GARDNER T VOORHEES

By EurIng Brian Roberts, CIBSE Heritage Group

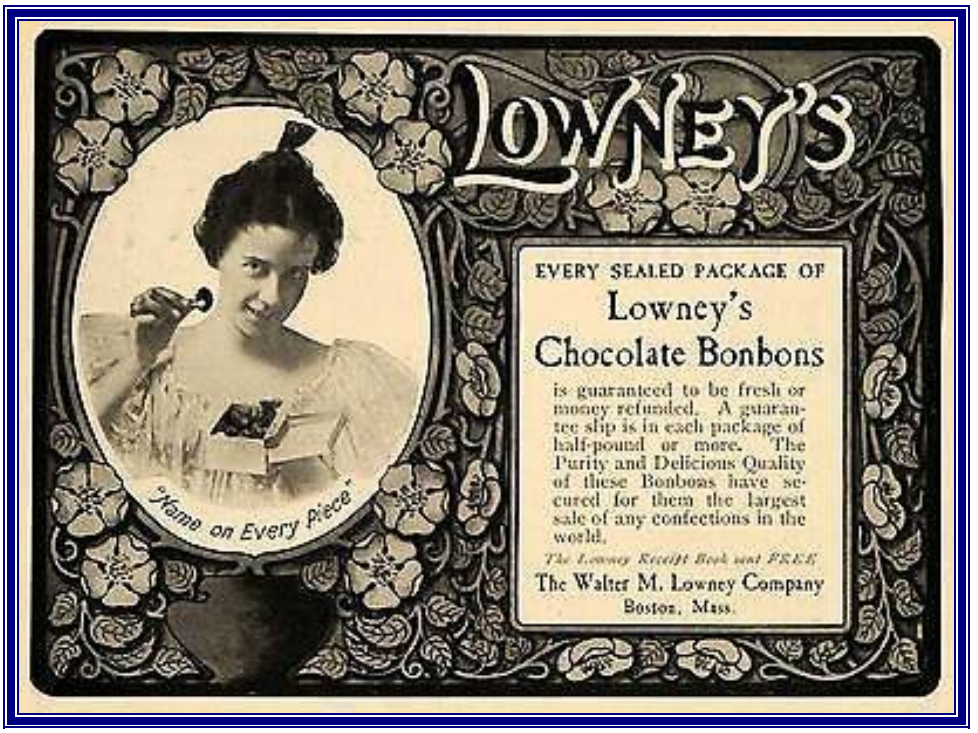
Gardner Tufts Voorhees, 1869-1937

Gardner Voorhees was born in 1869, possibly in or around Boston, Massachusetts, but no details of his childhood, family life or early education have so far been discovered, In fact, information on his business activities is also sparse. However, what is certain is that he was a leading authority on refrigerating equipment and in particular on ammonia absorption machines, writing five books on this type. He also took out refrigeration patents and pioneered the design of significant refrigeration and air cooling installations.

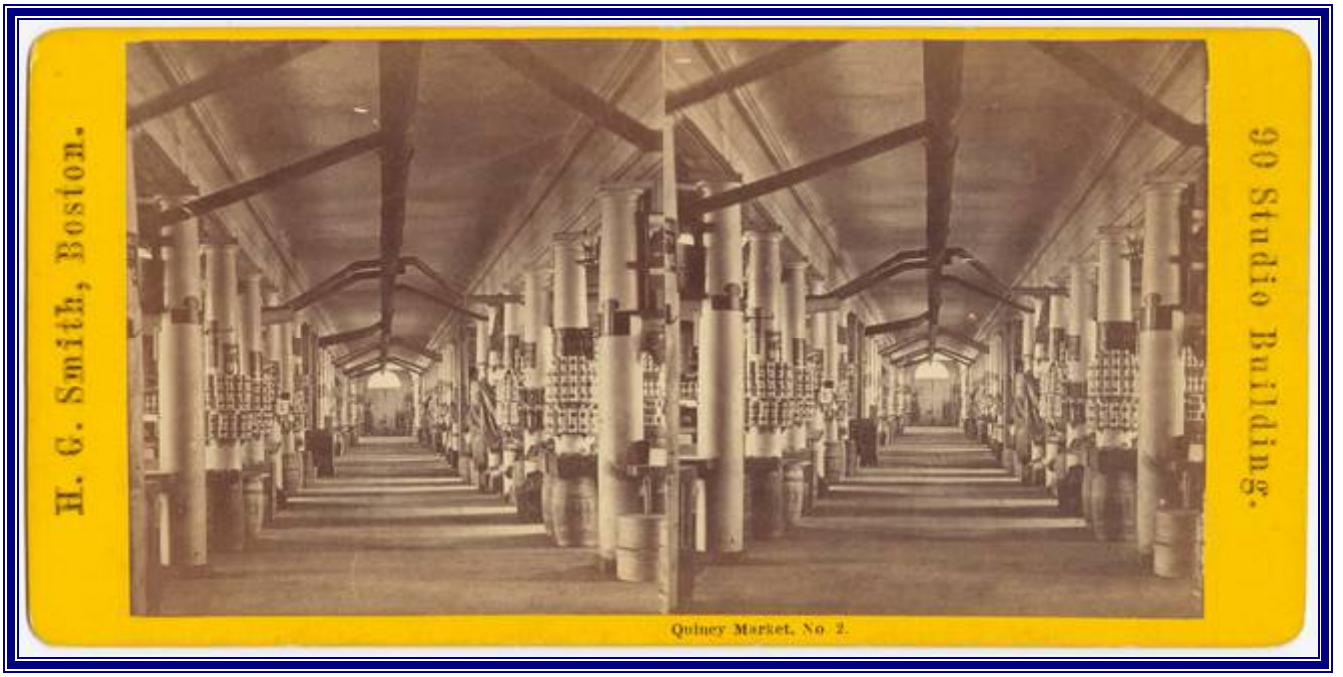
Voorhees obtained a Bachelor of Science Degree (SB) from MIT (Class of 1890) and set up in consultancy as a *Refrigerating Engineer & Architect* in Boston. He was a Member of ASME and later of ASRE. He promoted his expertise in "Mechanical Refrigeration in all its applications: Cold Storage Warehouses, Ice Factories, Street Pipe Line Refrigeration, Breweries…..etc."

