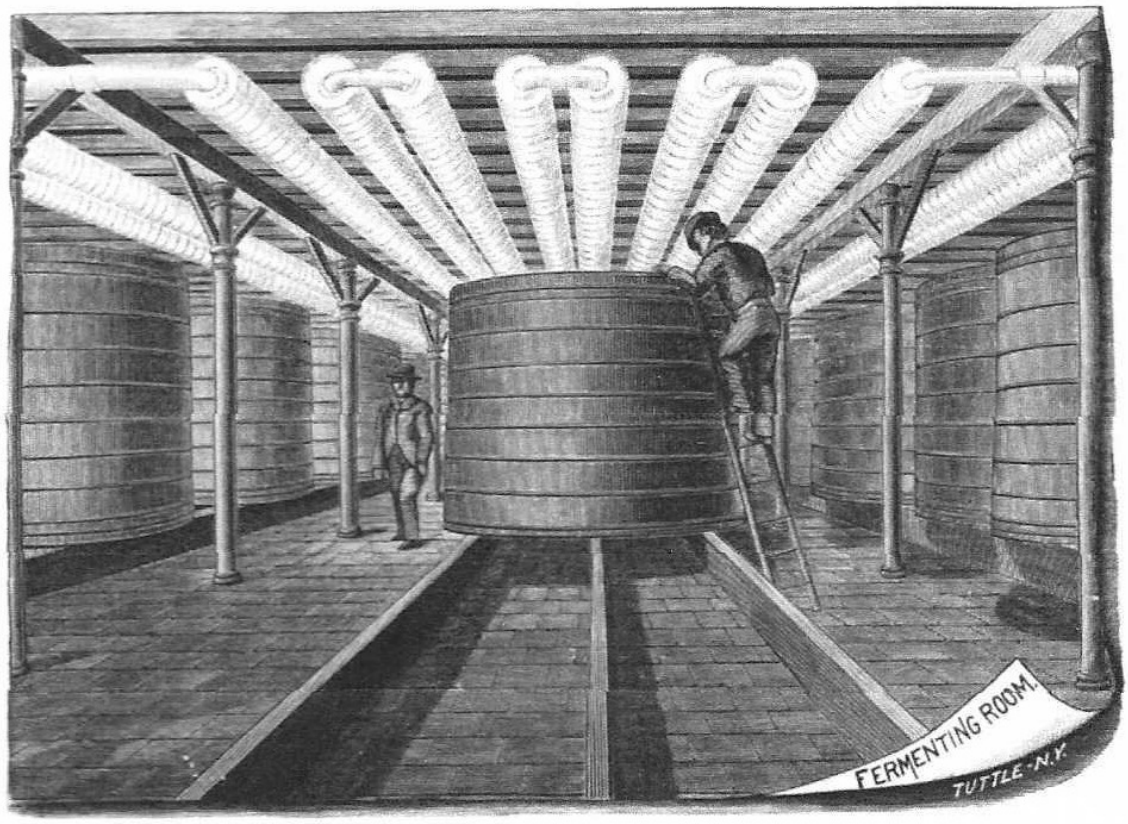

PLATE 13.—Fermenting-Room.

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CIBSE HERITAGE GROUP

Refrigeration in American Breweries 1860-1920

Introduction

The Heritage Group has considerable information on the history of Refrigeration covering systems, equipment, installations and manufacturers. In addition, the Heritage Group Archive, compiled over some forty-five years, holds a large collection of textbooks, catalogues and technical papers on the subject.

However, UK information on **Refrigeration in American Breweries** is small, one reason being the difference in brewing techniques between the Great Britain and the United States. Traditionally, Great Britain used the **top fermentation** process in making beer. However, from the beginning of the 19th century, breweries in some countries began to adopt **bottom fermentation**, which requires lower temperatures both for brewing and storage. The standard was set by Germany with its lager, this type of beer being introduced into the United States around 1840. Without control of temperature, good quality lager could only be made in spring and autumn. Thus lager breweries became large users of natural ice. In the United States, some breweries each used as much as 30,000 tons of ice each year, being difficult to handle, and so became increasingly attracted to the developments in refrigeration.* This was particularly important in the Southern States where supplies of natural ice were cut off during the Civil War.

*It has been said that British breweries were less interested in refrigeration, because they used top fermentation, but by 1900 there existed many refrigerated warehouses for hops. Also, ice-making and cold stores were important growth areas.

