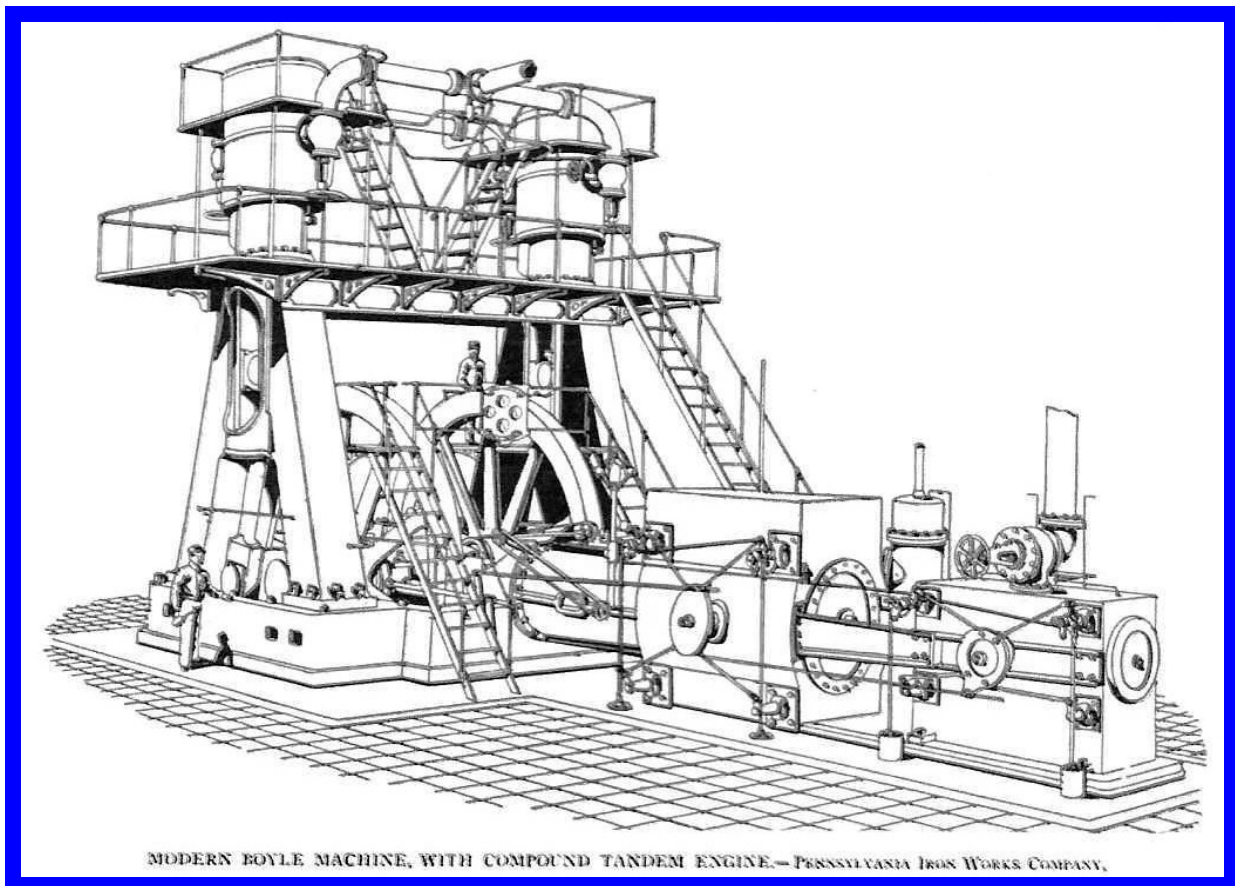


Refrigeration in American Breweries 1860-1920

Refrigeration in the Brewery

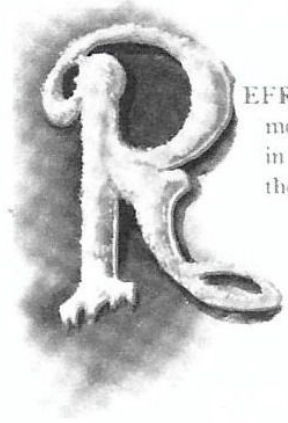


**From *ONE HUNDRED YEARS OF BREWING*,
Vol. II, Chapter X, 1903
H S Rich & Company, Chicago & New York**

CHAPTER X.

Refrigeration in the Brewery.

INTRODUCTION.



REFRIGERATION by mechanical means plays a very important part in modern brewing processes. In the development of nearly every operation in the brewery—in the cooling of the wort, in fermentation, in storage of beer and hops, in racking, in bottling, and even in the operation of malting—artificial refrigeration has played an important part. Indeed it may be said that the wonderful progress made in the art of brewing during the last twenty-five years is mainly attributable to the introduction of artificial refrigeration in the brewery, and for this reason it is imperative that a separate chapter should be devoted to refrigeration, which has already become not only an art in itself, but the basis of several other independent industries besides brewing, namely, cold storage, icemaking, etc.

Another temptation to treat the development of artificial refrigeration in a separate chapter is to be found in the fact that it is so recent and that it has been brought about by comparatively a few men, which renders it easier to collect and to verify the different data than is the case with most of the other brewing operations.

REFRIGERATION BY NATURAL ICE.

Nature furnishes abundant evidence of the production of refrigerants, or of refrigeration, by bringing into contact atmospheres or elements varying in degrees of temperature. One of the most common instances is the absorption of the latent heat of water by the atmosphere, causing a solidification of the fluid, or the forming of natural ice. This, as with other refrigerating processes which are constantly going on in the material world, is explained in the universal effort of nature to maintain an equilibrium of temperature in all those elements which are brought into close contact with each other.

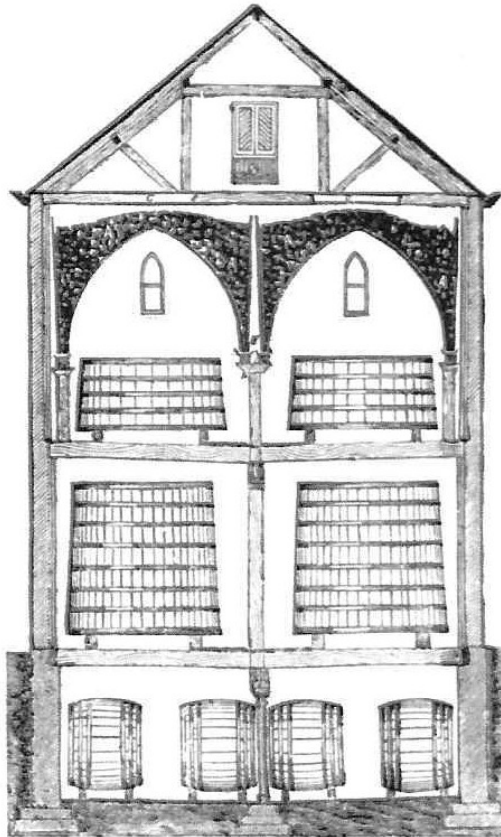
In the East Indies the principle of the extraction of latent heat by evaporation has been applied for centuries to the artificial production of ice. An Englishman who lived in India during the latter portion of the eighteenth century describes the process as conducted near Benares. Well water, at a temperature of 74° was placed in large, broad, shallow, porous pans, around which was laid dry straw or sugar-cane. With the atmospheric temperature at 95° in the shade, ice was formed by rapid evaporation of the water through the pores of the pans. The usual method, however, in the warmer countries, was to place the drinks and edibles to be preserved in caves, or bury them in earthen pots placed in shady spots on the ground, rather than to resort to such ingenious methods for the production of cold.

In temperate climes, or colder sections of the earth, where the evaporation is not so intense, the people trusted to nature to produce the refrigerant, or the ice, in her own good way and time. It may be stated, also, that it is only within comparatively recent times that even natural ice has been used for refrigerating and preservative purposes, and the custom is now by no means general in even the great nations of the western world. As to the people of the tropics, generally speaking, they have always been averse to the use of ice or cooling agents. In fact, the United States may be said to stand alone as the country which, as a whole, is devoted to the theory and practice of wholesale and retail refrigeration.

BREWERY REFRIGERATION.

The application of refrigeration to the brewing industry was the means of implanting in it the germ of indefinite expansion. In the old times brewing could be conducted only in the cooler months, and in the temperate countries. Stringent laws were enacted in Germany forbidding the manufacture of beer in the warm months of the year as a menace to public health. As brewers became ambitious, however, and the demand for their products became larger, they commenced to cut ice from adjacent ponds, lakes and rivers, and store it in huge underground cellars, or vaults,

with the barrels of malt liquors to be refrigerated. Some of the manufacturers of ale and porter in New York and Pennsylvania were undoubtedly supplied by the ice kings of Boston, who, in the early portion of



DAVID W. DAVIS' ICE AND SALT REFRIGERATOR.

the nineteenth century, were the largest dealers in the natural product in the world.