He is credited was the design of one of the earliest district cooling systems consisting of a central refrigeration plant serving multiple buildings by an underground network of insulated piping through which brine was pumped. This installation was for the Quincy Market Cold Storage Company in Boston. He also installed a comfort cooling system in his own office and designed a system for the Walter Lowney Candy Company, also in Boston.

Gardner Voorhees died in 1937. He was inducted into the ASHRAE Hall of Fame in 2005.



1904



Quincy Market, Boston, 19th century stereo cards

THE ABSORPTION REFRIGERATING MACHINE

A COMPLETE, PRACTICAL ELEMENTARY TREATISE ON THE ABSORPTION SYSTEM OF REFRIGERATION, AND ITS BROAD GENERAL PRINCIPLES OF OPERATION

BY

GARDNER T. VOORHEES, S. B.

MEMBER AM. SOC. MECH. ENGINEERS
MEMBER AM. SOC. REF. ENGINEERS

AUTHOR OF "INDICATING THE REFRIGERATING MACHINE"
AND
"REFRIGERATING MACHINES, COMPRESSION, ABSORPTION"

PUBLISHERS
NICKERSON & COLLINS CO.
CHICAGO—NEW YORK

No. 793,696. PATENTED JULY 4, 1905.

G. T. VOORHEES.

REFRIGERATING APPARATUS.

APPLICATION FILED JAN. 28, 1901.