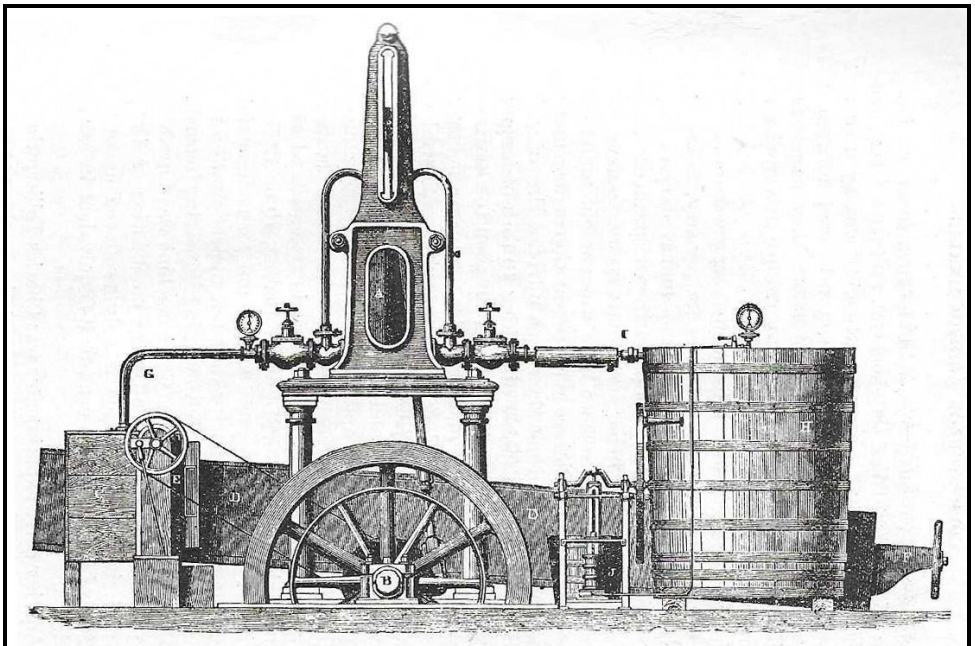


FIG. 2

HARRISON ETHER MACHINE, EXHIBITED IN 1851 BY SIEBE & CO. A–DOUBLE-ACTING AIR PUMP; B–REFRIGERATOR; C–ETHER COOLER; D–SELF-ACTING DELIVERY VALVE; E–ICE-MAKING TANK; G–CENTRIFUGAL PUMP

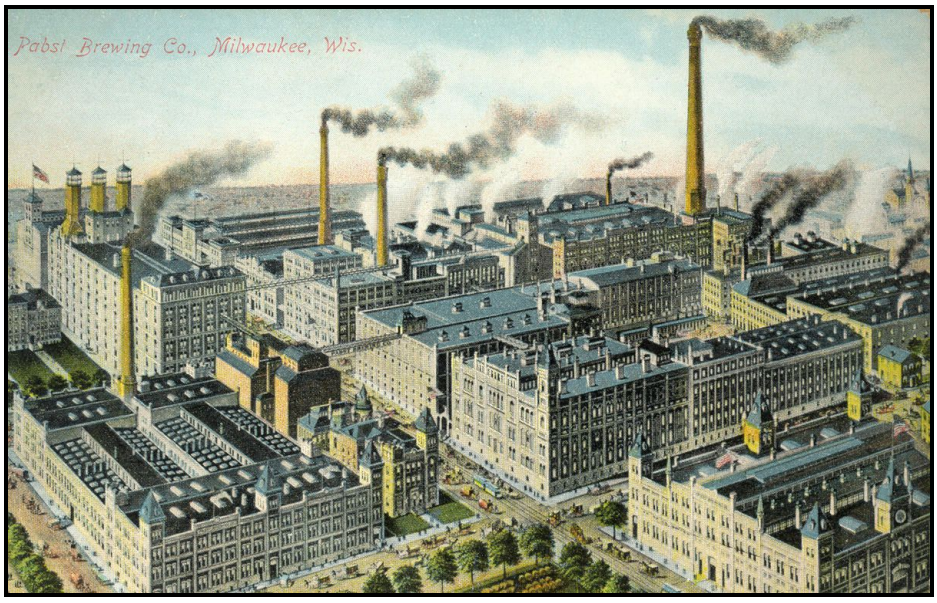
Refrigeration in American Breweries 1860-1920

This ebook starts from **1860**, when James Harrison installed his ether refrigerating compressor in the Bendigo Brewery near Melbourne, Australia. Over the next 25-30 years, many breweries across mainland Europe installed refrigeration systems, often using ice water or brine with the Baudelot cooler (a vertical bank of tubes through which a cold fluid circulates and over the outside of which the hot beer wort flows). From around 1890, experiments with direct-expansion refrigeration systems began, while refrigeration was also used for the storage of beer.