The introduction of bottom fermentation, or the manufacture of lager beer, about 1840 to 1850, had the effect of bringing the importance of brewery refrigeration more than ever to the attention of the brewers of the United States. With the wonderful development of the industry after 1860 the truth also dawned quite generally that the burying of the ice and beer underground, in the ancient way, was a drawback to refrigeration; that a brisk circulation of air and rapid evaporation should be the ends in view. Notwithstanding, however, that American brewers generally began to store the natural ice above ground, both to preserve it and to refrigerate their products, it is stated by a western brewer of that time that when he described to a German member of the fraternity in the old country his up-to-date, above-ground ice-house, the honest representative of the industry over the water shook his head and could not credit the tale.

REFRIGERATION BY SALT AND ICE.

The next step in brewery refrigeration was to increase the refrigerating properties of the ice by adding various salts to it, thereby producing a greater and more rapid solution and absorption of heat than would

be brought about by the natural absorbing powers of the surrounding atmosphere. In a word, ice itself was being refrigerated.

The efforts in this direction culminated in the ice-house patented by David W. Davis (see illustration), which was constructed first for E. W. Voigt, the brewer, of Detroit, Michigan, in 1880.

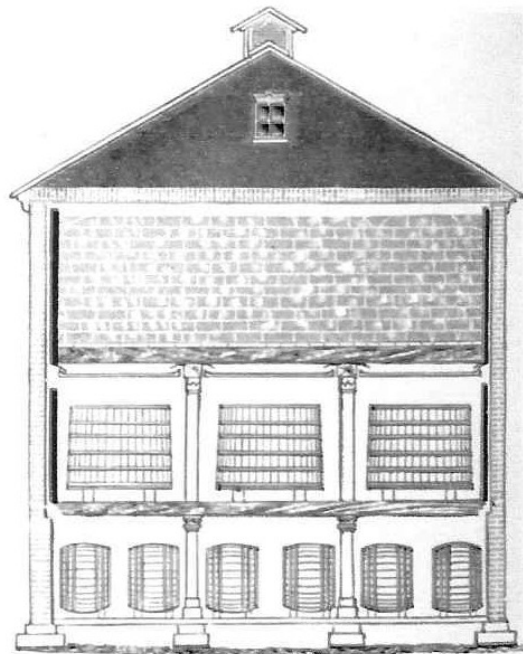
During all this period of groping through cumbersome methods and contrivances for an economical, easily controlled refrigerant, the scientists and inventors were working out the problem in their laboratories and shops.

FIRST BREWERY REFRIGERATING MACHINES.

The first brewery in the world to install an ice machine was that of Glasgow & Thunder, of Bendigo, Victoria, Australia. It was the Harrison improvement on the original Perkins ether machine of 1834, and was installed in the plant named during the year 1860. In 1868, Seibe, of Lambeth, England, placed an improved Perkins apparatus in the brewery of Truman, Hanbury, Duxton & Company, of London.

FIRST BREWERY REFRIGERATING MACHINES IN AMERICA.

With the patenting of the Carré ice machine, October 2, 1860, was inaugurated the modern era in brewery refrigeration. Its construction was based upon the principle established by Faraday that certain gases could be liquefied under pressure and that by the removal of the pressure, with consequent expansion and evaporation, intense cold would be produced. Faraday used chloride of silver as a heat absorbent; Carré, aqua ammonia. In 1865, Mignon and Rouart,



MODERN BEER STORAGE WITH ICE.

also Parisians, improved upon the original machine by adding an apparatus to insure continuous action, both machines being "specially designed to utilize the action of ammonia in solution in water."

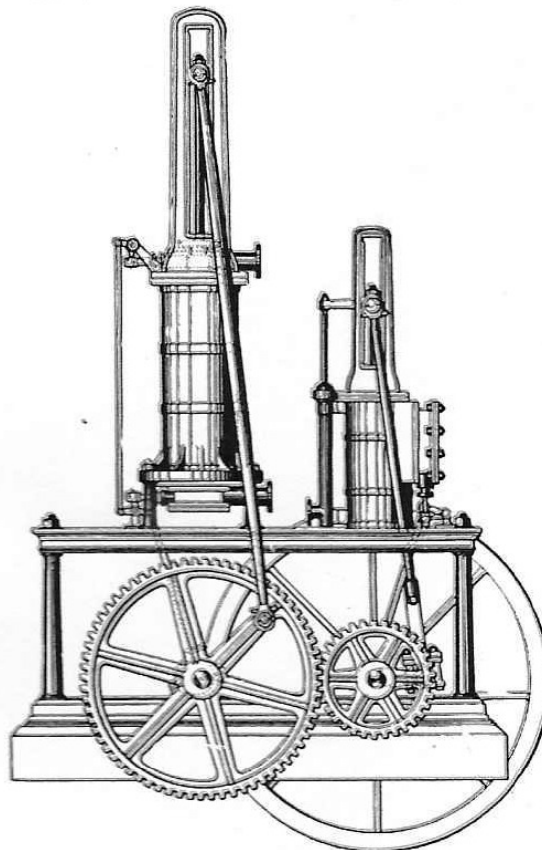
It is pertinent to remark here, however, that the first installation of a refrigerating machine in a United States brewery was not of the Carré patent, but the invention of Charles Tellier, also of France. In January, 1860, the latter took out a patent for his appa-

was evidently too small, and not strong enough to stand the working strains of anhydrous ammonia. It was design by the inventor for the use of methylic ether.



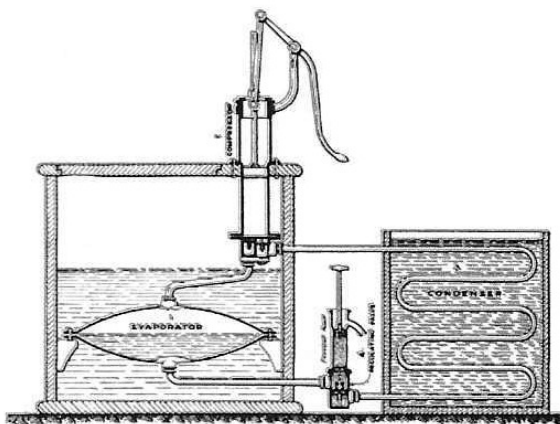
JACOB PERKINS (ICE MACHINE INVENTOR.)

ratus in this country. It was a compression machine, whose refrigerating agent was methylic ether. In the year named, George Merz, a prominent brewer of New Orleans, imported a small machine from the works of the inventor and erected it in his plant, with the object of producing cold, dry air and of making ale and lager beer without ice. The experiments with this machine,



JAMES HARRISON'S ETHER MACHINE, TABLE PATTERN.

The parties who sold the machine afterward transformed it into an ammonia machine. M. Tellier meanwhile had obtained patents for the use of liquefied



SECTIONAL VIEW OF JACOB PERKINS' ICE MACHINE.

as well as the partially successful installation of another apparatus in the same brewery, are thus described by F. V. De Coppet, his narrative being the opening chapter of artificial brewery refrigeration in the United States: "This machine, although well constructed,

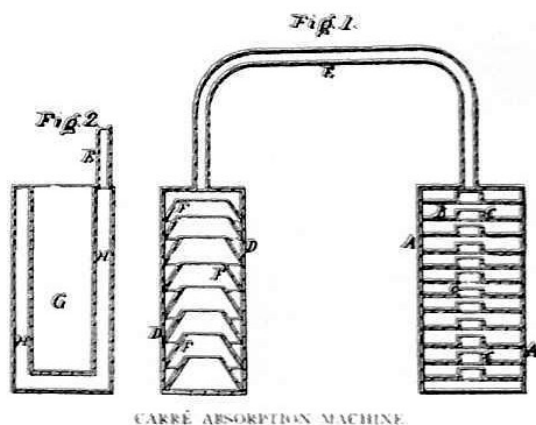


JAMES HARRISON, AUSTRALIA.

anhydrous ammonia, to be used as a substitute for methylic ether. The pump was $2\frac{1}{2}$ by $7\frac{1}{4}$ inch stroke, and had to run from two hundred and fifty to three

hundred and fifty revolutions per minute; and, being required to compress gas up to three hundred pounds per square inch, it kept breaking down, so that the temperature of the cellar could not be reduced more than 2°. It became troublesome to manage, under these conditions, and was discarded.