2 SHEETS—SHEET 1.

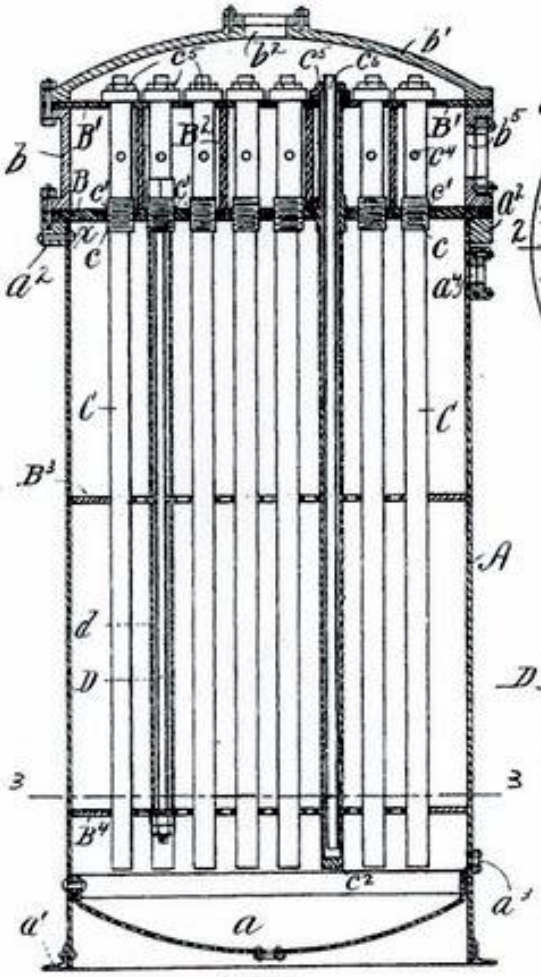


Fig. 1

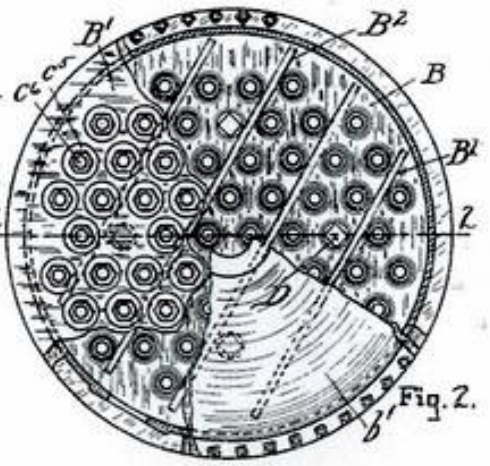


Fig. 2.

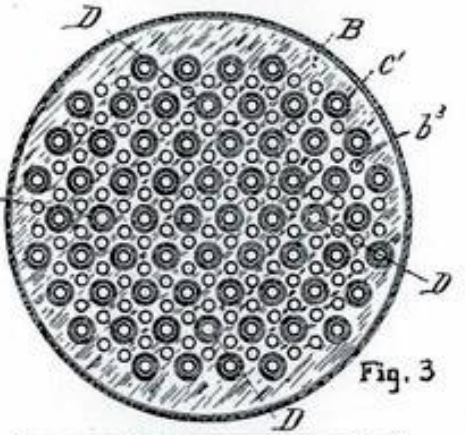


Fig. 3

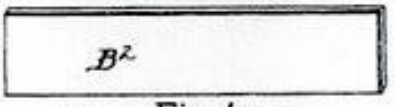


Fig. 4.

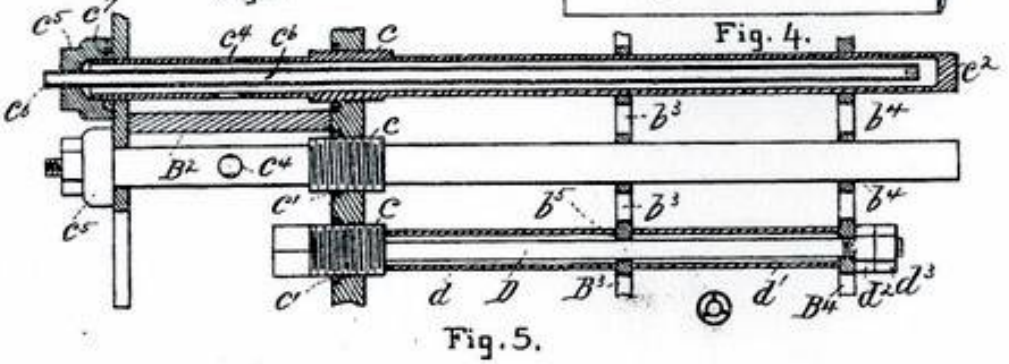


Fig. 5.

WITNESSES

A. L. Hodgdon.

E. A. Allen.

INVENTOR

Gardner T. Voorhees

by his attorneys

Peach & Richardson

No. 793,696. PATENTED JULY 4, 1905.

G. T. VOORHEES.

REFRIGERATING APPARATUS.

APPLICATION FILED JAN. 28, 1901.