The development of refrigeration machines and the growth of this industry was hastened by the significant increase in the output of beer (and also by the demand for artificial ice making and cold storage in other industries). This is shown in statistics for the American brewing industry:

YEAR	NATIONAL PRODUCTION MILLIONS OF BARRELS	NUMBER OF BREWERIES	AVERAGE BREWERY SIZE THOUSANDS OF BARRELS
1865	3.7	2252	1643
1870	6.6	3286	2009
1875	9.5	2783	3414
1880	13.3	2741	4852
1885	19.2	2230	8610
1890	27.6	2156	12801
1895	33.6	1771	18972
1900	39.5	1816	21751
1910	59.6	1568	38010
1915	59.8	1345	44461

Over the 50 years of this survey, United States beer production increased by a factor of 16, while the number of breweries fell by 40%. However, what is significant is that the average production of the remaining breweries rose by a factor of 27, demonstrating the enormous increase in size of the leading breweries. Leading examples are the Pabst Brewing Company and the Schlitz Brewery, both in Milwaukee, and Anheuser Busch in St. Louis.

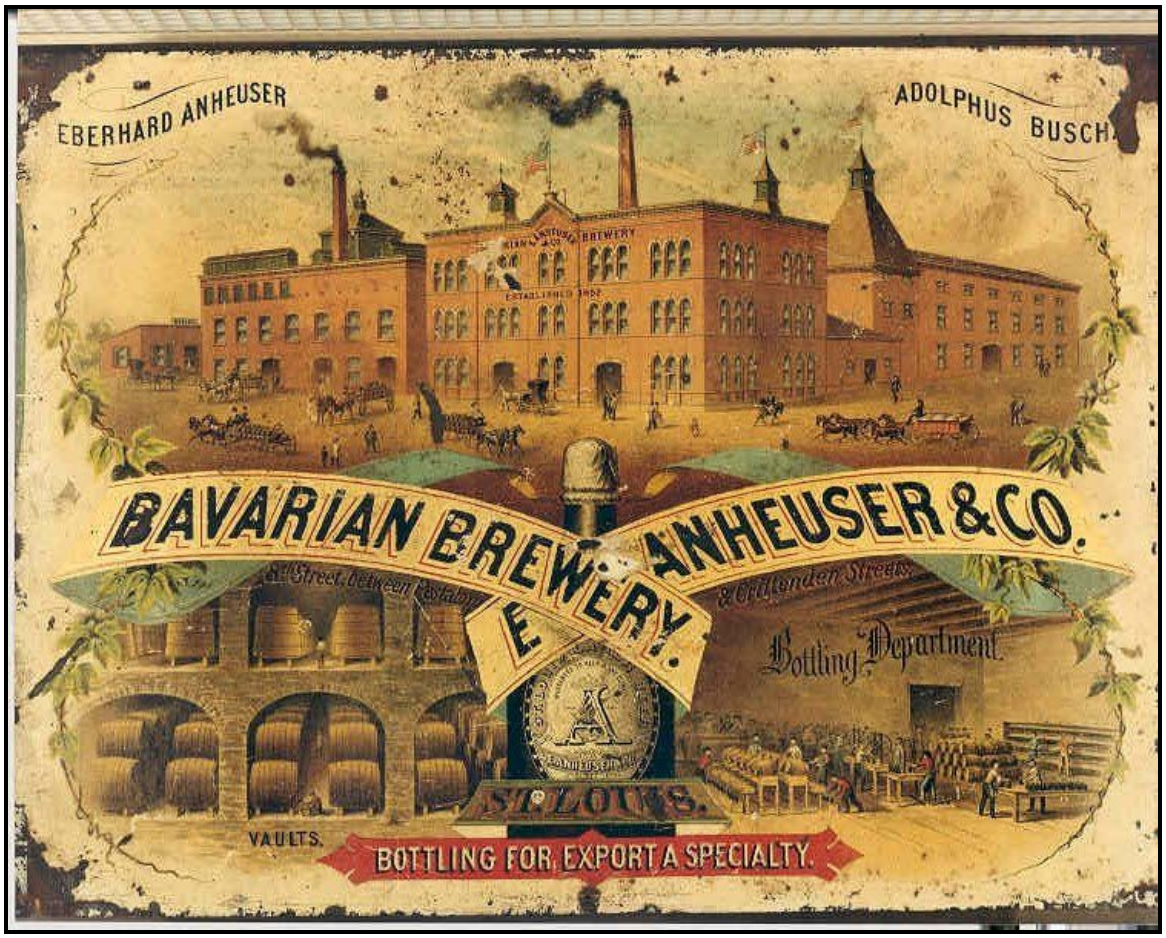


KEG-BEER BRANDS:
BUDWEISER,
PILSENER,
WIENER,
ERLANGER,
CULMBACHER,
"SCHLITZ-BRÄU."