"In the fall of 1866, Mr. Merz engaged the writer to design and construct an improved machine, the refrigerating agent to be anhydrous ammonia, and the apparatus of the double-acting compression type. It was erected in the spring of 1870 in place of the old one. It worked successfully for two seasons in the manufacture of ale, the temperature of the cellar, which contained forty thousand cubic feet, being easily kept to 40° F. The air was exhausted by a fan blower from a conduit placed near the ceiling and extending lengthwise with the cellar. The air was admitted through several small openings and was forced through a series of tubes contained in a cylindrical iron vessel into the front end and bottom of the cellar. The



tubes were immersed in the liquefied gas and, by the rapid evaporation produced inside by the action of the pump, the air was delivered at 32° in the cellar. I soon found that this method would be defective, on account of the freezing of the aqueous vapors in the tubes; the air supply being diminished, the machine had to be frequently stopped to allow the ice to melt.

"I tried another experiment on a small scale with a short zigzag coil, through which I passed a current of ammonia gas at the top, delivering it to the pump from the bottom of the coil. This worked well for a time, but it became leaky on account of poor material and defective joints. The cellar which contained this coil became so impregnated with ammonia that some of the ale had to be turned out into the ditch.

"Mr. Merz objecting to this system, I proposed to circulate brine through the coil and use it for cooling beer in place of the Baudelot; but being afraid the beer would come in contact with the brine, we concluded to alter the machine so as to make ice. This machine made five tons of ice daily during the following summer (1872). The ice was placed upon the casks as in the old style. It worked thus for two years, until the death of Mr. Merz, when the brewery property was sold, the machine being removed to make room for improved ones."

It will be remembered that the second machine operated in the Merz brewery, although a double-compression-ammonia apparatus, failed as a refrigerator and was finally used as an icemaker. Mr. De Coppet, however, took out a number of patents for icemaking machinery from 1870 to 1880, his inventions being adopted and manufactured by the Cincinnati (afterward the Blymyer) Ice Machine Company.

As before stated, it was the coming into the field of the Carré apparatus which inaugurated the era of practical brewery refrigeration by machinery. The first of this patent to be employed in brewery refrigeration, in the United States, was installed about the time that De Coppet had completed the second machine for the New Orleans plant. The first Carré machine thus used in the United States was by S. Liebmann's Sons' Brewing Company, during the spring of 1870, in their brewery at Brooklyn. It was manufactured at the Port Morris Iron Foundry, in Philadelphia, which is now included in the Cramp's ship-yard. The idea was to cool the air in the cellars, but the machine did not accomplish this economically and was then used partly for making ice and partly for cooling brine, the latter being forced through the Baudelot cooling apparatus. This was one of the first applications of the brine system to the cooling of beer.

IMPROVED CARRÉ MACHINE.

In 1871, Vaas & Littmann, among the earliest manufacturers of the Carré machine, made important improvements in the continuous freezing apparatus, which they thus describe: "These improvements relate to the arrangement of a sheet-metal cylinder in combination with the rectifier in the interior of the boiler. In this the ammoniacal vapors are formed for the purpose of separating from the ammonia the aqueous vapors and returning them to the lower part of the boiler in such a manner that the liquid ammonia admitted into the boiler collects in the space between the rectifier and the cylinder. There it is heated to a high temperature before it trickles down into the boiler in the form of a shower, while the gas rising from the liquid in the boiler has to pass through said shower and then through the rectifier, and thereby the aqueous parts, still mixed with said gas, are effectually disengaged." The final improvement of the machine, as made by its inventor, F. P. E. Carré, was published (application filed) in November, 1876, and letters patent were issued February 13, 1877.

One of the first machines of this type (Vaas & Littmann's improved) brought to America and used in brewing, was exhibited at Cincinnati in 1876, and subsequently did duty in some brewery there (probably the Moerlein Brewery) for four or five years. About 1881 it was brought to Rome, Georgia, and put in operation by Messrs. Leopole & Boeckh. The operators failed and the plant was sold by the courts to J. A. Bale, who managed it for two or three years, or until it was superseded by a more modern plant. About 1888 it was burned and the wreckage sold as scrap iron. It may be added that the price of the machine was \$3,000, with \$2,800 added as import duty. Its capacity was three tons and it was of the absorption

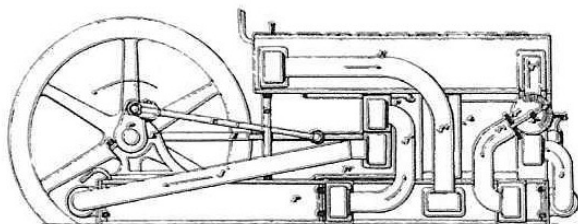
type, the blocks (small, flat cakes) weighing twenty pounds each.

THE VAN DER WEYDE MACHINE.

As stated, the modern era of the brewing industry may be said to have originated in the United States in the year 1862, and it was but natural that from that year the inventors of refrigerating apparatus should have experimented with many agents designed to act as absorbents of the latent heat thrown off from water. Prof. P. H. Van der Weyde, of Philadelphia, was among the most prominent of these experimenters. In April, 1867, a patent was granted to him for the use of naphtha, gasoline, rhigoline, petroleum-ether, or condensed petroleum gas (chimogene), his machine being of the vacuum type and consisting chiefly of an exhaust and force pump and cooling coil.

THE WINDHAUSEN MACHINES.

The Windhausen ice machines cut a large figure in the development of artificial refrigeration, which really commenced to be established on an industrial and commercial basis early in the seventh decade. The Carré machines had been introduced into but a very few American breweries previous to the installation of a Windhausen, at Hildebrand's Brewery, in Pfungstadt, in 1872, and the brewery of Christ, Moerlein, of Cincinnati, in 1875. The original letters patent were issued in the United States to the inventor, Franz Windhausen, of Braunschweig, Germany, on March 22, 1870, and are described as relating "to that class of freezing and icemaking machines in which atmospheric air is compressed, then passed through a cooler and afterward expanded to remove the heat (or, in other words, to produce cold), but which machines have hitherto been limited in their cold-producing properties by the degree of expansion to which the air is subjected and by the temperature of the cooling water employed. The invention has for its object the construction of a machine of small compass, which, with one constant degree of expansion of the air employed, produces any requisite degree of cold, which can be regulated to the greatest nicety by the hand of the attendant, by means of graduated adjusting valve



SIDE ELEVATION, WINDHAUSEN'S ICE MACHINE.

mechanism." The air was kept in continuous circulation.

Windhausen patented his vacuum machine in Germany in 1877, and subsequently in France, England, Austria, Spain, Belgium and the United States. In 1878 he invented his compound vacuum pump for producing ice on a large scale, and greatly improved it in 1881, so that his machine would produce fifteen tons

of ice in twenty-four hours — which was considered quite remarkable for that time. In 1885 he adopted sulphuric acid as his absorbent and in 1891 patented



FRANZ WINDHAUSEN, BRAUNSCHWEIG, GERMANY.

a compression apparatus for which carbonic acid gas was the cold-producing medium.

HOLDEN'S FIRST COMPRESSION MACHINE.

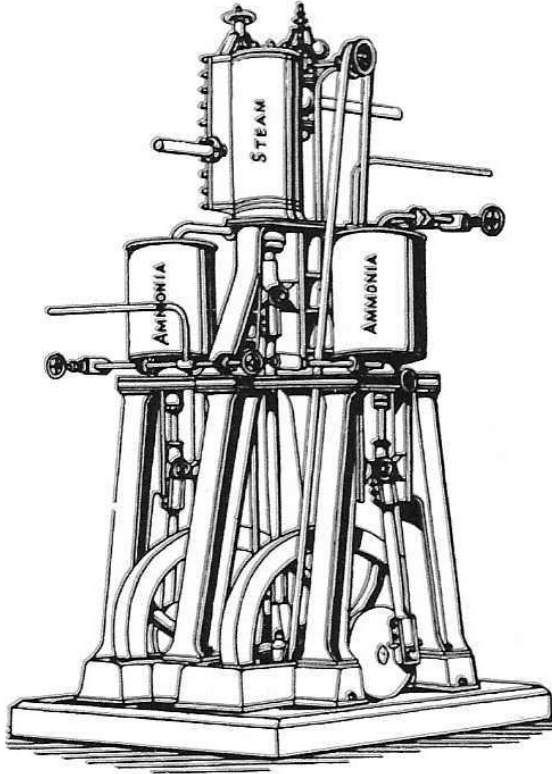
One of the pioneers in the development of artificial refrigeration was Daniel L. Holden, in the early years of Covington, Kentucky, now of Philadelphia, Pennsylvania. As described in his letters patent, dated April 24, 1877, his ice machine was "constructed upon the general principle of the employment of a non-congealable liquid as a vehicle for conveying the cold produced in a refrigerator to a case where the temperature of the cooled liquid is transmitted to atmospheric air, and the latter from thence directed into a congealing case, where it produces the freezing effect upon the water contained in the pan. The invention consists in the construction of the refrigerator for facilitating evaporation to effect the cooling of the non-congealable liquid, the construction and arrangement of the case for imparting the temperature of the non-congealable liquid to the air circulating in the congealing case; the construction and arrangement of the congealing case and its adjuncts; a receiver and purger for containing the condensed volatile gas, and removing the air from the gas-circulating apparatus, and the combination, with the refrigerator and the receiver, of an automatic valve for feeding the condensed volatile liquid back to the refrigerator."