2 SHEETS—SHEET 2.

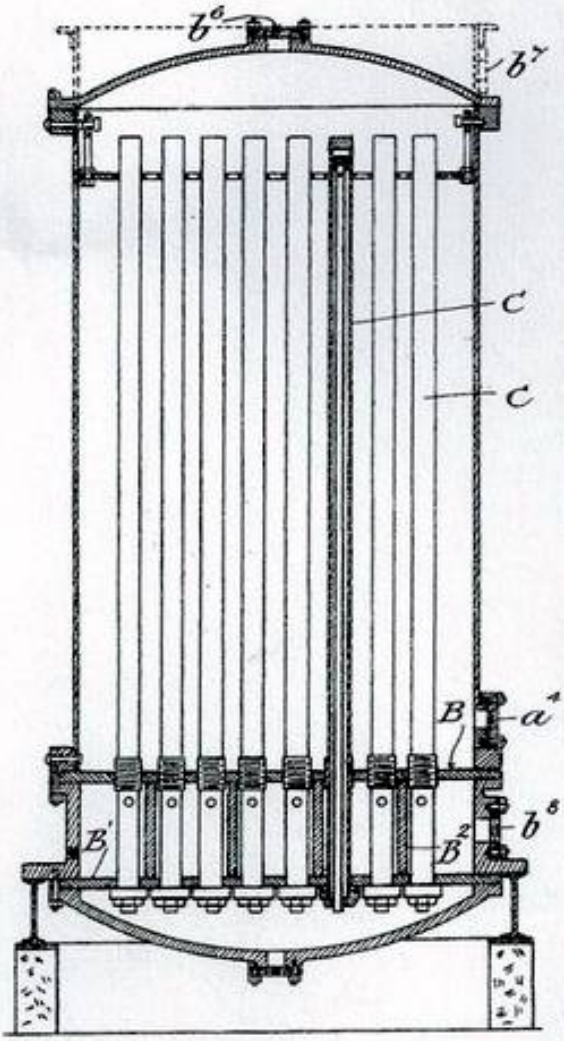


Fig. 6.

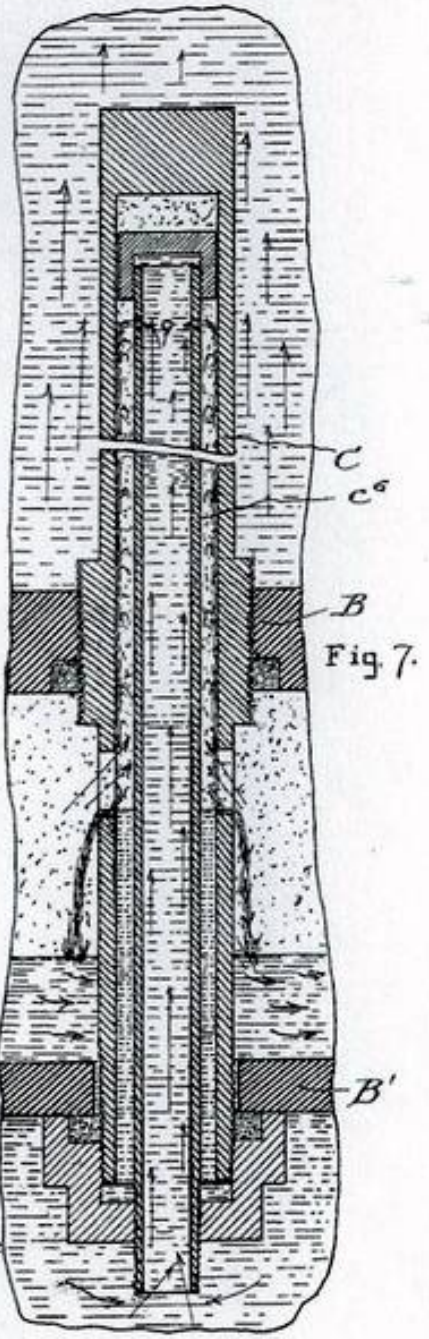


Fig. 7.

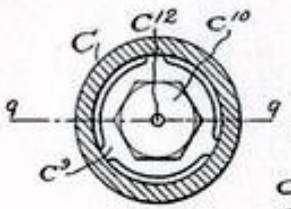


Fig. 9.

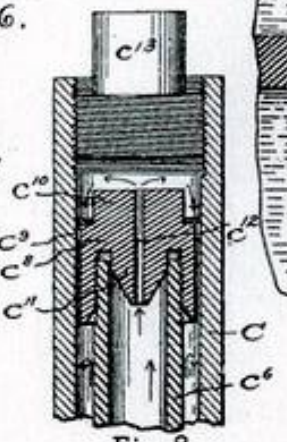


Fig. 8.

WITNESSES

A. L. Hodgdon

E. A. Allen

INVENTOR

Gardner T. Voorhees

by his attorneys

Beach & Richardson

No. 793,696. Patented July 4, 1905.

UNITED STATES PATENT OFFICE.

GARDNER T. VOORHEES, OF BOSTON, MASSACHUSETTS.

REFRIGERATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 793,696, dated July 4, 1905.

Application filed January 23, 1901. Serial No. 44,985.

To all whom it may concern:

Be it known that I, GARDNER T. VOORHEES, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Refrigerating Apparatus, of which the following is a specification, reference being had therein to the accompanying drawings.