Jos. Schlitz Brewing Co.
MILWAUKEE

BOTTLED-BEER BRANDS:
PILSENER,
EXTRA-PALE,
EXTRA-STOUT,
"SCHLITZ-PORTER."

ANNUAL CAPACITY: ONE MILLION BARRELS OF BEER.



This was accompanied by a tremendous growth in the provision of brewery refrigeration (see for example the list of installations in Section **[8] De La Vergne Refrigerating Machine Company**, catalogue of 1890).

LIST OF CUSTOMERS.

January 1, 1890.

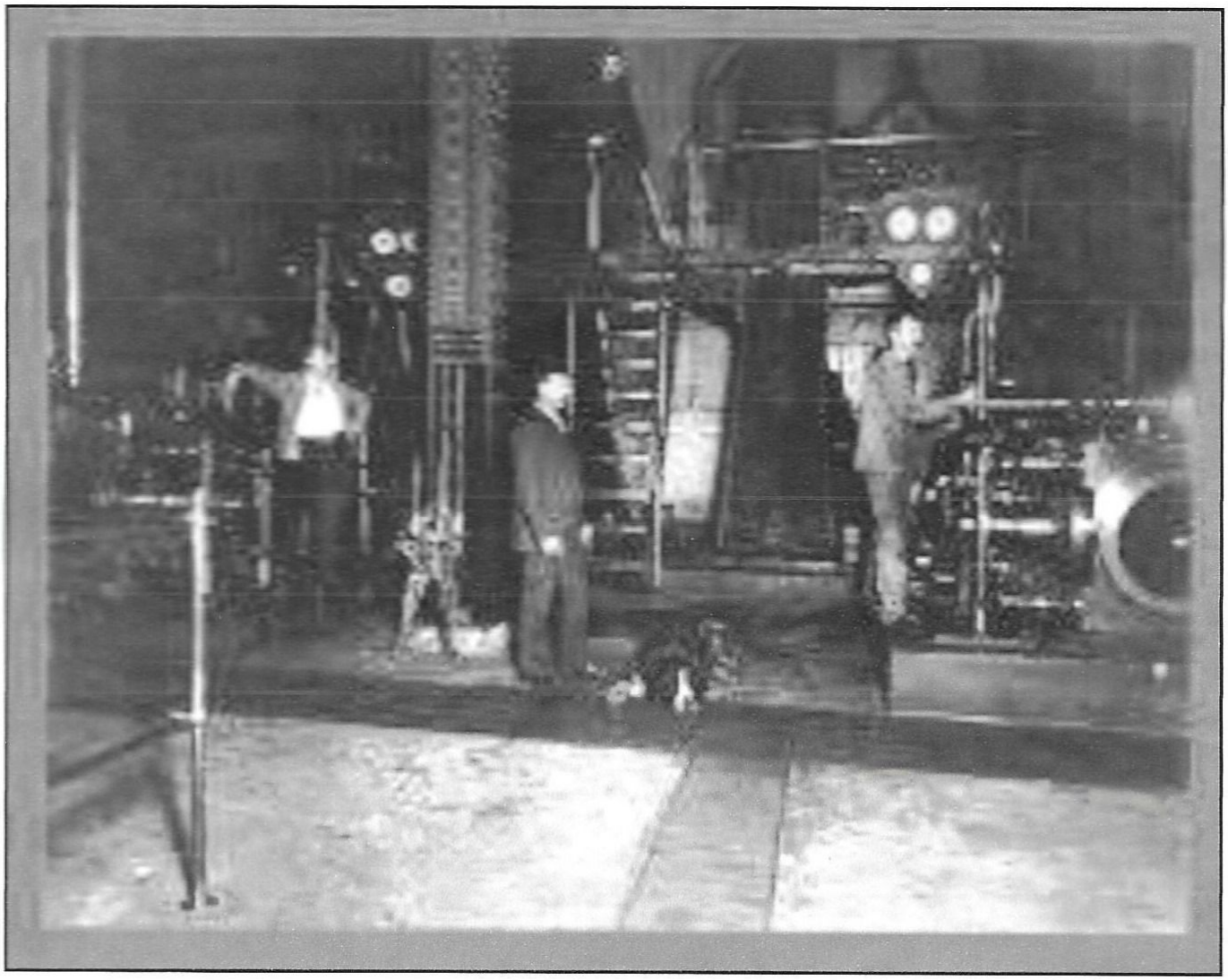
The De La Vergne Refrigerating Machine Co.,

Foot of East 138th Street, NEW YORK CITY.