The first machine of this patent to be used in a brewery was built in Philadelphia, in the same year (1877) and installed at the Bergner & Engel Brewery. After running several months, it was abandoned for the

reason that the chemical used (chimogene) was considered too dangerous by the insurance companies, who threatened to withdraw their risks.

RANKIN AND HIS ABSORPTION MACHINE.

One of the earliest inventors and builders of refrigerating machinery in the United States was Thomas L.



AMMONIA COMPRESSOR. — ORIGINAL BOYLE PATTER.

Rankin, whose earliest experiments were conducted in the South. His machines are of the absorption type and were introduced into not a few of the breweries of the country. From 1868 to 1884 no less than twenty-four patents were issued to him, improving his apparatus and applying it to various specialties, such as the manufacture of ice for skating rinks; the construction of an ice-machine barge; the refrigeration of breweries and packing-houses; vessels carrying meats, etc. The last named was patented March 29, 1881, the object of the invention being to "provide a compact, durable and effective apparatus" for the purpose named. The invention itself consisted in extending the ammonia tubes at both ends and through both heads of the boiler, to bring the joints and connections on the outside; in combining with the ammonia tubes shorter tubes passing through the heads and having suitable connections; in combining an equalizer of particular construction with the ammonia tubes, and in a general combination of the essential elements of the refrigerator — the latter consisting of a boiler, still, aqueous-vapor condenser, weak-water receiver, equalizer, condenser, absorber, liquid receiver, refrigerating cylinder and pump.

Mr. Rankin constructed his first machine of this type in 1879, and the first brewery to install it was

that of Jacob Ruppert in the city of New York. As stated, his early experiences were in the South.

Mr. Rankin says: "The first absorption ice machine I ever saw was a Carré, in 1866, at New Orleans; the first compression, a Van der Weyde, at Memphis, Tennessee, about 1869. Among the earliest imported Carrés were those to Austin, Texas; New Orleans and Shreveport, Louisiana. About 1870 came the Windhausen air and the Tellier style of compression. The latter was about the first compressor offered, but did not succeed in this country — not on account of workmanship or its capabilities, but because of the light ether used. One of this style of machine struggled along between starts and stops until about 1875.

"Among the early operators in ice machinery, antedating my beginning, was D. L. Holden, formerly of Covington, Kentucky. Then there were Martin & Beath, in San Francisco, who really made good machines in the early seventies."

In this connection it should be stated that one of the pioneers in the development of artificial refrigeration, who several years ago was associated with Mr. Rankin, was C. C. Hutchinson, one of whose patents for refrigerating rooms was issued in August, 1886.

THE BOYLE COMPRESSOR.

In 1877 David Boyle, a Scotchman, who had spent a number of years in the South and California experimenting in refrigerating machinery, installed a com-



DAVID BOYLE, CHICAGO.

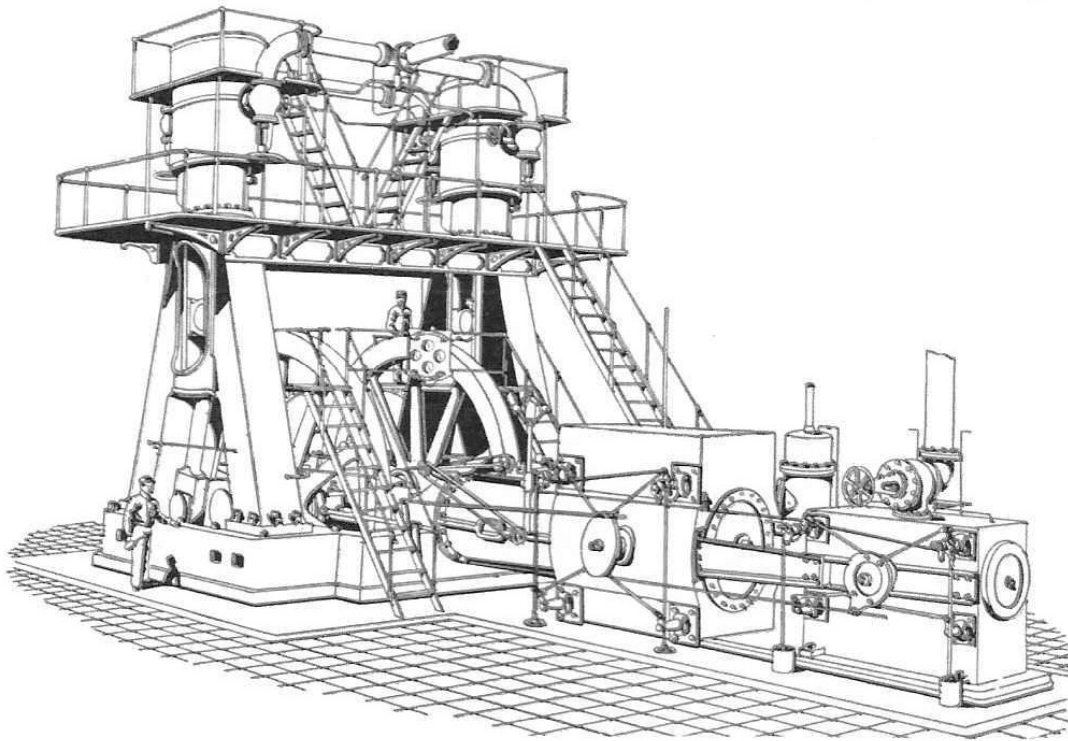
pression ammonia plant in the brewery of Lemis & McAvoy, Chicago. It was in operation for several years, and as it was one of the very first successful refrigerating machines engaged in the brewing industry, a somewhat detailed description seems to be war-

ranted. The apparatus consisted of a pair of ten by eighteen inch vertical single-acting pumps, operated by a horizontal engine, and the sweet-water tank, fourteen by twelve by eight feet, containing a double system of one-inch coils. An agitator prevented the sweet-water from freezing, which was pumped through the Baudelot cooler and returned to the reservoir. The condenser, which was submerged in a tank, consisted of eighteen coils of one-inch pipe and was seven and one-half feet long.

F. Heim, of the Ferd. Heim Brewing Company, Kansas City, Missouri, has this to say regarding the installing of a Boyle ice machine (ammonia and brine), in 1878: "If the writer is not mistaken, when we put in this Boyle machine, there was one being put in by the same parties at the Frank Fehr Brewery, in Louis-

David Boyle & Company, up to 1878. During the succeeding seven years the business was conducted under the name of the Boyle Ice Machine Company. In 1884 the Consolidated Ice Machine Company was formed by a consolidation of the Boyle interests with those of the Empire Ice Machine Company, of St. Louis. The Consolidated Ice Machine Company went out of business in 1890, Mr. Boyle continuing an independent business (as he had since 1884), the Consolidated Company being purchased by John Featherstone Sons, of Chicago. The latter continued the business until 1900, when the Featherstone Foundry and Machine Company assumed it.

In January, 1892, the Pennsylvania Iron Works Company, of Philadelphia, entered into an agreement with Mr. Boyle's estate whereby the title to his patents



MODERN BOYLE MACHINE, WITH COMPOUND TANDEM ENGINE.—PENNSYLVANIA IRON WORKS COMPANY, PHILADELPHIA, PENNSYLVANIA.

ville. By our system the brine was piped through the different cellars, while at the Fehr Brewery it was pumped to a certain height and then precipitated through an open space. Our system was successful and Fehr's was not; ours, in fact, was one of the first really successful ice machines to be installed in any brewery in the United States. We had visitors from all over the country — from the larger breweries and packing-houses."

In 1879 Mr. Boyle erected a machine at Atlanta, Georgia, on a new plan, making ice from distilled water, and in the same year installed a machine at the Empire Brewery (now owned by the Pabst Brewing Company), of Milwaukee.

For many years Mr. Boyle had charge of the manufacturing of his own machines, the firm name being

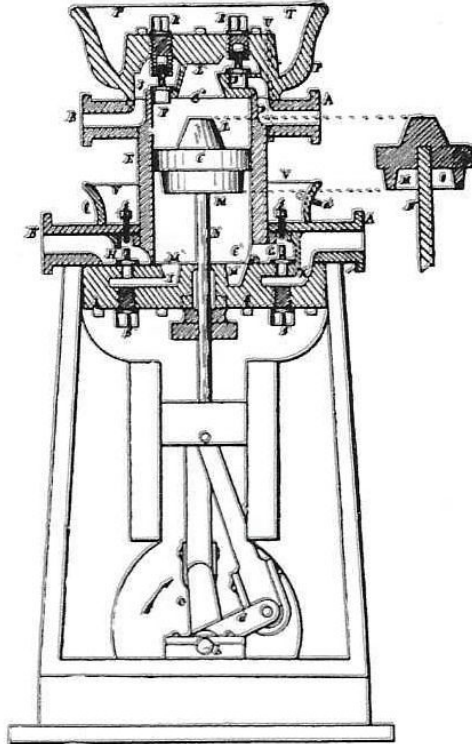
was turned over to that corporation. The plant was then extended so as to include an ice-machine department, which has since manufactured the various Boyle devices. For several years previous, however, the company had been experimenting with various machines, their first one to be installed being of the Rankin absorption type, in 1889. The first Boyle compression machine to be placed by the company was in the brewery of J. W. Russert, La Porte, Indiana, in the spring of 1892.