Figure 1 is a vertical section of a cooler on line 2 2 of Fig. 2. Fig. 2 is a plan of Fig. 1, showing portions of the main-tube plate into which the main tubes are secured and also the trusses which lie between the main-tube plate and the secondary-tube plate, together with other details, portions of the dome and portions of the secondary-tube plate being broken away. Fig. 3 is a transverse section on lines 3 3 of Fig. 1. Fig. 4 is a perspective view of a truss or rib. Fig. 5 is an enlarged detail showing the method of securing the tubes to the main and secondary tube plates and one of the numerous trusses between said plates. It also shows one of the stays and the plates which support the main tubes when not in a vertical position. Fig. 6 is a longitudinal section of substantially the same form of device shown in Fig. 1, but adapted to be used as an absorber. Fig. 7 is an enlarged detail of one of the tubes and plates of said absorber. Fig. 8 is a section of the same on line 9 9 of Fig. 9. Fig. 9 shows a section of the preferred form of perforated plug to be used at end of inner tube of absorber.

The present form of cooler used with refrigerating apparatus, although vastly superior to any known form of expansion-coil, is open to many objections. It generally consists of an outer vertical cylindrical shell having domed heads bolted, respectively, to the top and bottom flanges thereof. Each of these heads has a row of holes through which pass the coil tails or ends of several long closely-wound spiral brine cooling-coils of pipe, lock-nuts or stuffing-boxes, together with rubber gaskets, being used to make tight joints between coil-tails and the domed heads. These coil-tails outside of the cooler are gathered together in headers, one at the top and one at the bottom of the cooler, and are provided with more lock-nuts or stuffing-boxes. The cooler is usually supported some little distance above its foundations either on cast-iron legs or structural-iron frames, so that the lower header is accessible. Liquid ammonia is fed into the cooler near the bottom thereof and surrounds the comparatively warm brine-coils inside the cylindrical shell. This liquid ammonia is thus vaporized and passes off as vapor through an outlet at the top of the cooler. The following are the vital points wherein this type of cooler is at fault: The great length and comparatively small cross-sectional area of each of these spiral coils offers an excessive frictional resistance to the passage of the brine. In order to force the requisite amount of brine therethrough, there must be a difference of from twenty-five to seventy-five pounds pressure per square inch between the pressures at the inlet and outlet brine-headers. This is a serious objection. It means that extra work must be done by the brine-pumps, which is a source of unnecessary expense. These long spiral coils are heavy and difficult to handle, are difficult to repair, and difficult to replace quickly. If from any cause one of these spiral coils should leak, the operation of the whole cooler must be stopped until the leak is discovered and repaired. The insulating of the spiral-coil coolers is expensive, as much difficulty is experienced in getting at and working around the coil-tails and headers. Having now pointed out some of the objections which I have found in these coolers, the following description of my cooler will clearly show how I overcome them.

In the drawings illustrating the principle of my invention and the best mode now known to me of applying that principle, A is an upright cylindrical shell of a cooler having a main domed head a riveted thereon near the bottom thereof. The casing projects below the main domed head a and, with an angle-iron a', which is riveted to the shell, forms the base of the cooler. This construction thus does away with the usual cast-iron legs. To the top of the shell is riveted a wrought-iron flange a^2, and to this flange is bolted a

No. 793,864. PATENTED JULY 4, 1905.

G. T. VOORHEES.

MULTIPLE EFFECT COMPRESSOR.

APPLICATION FILED JULY 30, 1903.