BREWERIES.

Name.	Address.	Number of Machines.	Total Refrigeration.	Year of Completion.
Jacob Ruppert	New York	One 110-ton	=110 tons	1884
Jacob Ruppert—Second Order	New York	Two 110 "	220 "	1885
George Ehret	New York	One 110 "	110 "	1885
George Ehret—Second Order	New York	Two 110 "	220 "	1885
William J. Lemp	St. Louis, Mo.	Two 110 "	220 "	1888
William J. Lemp—Second Order	St. Louis, Mo.	One 110 "	110 "	1889
Bernheimer & Schmid	New York	One 220 "	220 "	1888
†Anheuser-Busch Brewing Ass'n	St. Louis, Mo.	One 110 "	110 "	1886
Anheuser-Busch Brewing Ass'n—Second Order	Kansas City, Mo	One 12 "	12 "	1886
†Anheuser-Busch Brewing Ass'n—Third Order	St. Louis, Mo.	One 110 "	110 "	1889
Anheuser-Busch Brewing Ass'n—Fourth Order	Dallas, Texas.	One 4 "	4 "	1889
(For Fifth and Sixth orders from Anheuser-Busch Brewing Association, see Artificial Ice Plants.)				
Budweiser Brewing Co., Lim'd	Brooklyn, N. Y.	One 110 "	110 "	1886
*L. Schlather Brewing Co.	Cleveland, Ohio.	One 110 "	110 "	1888
Hinckel Brewing Co.	*Albany, N. Y.*	*One 100 "*	*100 "*	*1889*
Joseph Schlitz Brewing Co.—First Order	Memphis, Tenn.	One 4 "	4 "	1886
Joseph Schlitz Brewing Co.—Second Order	Milwaukee, Wis.	One 100 "	100 "	1890
Eberhardt & Ober Brewing Co.	Pittsburgh, Pa.	One 100 "	100 "	1890
†Hyde Park Brewery Co.	St. Louis, Mo	One 75 "	75 "	1886
†Pabst Brewing Co.	Milwaukee, Wis.	One 75 "	75 "	1886
*John Wieland Brewing Co.	San Francisco, Cal.	One 75 "	75 "	1889
Falk, Jung & Borchert Brewing Co.	Milwaukee, Wis.	One 75 "	75 "	1889
Ballantine & Co.	Newark, N. J.	One 64 "	64 "	1882
Ballantine & Co.—Second Order	Newark, N. J.	One 110 "	110 "	1886
Ballantine & Co.—Third Order	Newark, N. J.	Two 100 "	200 "	1890
†Bergner & Engel Brewing Co.	Philadelphia, Pa.	One 50 "	50 "	1884
†Bergner & Engel Brewing Co.—Second Order	Philadelphia, Pa.	One 50 "	50 "	1885
†Bergner & Engel Brewing Co.—Third Order	Philadelphia, Pa.	One 110 "	110 "	1888
†Bartholomay Brewing Co.	Rochester, N. Y.	One 50 "	50 "	1886
Bartholomay Brewing Co.—Second Order	Rochester, N. Y.	Two 50 "	100 "	1887

However, all this changed in **1920**, the end date of this ebook, due to the introduction of Prohibition (the Volstead Act), which banned the production, distribution and drinking of beer and spirits. Breweries closed, workers lost their jobs, though a few breweries survived by making non-alcoholic beverages. This continued until 1933 when the Volstead Act was repealed. A few photographs of brewery refrigeration plant from after Prohibition have been included; those from before being scarce.



Frick refrigeration machine at the Reymann Brewing Company, Wheeling, West Virginia, undated

BREWERY REFRIGERATION.