At the time of his death, in 1891, Mr. Boyle, perhaps more than any other one man, had practically developed the type of refrigerating machinery known as the "compression ammonia," and, in view of the large manufacturing interests which have been founded upon his inventions, it is doubtful whether any other

patents have been more generally utilized in the building of ice and refrigerating machinery.

DIRECT GAS EXPANSION.

The introduction of direct gas circulation or expansion as a refrigerant began with the installation



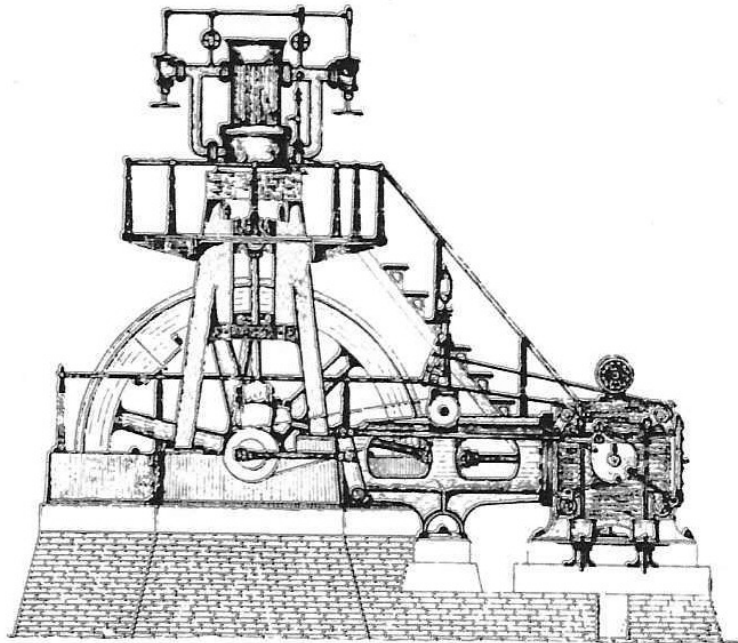
SECTION OF ENRIGHT'S AMMONIACAL GAS PUMP.

of the first Silas Merchant ammonia compressor at the brewery of A. Ziegele, of Buffalo, New York, in the

McMillan & Company, in Cleveland, Ohio, for the purpose of manufacturing and selling icemaking machines. They employed Mr. Enright as supervising engineer. The machine which they proposed to build was one designed by McMillan, and had a single-acting compressor. No patents seem to have been taken out for this machine; but several machines were constructed for the freezing of plate ice twelve by twelve by forty inches — probably the largest plates ever made. The ice was loosened by hot ammonia gas and the blocks cut up by vertical saws. This was the style of machine erected at the Ziegele Brewery, Buffalo. Mr. John Enright, now connected with the Arctic Machine Company, Canton, Ohio, has the following to say regarding the installation of this plant: "Theodore Krausch — in those days a prominent and respected German brewery engineer, came to the office in much despair about a patent ice chamber or cage he had erected in Ziegele's Brewery. The ice melted too quickly, and he was sent into my room from the main office to see what I could suggest. Why, of course I wanted to plan an ice machine, and very badly, too! I succeeded in persuading Mr. Krausch that I could hold that ice in its chamber for all time; and I was not permitted to get out of his sight until we both brought up in Buffalo and in that ice chamber.

"Mr. Enright," he asked, "how are you going to do this?" "Oh, that's easy, Mr. Krausch. I will put cold piping over this ice." "What, over! What is the matter with putting pipes over, under and all around?" "Too expensive, and unnecessary, Mr. Krausch." "Don't you talk about dot expenses!" he emphatically concluded.

"This chamber was about 100 by 60 by 70 feet, and about 25 feet high, arranged so that the ice cage was



SECTION ARCTIC MACHINE — ARCTIC MACHINE COMPANY, CANTON, OHIO.

fall of 1877. In the previous year F. M. McMillan and clear of main walls. At all events, I secured the con-
Silas Merchant had founded the firm of F. M. tract, the great anxiety of Mr. Krausch and Mr.

Ziegele being to get the machine installed as soon as possible so as to save the ice and liquidate matters generally. I don't think I ever completed plans for brewery refrigeration so quick before or since, or with such anxiety and with less real apprehension.

"As to the result, I believe that Krausch's ice stayed in that chamber for ten years, and a company was afterward formed to build the chamber, with ice machine combined. I am certain, however, that it was a year or two before the brewers had confidence in the machines alone (i. e., without the ice). That Krausch incident was in '77, as near as I can remember. Krausch got paid for his patent ice chamber and our company got well paid for its machine. The brewery people were delighted, and doubtless thought they had this beer business in a special cage. Altogether we were a very happy combination."

THE ARCTIC MACHINE IN CINCINNATI.

Mr. Enright continues: "A few years after this I sold G. M. Herancourt, of Cincinnati, a 50-ton refrigerating machine—the first of my Arctic machines in that city. I had to build a big icemaking tank right over the arches of his cellars, besides putting much piping below and everywhere he designated. They all laughed at me when I would tell them I could cool them with the machine alone. Armour, even, would not have pipes at first; I could not persuade him to depend on them and dispense with his mountain of ice over his rooms, until I showed him a trough system (upon which I obtained a patent afterward) by which I could maintain a river of cold (naked) brine over his hogs. He had confidence in my machine, but not in pipes."

The Arctic Machine Company was incorporated in 1878, both Mr. McMillan and Mr. Enright being interested in it. To the latter patents had already been issued for double-acting compressors, an ammoniacal gas pump, and the pipe joint commonly known as the "Arctic." The company was the first to manufacture anhydrous ammonia and place it on the market as a commercial article and adopted can in preference to plate ice, determining upon the standard size 11 by 22 by 44.

OTHER EARLY MACHINES.

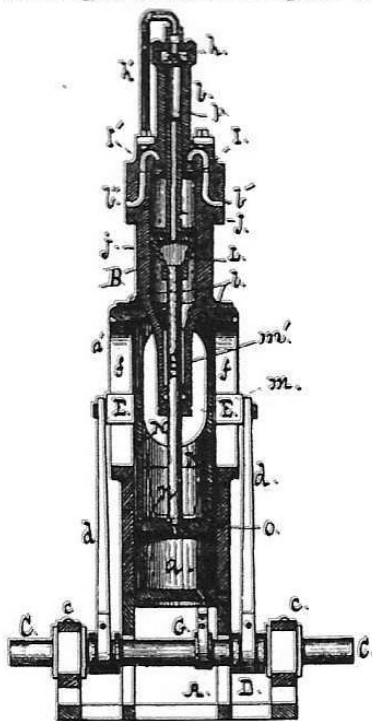
After the incorporation of the Arctic Company, Mr. Merchant built a few so-called Zero machines, but they do not appear to have figured in the refrigeration of breweries. The Silas Merchant machine mentioned as having been erected in the Ziegele Brewery was placed there by E. Jungenfeld & Company, of St. Louis, brewers architects and engineers, who, for several years prior to 1877, had been calling the attention of the trade to the importance of artificial refrigeration. Subsequently they erected several similar machines in various breweries. In the summer of 1880 they executed a contract for S. Luscher, of Frankfort, Kentucky, based upon the brine system, upon which they had obtained several patents.

In 1881 they formed the Empire Refrigerating Company, and operated under the Charles G. Mayer patents, and in June, 1882, they formed a corporation

for the construction and sale of the "Perfect System" of brine circulation.

THE BALLANTINE MACHINE.