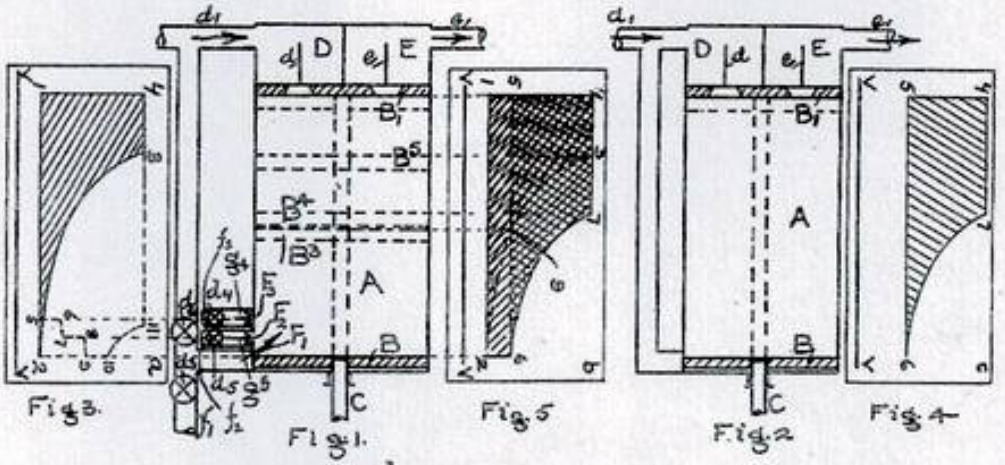


Fig. 3. Fig. 1. Fig. 5 Fig. 2 Fig. 4

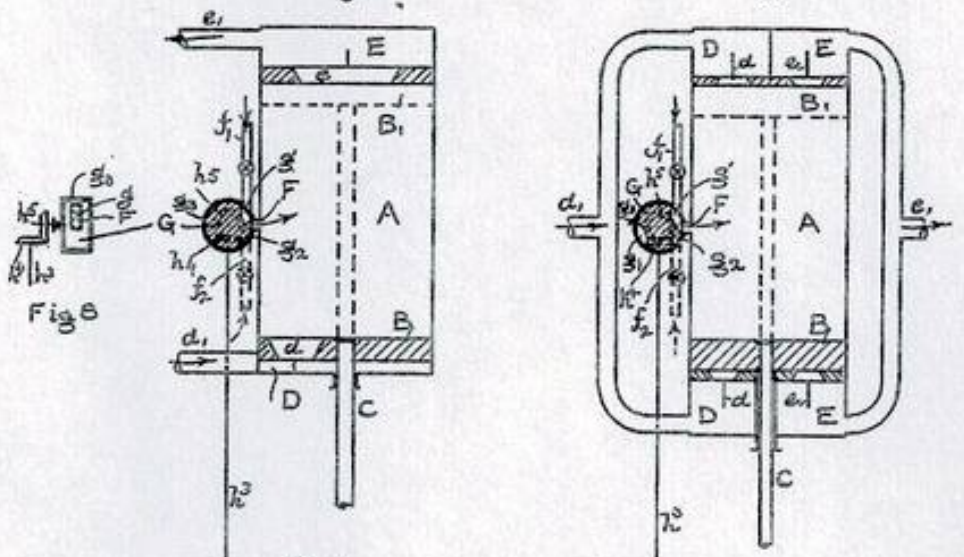
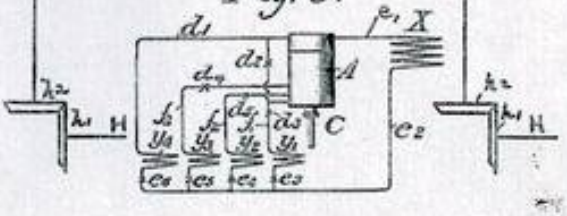


Fig. 8 Fig. 6 Fig. 7

Fig. 9.



Witnesses:
L. P. Gallagher.
J. W. Sarle.

Gardner T. Voorhees, Inventor:
By his Attorney, Charles F. Richardson

No. 793,864. Patented July 4, 1905.

UNITED STATES PATENT OFFICE.

GARDNER T. VOORHEES, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO WILLIAM H. HARRIS, TRUSTEE, OF NEW YORK, N. Y.

MULTIPLE-EFFECT COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 793,864, dated July 4, 1905.

Application filed July 30, 1903. Serial No. 167,582.

To all whom it may concern:

Be it known that I, GARDNER T. VOORHEES, a citizen of the United States of America, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Multiple-Effect Compressors, of which the following is a specification.

My invention relates to refrigerating apparatus, particularly to compressors.

In many applications of refrigeration it is often desirable to maintain in different refrigerators different temperatures of the volatile refrigerant—for example, in a cold-storage warehouse where brine, say, at 0° and 15° Fahrenheit temperature is to be used, in a plant making plate-ice and also can-ice or where a high temperature is required for the first freezing of the plate and a low temperature for the last freezing, also in cooling living-rooms, requiring brine of high temperatures in connection with an ice or cold-storage plant using lower temperatures. Further, in an ice-cream-freezing plant a low temperature may be maintained to freeze the cream, while higher temperatures are employed in freezing ice and cooling storerooms. Likewise a cooling-water plant may require low temperatures besides the higher temperature for cooling the water. In ice-making if the water before going to the cans is cooled, say, from 80° to 32° Fahrenheit thirty-five per cent. would be added to the capacity of the compressor. The additional power required could be furnished without the use of extra steam by making the engine compound. The above cases and many others necessitate the use of two or more different compressors, each operating at a different back pressure, and therefore temperature.

Now the object of my invention is so to modify existing forms of compressors that a single compressor can do refrigeration at two or more different back pressures, and I accomplish this object by providing a compressor with a cylinder having therein two or more back-pressure inlets leading from refrigerators having different temperatures.

The principle of my invention involves Boyle's law. If in a given case a vessel is full of gas at twenty pounds absolute pressure and a like gas at forty pounds pressure is allowed to enter the vessel, the original gas at twenty pounds will be compressed to one-half its volume, have its pressure doubled to forty pounds, and the remaining half of the space in the vessel will be filled by gas at forty pounds pressure. Similarly the pressure of the gas in the vessel could be raised to sixty pounds, then to eighty, or any other higher pressure, if so desired.