In 1909 the ICE AND REFRIGERATION BLUE BOOK recorded a total of 1,248 breweries equipped with 2,448 refrigerating machines, with an aggregate refrigerating capacity of 148,031 tons. In 1911 the BLUE BOOK recorded a total of 1,265 breweries equipped with 2,547 refrigerating machines of an aggregate refrigerating capacity of 159,510 tons each 24 hours. In 1914 the BLUE BOOK records 1,225 brewing plants equipped with 2,456 refrigerating machines having aggregate capacity of 172,871 tons daily.

The total sales of beer for the year ending in June, 1914, according to official reports, amounted to 66,189,473 barrels of 31 gallons each. Assuming that for each barrel of beer brewed yearly a cold storage space of four cubic feet is provided, this would mean that the cold storage or refrigerated space in United States breweries aggregates about 265,000,000 cubic feet. In 1909 the figures were 235,000,000 and in 1904, 192,800,000.

	No. of Breweries Having Ref'g. Plant	No. of Refrigerating Machines	Capacity of Machines in Tons
1904.....	1036	2135	107,025
1909.....	1248	2448	148,031
1911.....	1265	2547	159,510
1914.....	1225	2456	172,871

The largest installation of refrigerating machinery in any one brewing plant is in the brewery of the Anheuser-Busch Brewing Association, St. Louis, Mo., where there are 15 machines, of which eight having a capacity of 1,920 tons refrigeration per day, are used for the brewery proper. This is exclusive of the ice making plant, which has six machines with a total refrigerating capacity of 2,180 tons, besides an auxiliary ice plant of 80 tons capacity. The total capacity of all the refrigerating machines used by the Anheuser-Busch Brewing Association in St. Louis is 4,260 tons daily, and of the ice making plant 1,200 tons daily.

Other large installations of refrigerating plant in breweries are the Jos. Schlitz Brewing Plant, Milwaukee, Wis., 1,910 tons refrigerating capacity, with a 125 ton ice making system, and the Val Blatz Brewing Plant, Milwaukee, Wis., 1,150 tons refrigerating capacity.

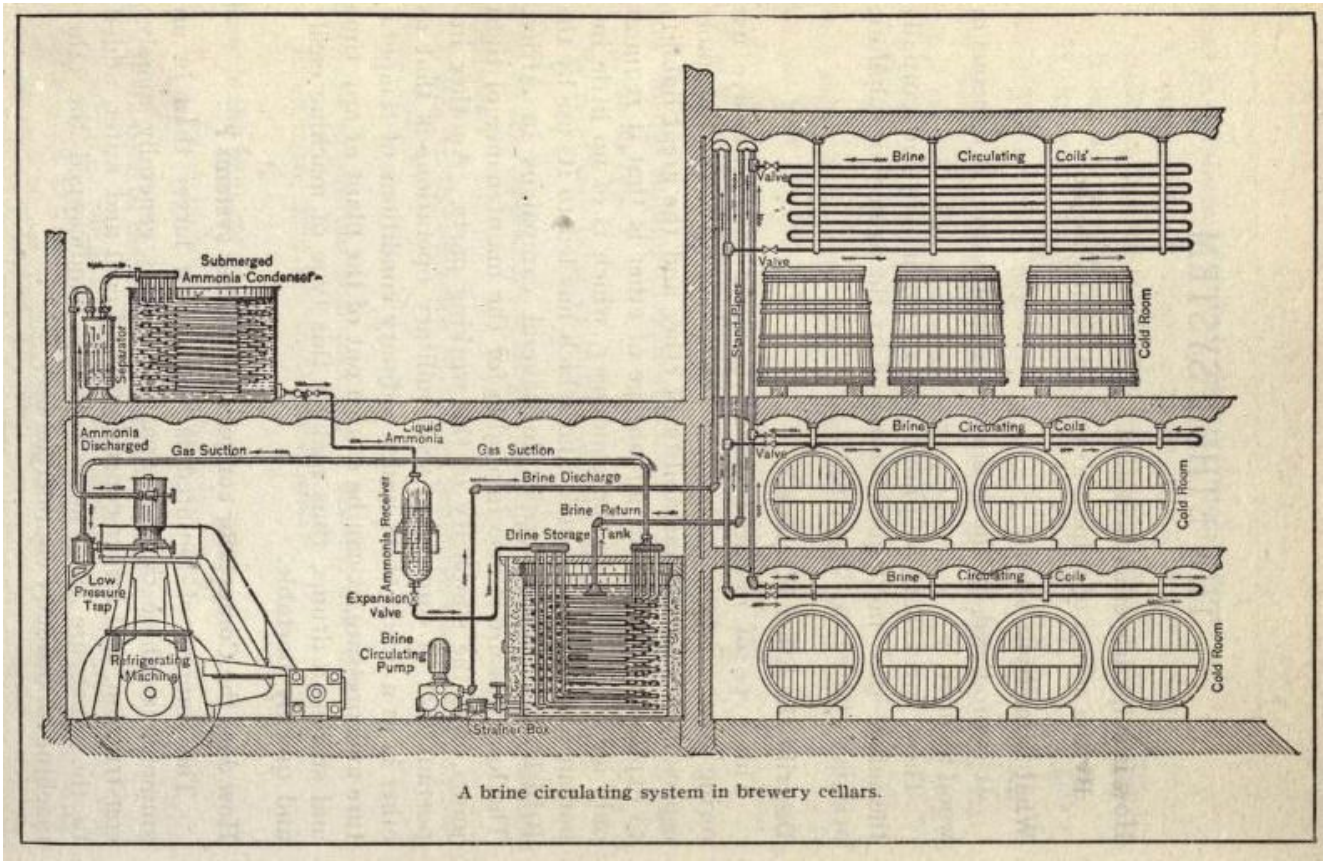
The reduction in the number of breweries is due partly to consolidation, but mainly to operation of prohibition legislation.