In 1876 the late A. T. Ballantine, a Maine mechanic and inventor, installed an ice machine (made from drawings by Tellier) for a small brewery on Forty-seventh street, New York city. Those originally engaged in the work for D. C. Reed, president of the United States Ice and Refrigerating Company, relinquished the undertaking to Mr. Ballantine. Partial success crowned his efforts, or, as he says, he "completed the work after a fashion, and a poor one at that. It did the work at the expense of a large quantity of gas each day, the retorts constantly making new gas to replace the loss. It was, in fact, a most crude affair, showing the designer had not the slightest idea of the



THE BALLANTINE COMPRESSOR

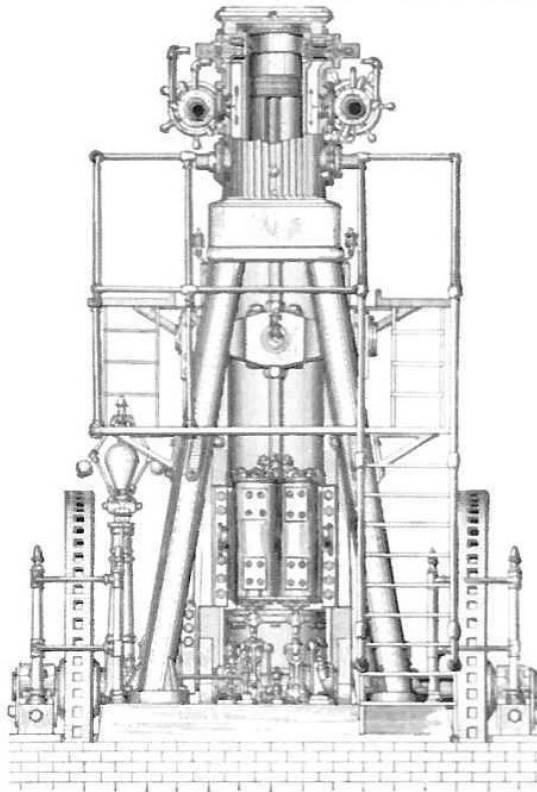
requirements of a gas compressor. For instance, the piston heads were solid, without springs, and the clearance under the valves was so great that, even if the compressor did get the gas up to the liquefying point, the pressure would follow at least three-quarters of a stroke back, making refrigeration out of the question.

"However, Mr. Reed's enthusiasm knew no bounds at the wonderful exhibit, and he arranged for a more public performance, to which Peter Cooper, George Ehret, Ringler and many others were invited. I shall never forget an expression by George Ehret—'It will be done, but not yet!' After this show the machine went into the scrap heap. This was in the summer of 1876. I then began the drawings for the Marion Brewery (near Jersey City) machine, which I began to install in the following January. Although this apparatus did good work, it was not large enough; but in its construction I accomplished what I thought the most essential point—to make it 'hold the anhy-

drous ammonia," which, at that time, was about one dollar per pound."

In 1882 Mr. Ballantine designed another machine for the brewery of Gerhard Lang, of Buffalo, New York. It was of the ammonia compression style, he having already (1877 and 1880) secured patents to prevent leakage of gas. The arrangement is described in his first patent as "a pump for forcing the refrigerating agent and a chamber, closed to the atmosphere, which surrounds and contains the piston-rod of the pump, and receives and holds whatever matter may escape from that end of the pump-cylinder through which the piston-rod works."

At the time Mr. Ballantine installed the two machines mentioned ice was so scarce as to command



SECTION CASE COMPRESSOR.
CASE REFRIGERATING MACHINE COMPANY, BUFFALO, NEW YORK.

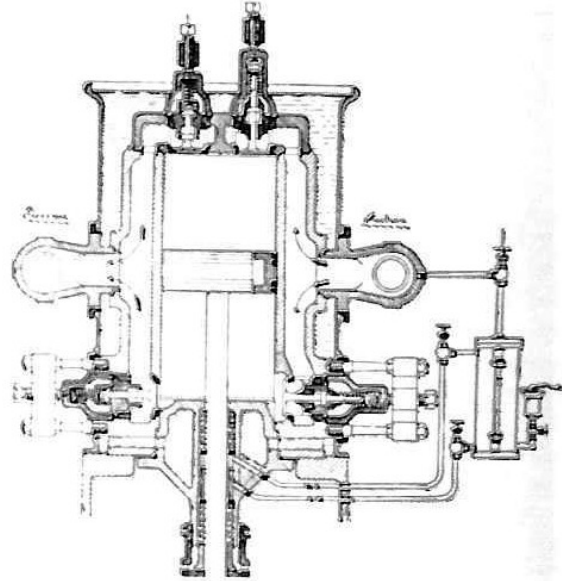
\$7 per ton, and the brewers who kept pace with the times were conducting their business at a great loss. The desirability of having a machine which would actually make ice was therefore very obvious to both Mr. Lang and Mr. Ballantine. The latter started the apparatus at four o'clock one Sunday morning of July, 1882, and, as narrated by him, "by nine o'clock every foot of pipe was well covered with frost, with the temperature going down, and Gerhard Lang, with tears in his eyes and arms around my neck, exclaiming, 'You have saved my brewery and me from bankruptcy!' And whenever he met me he always repeated the story. The two engines were never stopped, except by the engineer, until January, 1883."

The Ballantine machine, greatly improved, is now being manufactured by the Case Refrigerating Machine Company, Buffalo, New York.

The Buffalo Refrigerating Machine Company, of the same place, are also manufacturing a machine constructed upon similar lines.

PICTET'S REFRIGERATING MACHINE.

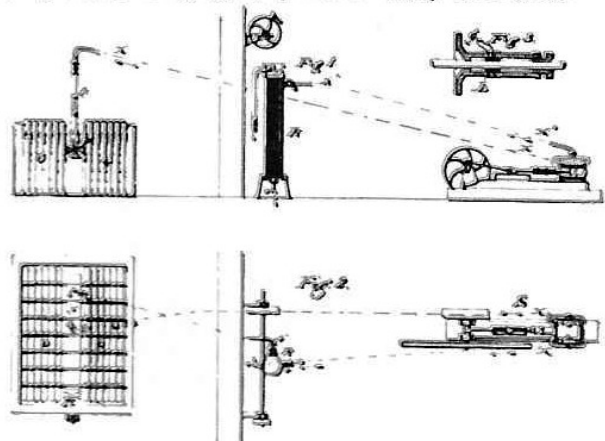
In 1877 were introduced the machines invented by Raoul Pierre Pictet, of Geneva, Switzerland. One



SECTION BUFFALO COMPRESSOR.
BUFFALO REFRIGERATING MACHINE COMPANY, BUFFALO, NEW YORK.

of the first to adopt them, and certainly the pioneer in the United States, was Rudolph Schmidt, of St. Louis, founder of the malting company of that name, and for many years a brewer and maltster in Germany and America.

The refrigerating agent employed in the Pictet machine is anhydrous sulphurous oxide, which the inventor was the first to use, and whose merits he sets forth as follows: "It is known that sulphurous oxide as a refrigerating agent possesses many and great

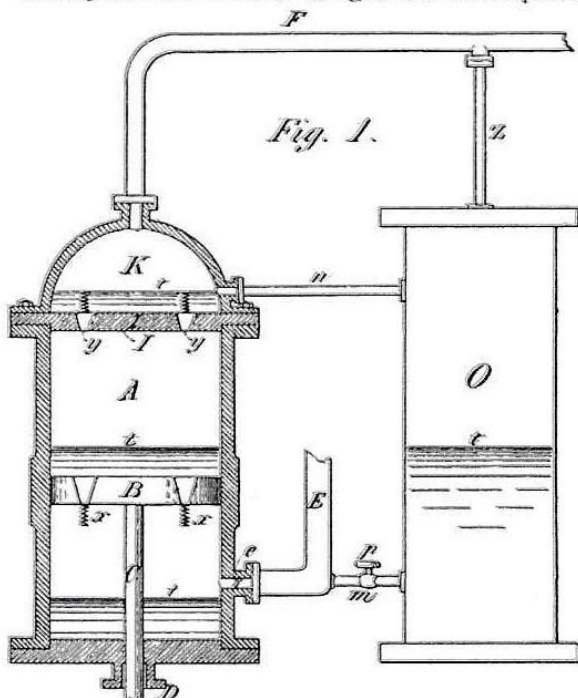


SECTION AND PLAN, RAOUL P. PICTET'S SO₂ ICE MACHINE.

advantages over any of the other volatile substances that have been employed as such. It liquefies at 10° C. and then has a tension equal to the pressure of the atmosphere; and at 30° C. its tension does not equal four atmospheres; so that an excessive and dangerous pressure in the apparatus employed is avoided by its

use, and much less power is of course required to reduce it from a state of vapor to a liquid form in ice-making and other forms of refrigeration than sulphuric

ing vessel to the refrigerating cans, without being brought in contact with the atmosphere, the design being to insure a transparent ice free from air and that "milky" appearance seen in much of the product which is not thus protected. In the Kropff air-cooling apparatus atmospheric air is forced through upright cylinders and cooled by being exposed to finely divided jets of water of different temperatures, the jets being produced by perforated plates in the upper part of the cylinders. The tubes connecting the cylinders are inclosed at their upper part by enlarged casings, which form, with the tubes, traps for collecting the water mechanically carried along by the air. The process of cooling air by bringing it in contact with refrigerated water in the form of a spray was no innovation, Mr.