In the following diagrammatic drawings, Figure 1 is a sectional view of the preferred form of my invention as applied to compressors. Fig. 2 is a like view of a common single-acting compressor having one-half the volume of the compressor shown in Fig. 1. Figs. 3, 4, and 5 are indicator-diagrams showing the action of the compressors in Figs. 1 and 2 in various ways. Fig. 6 is a modified form of single-acting compressor with my invention applied thereto. Fig. 7 is a double-acting compressor having my invention applied thereto. Fig. 8 is a sectional view of the valve G and its gears shown in Figs. 6 and 7, while Fig. 9 is a diagrammatic view showing my compressor in connection with a high-pressure-gas receiver and several sources of low-pressure gas.

In the drawings illustrating the principle of my invention and the best way now known to me of embodying that principle a compressor-cylinder A has a piston B, provided with a piston-rod C, which is caused to reciprocate by any well-known means. Said cylinder has a suction-valve-chamber D and a discharge-valve chamber E. An opening leading from the former into the cylinder is controlled by suction-valve d, while an outlet from the cylinder into the discharge-chamber E is controlled by a discharge-valve e e', being a discharge gas-outlet leading to a condenser. (Not shown.) Connecting said suction-valve chamber D with some refrigerator (also not shown) is a suction gas-inlet d'. F' F^2 F^3 are ports opening into the cylinder A for auxil-

THE ABSORPTION REFRIGERATING MACHINE, Elementary Theory and Practice

A COMPLETE PRACTICAL ELEMENTARY TREATISE ON THE ABSORPTION SYSTEM OF REFRIGERATION, AND ITS GENERAL FUNDAMENTAL PRINCIPLES OF OPERATION

SECOND EDITION

REVISED AND AMPLIFIED

BY

GARDNER T. VOORHEES, S.B.

MEMBER AM. SOC. MECH. ENGINEERS

MEMBER AM. SOC. REF. ENGINEERS

AUTHOR OF "INDICATING THE REFRIGERATING MACHINE" "REFRIGERATING MACHINES, COMPRESSION, ABSORPTION," "THE ABSORPTION REFRIGERATING SYSTEMS, ADVANCED PRACTICE AND THEORY."

PUBLISHERS

NICKERSON & COLLINS CO.

CHICAGO

THE ABSORPTION REFRIGERATING MACHINE

ADVANCED PRACTICE and THEORY

A COMPLETE TECHNICAL TREATISE ON ABSORPTION REFRIGERATING SYSTEMS CONTAINING NOT ONLY THE FUNDAMENTAL PRINCIPLES, BUT ALSO DETAILED DATA FOR THE DESIGN AND CONSTRUCTION OF THE ABSORPTION MACHINE FOR ALL WORKING CONDITIONS

BY

GARDNER T. VOORHEES, S. B.

MEMBER AM. SOC. MECH. ENGINEERS
MEMBER AM. SOC. REF. ENGINEERS
MEMBER N. A. P. R. E.

AUTHOR OF "INDICATING THE REFRIGERATING MACHINE," "REFRIGERATING MACHINES, COMPRESSION, ABSORPTION," "THE ABSORPTION REFRIGERATING MACHINE, ELEMENTARY THEORY AND PRACTICE," "THE COMPRESSION REFRIGERATING MACHINE."

PUBLISHERS
NICKERSON & COLLINS CO.
CHICAGO

VOORHEES' PATD.

M. E. C. DEV. & M. E. R.

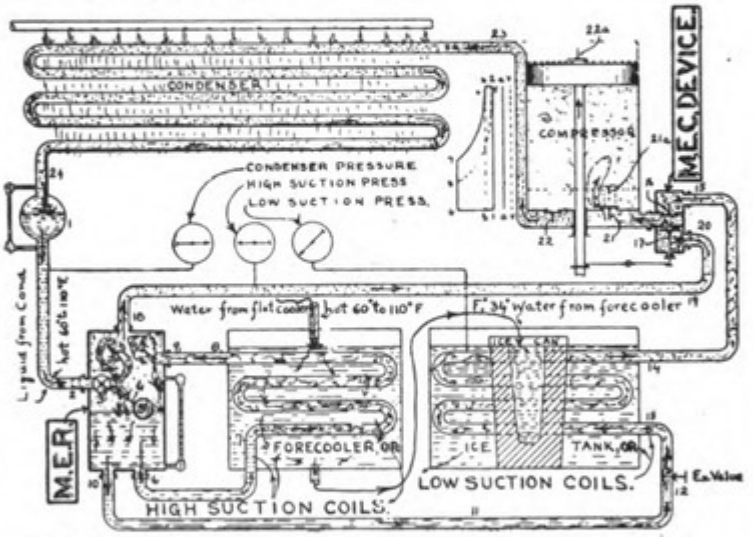
(Multiple Effect Compressor Devices)
(Multiple Effect Receiver)

Will Make Your Compressor

1—**Give same ice or refrigeration** for less speed and **less power.**

2—**Give more ice or refrigeration** for less speed and **same power.**

3—**Give much more ice or refrigeration** for same speed and for a little more power but for **less power per ton** of ice or refrigeration.