VALUE OF BREWERY PRODUCTS.

Over $600,000,000 is invested in brewing operations in slightly under 1,400 breweries in operation in the United States. The total amount of beer produced and marketed during the fiscal year ending in June, 1914, was 66,189,473 barrels of 31 gallons each. The total wholesale value of this beer was approximately $400,000,000, or, considering the large proportion of bottled beer which sells at higher prices than keg beer, the actual value is probably not far from $420,000,000.

Refrigeration in American Breweries 1860-1920

Introduction of Refrigeration in Brewing



A brine circulating system in brewery cellars.

INTERNATIONAL INSTITUTE OF REFRIGERATION, PARIS 1979

2.3. INTRODUCTION OF REFRIGERATION IN BREWING

2.31. It may seem surprising to find a whole chapter, even if brief, devoted to brewing, as part of the evolution of refrigeration during this period from 1875 to 1914, but there are many reasons for it. In the first place, breweries were very large users of natural ice in many countries, since the middle of the 19th century. There were many drawbacks to this practice, and naturally the breweries were among the first to be interested in possibilities of using artificial cold. The relationship with the preceding chapter is quite close because mechanical refrigeration was first used in breweries to produce ice. Thus, although the breweries represented only a relatively restricted part of the professional life of a country, they absorbed a considerable proportion of the total installed refrigeration capacity, in many countries around 1900 to 1910. This amounted to 70% in Sweden, 60% in Germany and Austria, 50% in Holland, 40% in France and Denmark, and 30% in the United States. Many of the very first refrigerating machines constructed by the great pioneering firms were installed in breweries, around 1860-70, and, oddly enough, brewery refrigeration played a determining rôle in the rational and scientific development of the compression refrigeration system, as we shall see.

2.32. At the beginning of the 19th century, breweries in some countries began to adopt "bottom fermentation", which requires relatively low temperatures for the fermentation of the wort (6 to 8 °C) and for storage of the beer (0 to +4 °C). The standard was set by Germany with its lager; this type of beer was introduced into the United States about 1840. (Great Britain for a long time remained faithful to its "top fermentation" beer.) Without means of controlling the temperature in bottom fermentation it was not possible to make good quality beer except in spring and autumn, in most regions. Thus breweries became large users of natural ice. In Europe, the use of natural ice first began to expand in Austria towards 1820, then in Germany, Switzerland and Alsace-Lorraine. About 1875 in the United States, brewing was the sector of the economy which used most natural ice, many breweries using 20 to 30 000 t/year. The encumbrance of the stock of ice, to get through the summer, was really extravagant. The brewery in Pilsen, the largest in continental Europe, which used natural ice up to 1884, was obliged to operate a system of ponds from which to collect ice in the winter. Thus one can understand why the brewers were only too pleased to welcome artificial refrigeration to free them from such constraint.

How was natural ice used at that time? Recollect that in 1819 Salmon and Warell were granted a British patent for cooling malt in a brewery by blowing cold air over the surface. But the real breakthrough came in 1856, when the French engineer Jean-Louis Baudelot (1797-1881) introduced the wort cooler which bears his name. This is made up of a vertical bank of tubes through which a cold fluid circulates, and over which the wort flows. Iced water could be used in the tubes, and cooling was very rapid. On leaving the "baudelot" the wort is taken to the fer-

mentation vessels, in which at that time the temperature was kept at a correct level by "swimmers" containing natural ice (50 to 60 kg); these floated on the surface. They were much used in Germany and Austria.