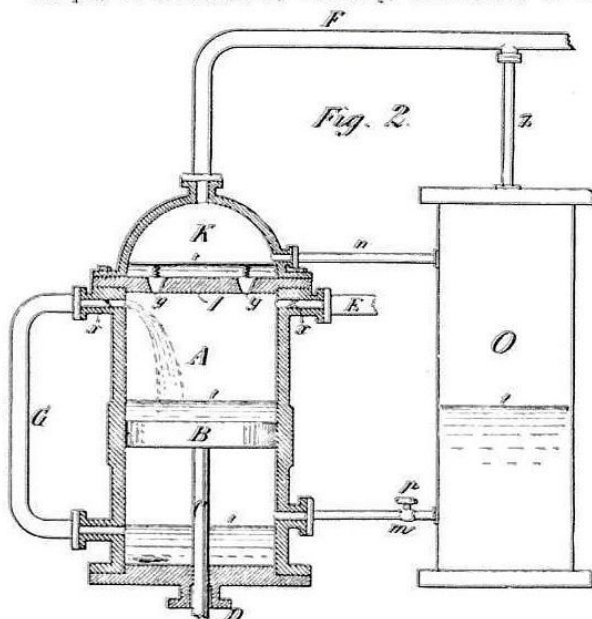


SECTION DE LA VERGNE-MIXER COMPRESSOR.

ether and the other substances above named" (saturated solution of ammonia, liquefied ammonia and sulphuric ether).

KROPFF'S ABSORPTION MACHINE.

About 1880 the Kropff machines, invented by Oscar Kropff, of Nordhausen, Germany, commenced to be



SECTION MODIFIED DE LA VERGNE-MIXER COMPRESSOR.

introduced for purposes of brewery refrigeration. This machine is of the ammonia absorption type, and has a patented apparatus by means of which the distilled water is conducted through coils and a lower cool-



JOHN C. DE LA VERGNE, NEW YORK.

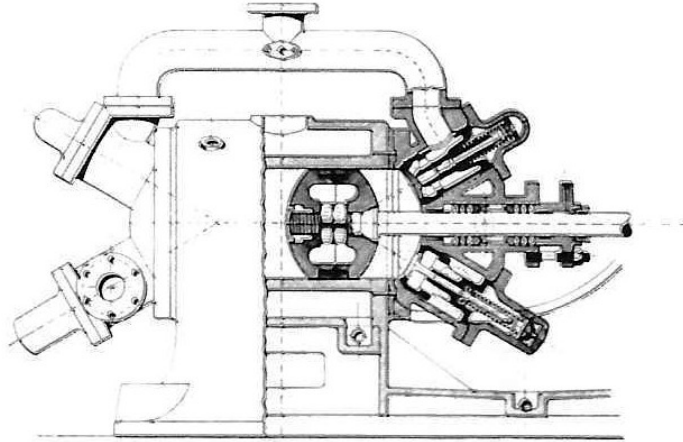
Kropff's method being new in that the air was cooled successively — first by well water to a medium temperature, then by ice water to a lower temperature.

THE DE LA VERGNE COMPRESSOR.

The first brewery equipped with the De La Vergne refrigerating machine, which has become one of the most popular ever invented, was the Hermann brewery, at No. 221 West Eighteenth street, New York city, in 1879. The inventor of the original apparatus, John C. De La Vergne, had long been engaged in the produce business in New York previous to becoming identified with the brewing industry, in 1876. It was this latter circumstance which seriously turned his attention to artificial refrigeration, and in 1881 he formed the De La Vergne Refrigerating Machine Company, with works in Bank street, New York city, for the manufacture of the so-called De La Vergne-Mixer

machine, the second-named patentee being William M. Mixer, of New York. The material improvements of their patent over other refrigerating machinery based upon the compression and expansion of ammonia, are

United States that in 1889 a large manufacturing plant was erected at the foot of East One Hundred and Thirty-eighth street, New York city. Upon the death of Mr. De La Vergne, in 1896, Jacob Ruppert, the



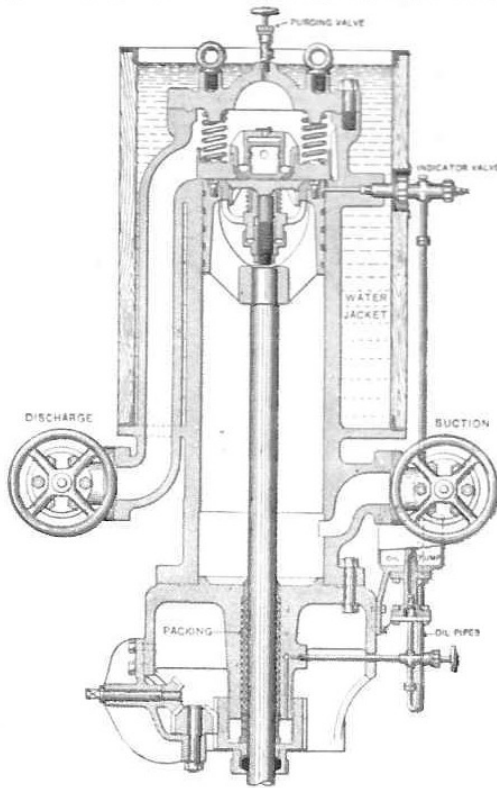
SECTION WOLF-LINDE COMPRESSOR.—THE FRED W. WOLF COMPANY, CHICAGO.

the effective means adopted for sealing the valves and joints and lubricating the internal mechanism of the compression pump. Superheating is prevented, as far as possible, by the oil circulated by a pump, clearance

well-known brewer, was elected president of the company.

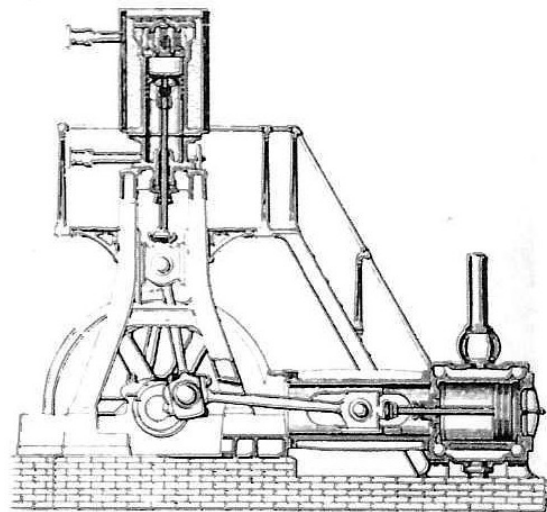
THE LINDE AMMONIA MACHINE.

Professor C. P. G. Linde, of Munich, Germany, introduced his ammonia refrigerating machine in 1873 to 1875. He is now generally considered the foremost exponent of the compression system. The first attempts at putting the machines in operation were made in 1873, and in 1875 was erected a compressor for sweet-water cooling in the Spaten Brewery, Munich. In 1876 a further installation was made in the Anton



SECTION FRICK COMPRESSOR.
FRICK COMPANY, WYNNESBORO, PENNSYLVANIA.

being avoided by the forcing of the oil both ahead and behind the piston. The De La Vergne-Mixer machine had been installed so generally in the breweries of the



SECTION YORK COMPRESSOR
YORK MANUFACTURING COMPANY, YORK, PENNSYLVANIA.

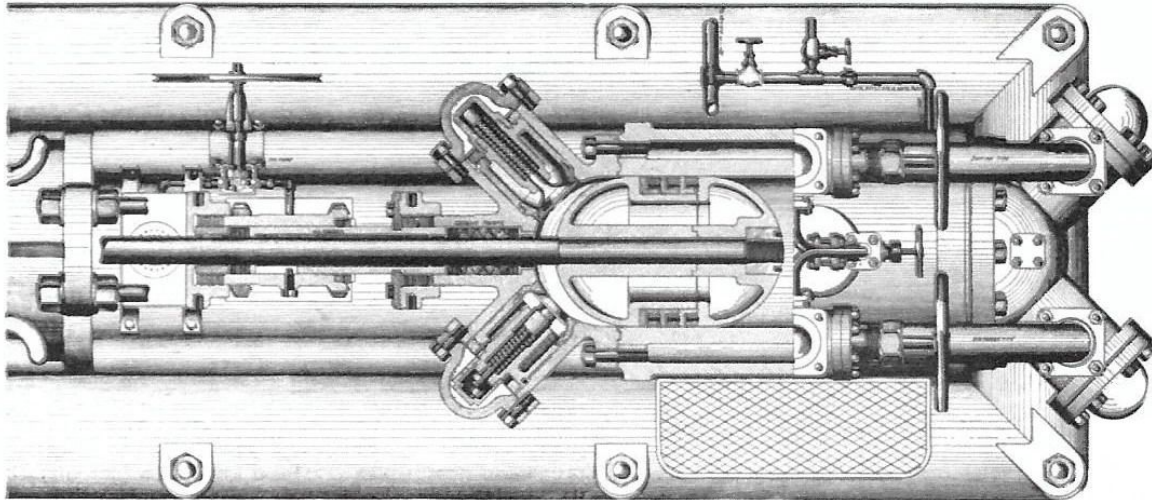
Dreyer Brewery, Trieste, Austria. Professor Linde patented his machine in the United States in 1880, assigning his right to Fred W. Wolf, and they have been manufactured ever since by the Fred W. Wolf Company, of Chicago.