Standardized. Compact. Simple.

This gives nearly uniform ice tonnage Winter and Summer, with MORE ICE IN SUMMER THAN YOU CAN NOW GET IN WINTER. Very much less regulation of expansion valves. All who have once used this apparatus, then again ordered for other compressors.

In an average ice plant, if you install **M.E.R.** and put **M.E.C. Devs.** on **your present compressor** you **will have as much** extra compressor **capacity** and economy **as if you had installed a new compressor, ½ the size of your present compressor** that made its ice for **35% less power per ton.**

Cold Storage, Packing House, Ice Cream Plants, etc., give **greater gains** in capacity and economy than do ice plants.

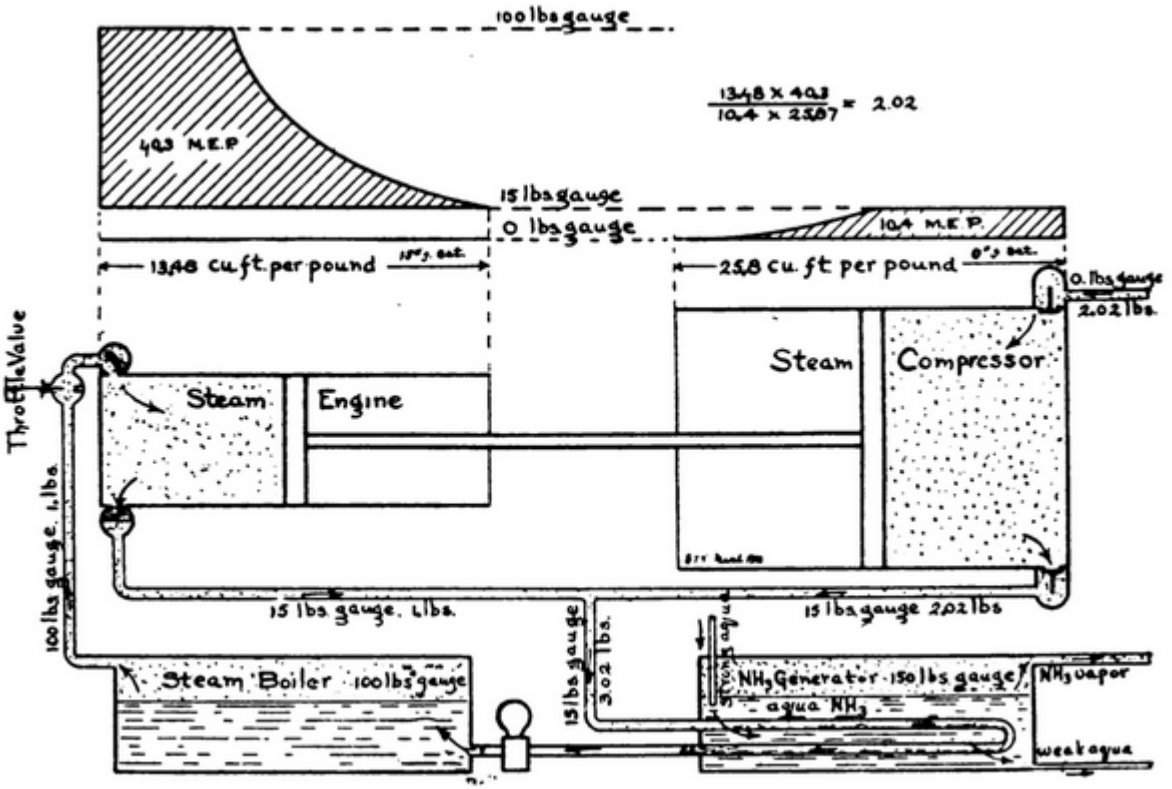


FIG. 43.—VOORHEES PATENTED COMPRESSED EXHAUST STEAM FOR REFRIGERATION.

References

*Heat & Cold: Mastering the Great Indoors***,** Barry Donaldson & Bernard Nagengast, ASHRAE, 1994

Gardner T Voorhees, ASHRAE Hall of Fame, 2005