When breweries began to use artificial ice, they still used these "swimmers". They also used floating coils of iced water. But it soon became general practice to cool the fermentation vessels by means of fixed immersed systems. Firstly, there were coils of iced water, then systems of tubes sandwiched between two plates. The "baudelot" was still used, with iced water or brine, and later (about 1890) with direct expansion of the refrigerant. (It was only much later that they dared to use direct expansion coils in the fermentation vessels).

It was only in about 1880 that the storage cellars were cooled, and then by ice tanks at the ceiling. In 1882 a German brewery, Aktienbräu at Dortmund, was the first to cool the cellar by brine coils. Much later they were emboldered to put direct expansion coils in the cellar.

2.33. From just before 1860, the large pioneering manufacturers of the period began to install their first refrigerating machines in breweries: in 1859, an ethyl ether compressor of F. Carré in the Velten brewery at Marseille; in 1860, a Harrison ether compressor in the Bendigo brewery near to Melbourne (perhaps there was a machine tested by Harrison in a brewery in 1857); in 1861, a Harrison-Siebe ether compressor in a London brewery; in 1868, a Tellier methyl ether compressor in the Merz brewery in New Orleans; in 1869, a Tellier machine in a Marseille brewery, in 1870, a Carré absorption machine in the Liebmann brewery in Brooklyn, New York.

As early as 1865, Charles Tellier * began to be interested in using refrigeration in brewing; he dealt very clearly with the topic in his book "Ammonia in industry", written in 1866. In 1871, he wrote a leaflet on "Refrigeration applied to the production and storage of beer", but French brewers largely ignored his work. On the contrary, the *International Congress of Brewers,* held in Vienna in 1873, was a resounding success and played a decisive rôle, not only in the development of the use of refrigeration in this industry, but also in a rational consideration of systems of production of cold in general. It was at this congress that Carl von Linde *, then a young professor in Munich, made a convincing story of the advantages of the system using compression of liquefiable gases. The machine using expansion of cold air was defended by Franz Windhausen *, at this congress.

It has already been said that in 1876 and 1877, Linde produced his two types of ammonia compressor. As early as 1877, this type of machine was installed in the Spatenbräu brewery in Munich (where it was used to cool the wort and the fermentation vessels), and in the Dreher brewery in Trieste (cooling also the storage cellars), and then, a little later in the Westminster brewery in London. The winter of 1883-1884 was especially mild in Germany, and the acute shortage of natural ice which resulted threw the brewers into the arms of Linde! In 1881, there were already 750 Linde machines in 445 breweries. The Carlsberg brewery in

Copenhagen installed Linde machines in 1879; their competitor Tuborg, also in Copenhagen, obtained their first machine in 1883 and in 1900 had an installed capacity of 750 000 kcal/h. The Pilsen brewery installed mechanical refrigeration in 1889, to cool wort. It still cooled the storage cellars by natural ice up to 1897, when all cooling was done mechanically. In 1907, they had an installed capacity of more than 3 M kcal/h, and also owned 300 refrigerated wagons. By 1891, most American breweries had changed from natural ice to artificial cooling. In 1904, the total breweries in America had 300 M kcal/h and 5 Mm^3 of cooled cellars. By 1911, the figures were 420 M kcal/h and 7 Mm^3 (the Anheurin Busch brewery, in Saint Louis, alone had 5.2 M kcal/h).

It has already been said that at this time, the English breweries were less interested in refrigeration, because they used top fermentation, but in 1900, there existed many refrigerated warehouses for hops (notably an establishment of 10 000 m^3 in Birmingham).

In 1903, Germany had 1 500 breweries with refrigerating plant (about 70% NH_3, 15% SO_2, 15% CO_2). At the same date, France had less than 100 breweries equipped with refrigeration. In 1915, 93% of the 1 350 breweries in the U.S.A. had refrigeration machinery.

2.34. A first conclusion may be drawn from these two chapters on ice and brewing; very broadly speaking it would be correct to say that the two driving forces for the development of artificial refrigeration, on a world scale around 1875 were: firstly the manufacture of ice in the southern United States, and secondly, brewing in Germany and the northern United States. With the transport of meat by sea, which will now be dealt with, we find the third "big event" of the beginning of this history of refrigeration.

Section **[2] A History of the Brewing Industry** follows.