The first Linde machine in the United States was erected in the brewery of the Wacker & Birk Brewing and Malting Company, Chicago, in 1880, and has been in constant operation ever since. It has a refrigerating capacity equal to the daily consumption of over twenty-five tons of ice. At the time of its purchase this brew-

ery by the Frick Company occurred in the spring of 1886, at the Phoenix plant of Henry Werner, in Baltimore, Maryland, and was a 20-ton machine.

PATENTS CONTROLLED BY THE YORK COMPANY.

In 1885 W. G. Lock, an engineer of Sydney, Australia, patented a compound compressor for ammonia,



SECTION VILTER COMPRESSOR.—VILTER MANUFACTURING COMPANY, MILWAUKEE, WISCONSIN.

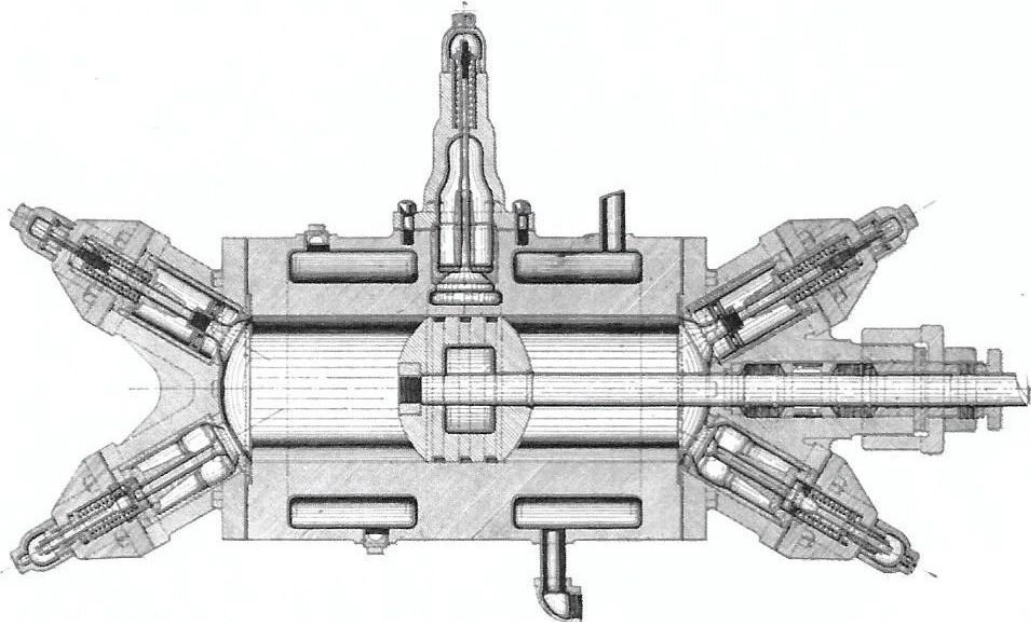
ery had an annual capacity of forty thousand barrels, depending entirely on the work of this machine to cool the cellars, fermenting room, beer wort, etc.

PATENTS CONTROLLED BY THE FRICK COMPANY.

In 1884 David Smith invented a machine for making ice according to the plate system. His patents are now controlled by the Frick Company, of Waynesboro, Pennsylvania, their manufacture constituting an

important part of the business of the refrigerating department of that company. The first of the so-called "Eclipse" refrigerating machinery to be installed in a

consisting of two single-acting high and low pressure pumps, side by side. Patents covering the idea were issued as early as 1867. Mr. Thomas Shipley has within the past few years made a number of most important changes and improvements in this machine, and has since designed an entirely new machine which the York Manufacturing Company, York, Pennsylvania, are building.



SECTION "TRIUMPH" COMPRESSOR.—TRIUMPH ICE MACHINE COMPANY, CINCINNATI, OHIO.

important part of the business of the refrigerating department of that company. The first of the so-called "Eclipse" refrigerating machinery to be installed in a

THE VILTER MACHINE.

About 1882 Peter Weisel, the founder of the business now conducted by the Vilter Manufacturing Com-

pany, of Milwaukee, Wisconsin, patented a double-acting, horizontal refrigerating machine, which Weisel & Vilter commenced to build in that year. The first machine was installed in the Cream City Brewery, of Milwaukee. Since that time various improvements have been made on the original and the Vilter apparatus has played a leading part in brewery refrigeration.

THE "TRIUMPH" ICE MACHINE.

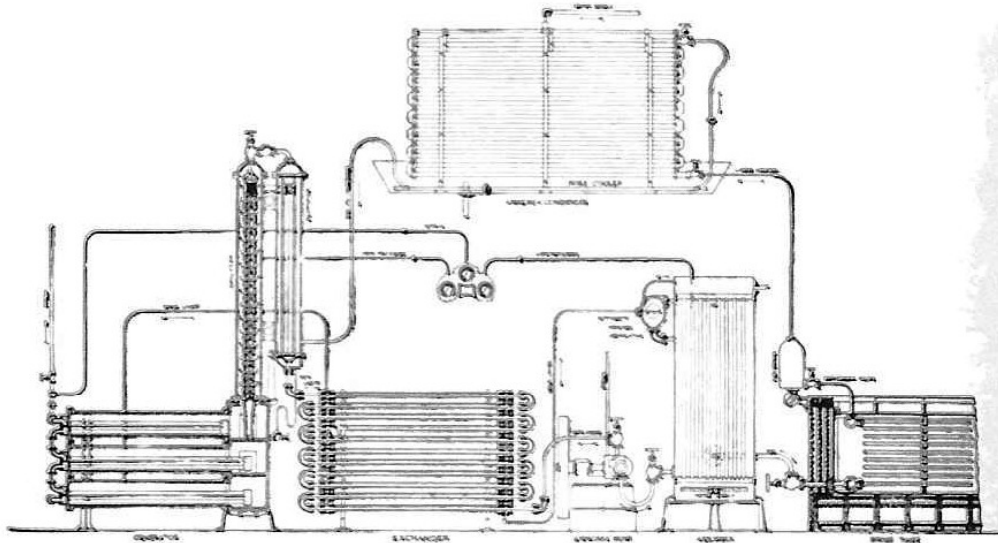
In 1894 F. W. Niebling, a refrigerating engineer of Cincinnati, patented a horizontal double-acting ammonia compressor. In it were incorporated three suction and two discharge valves, the patentee claiming that by the location of the third suction valve near the center of the ammonia cylinder a more uniform and effi-

THE KRAUSCH REFRIGERATING MACHINE.

Reference has already been made to the so-called Krausch ice chambers, with the mechanical device for the circulation of the surrounding air. In 1878 the inventor of this apparatus, Theodore Krausch, introduced a refrigerating machine of the ammonia compression type, which he first installed at Lemp's Brewery, St. Louis. This was one of the pioneer machines applied to the refrigeration of breweries in the United States. Mr. Krausch continued to manufacture his machines for many years thereafter.

CONCLUSION.

In the foregoing pages we have not attempted to present a history of artificial refrigeration and have



THE VOGT ABSORPTION SYSTEM - HENRY VOGT MACHINE COMPANY, LOUISVILLE, KENTUCKY.

cient suction of gas was attained. The machine known as the "Triumph" Ice Machine is built by the company of that name, Mr. F. W. Niebling being its superintendent.

THE VOGT ABSORPTION MACHINE.

The ice-making and refrigerating machines manufactured by the Henry Vogt Machine Company, of Louisville, Kentucky, are all of the absorption type. Although the company was founded in 1880 this class of machinery was not manufactured until 1887. The first machine to be applied to brewery refrigeration was installed during the year named at the Knoxville (Tennessee) Brewery. At the present time twenty per cent of the total number of machines turned out find their way into breweries.

given only the main facts as they bear upon the subject of refrigeration in the brewery. The topic has been treated chiefly from the standpoint of the inventor of the machinery which has been so instrumental in the wonderful development of the brewing industry. The principal manufacturers of the apparatus, who form a prominent industrial class by themselves, have also been mentioned as a marked feature of the subject; but, as stated, the plan has been followed of dealing chiefly with the pioneer inventors of those distinct types of refrigerating machinery which have been found, by practical experiment, to be best adapted to the refrigeration of the brewery and best applied to the various processes connected with brewing, as well as the preservation of the manufactured product.

