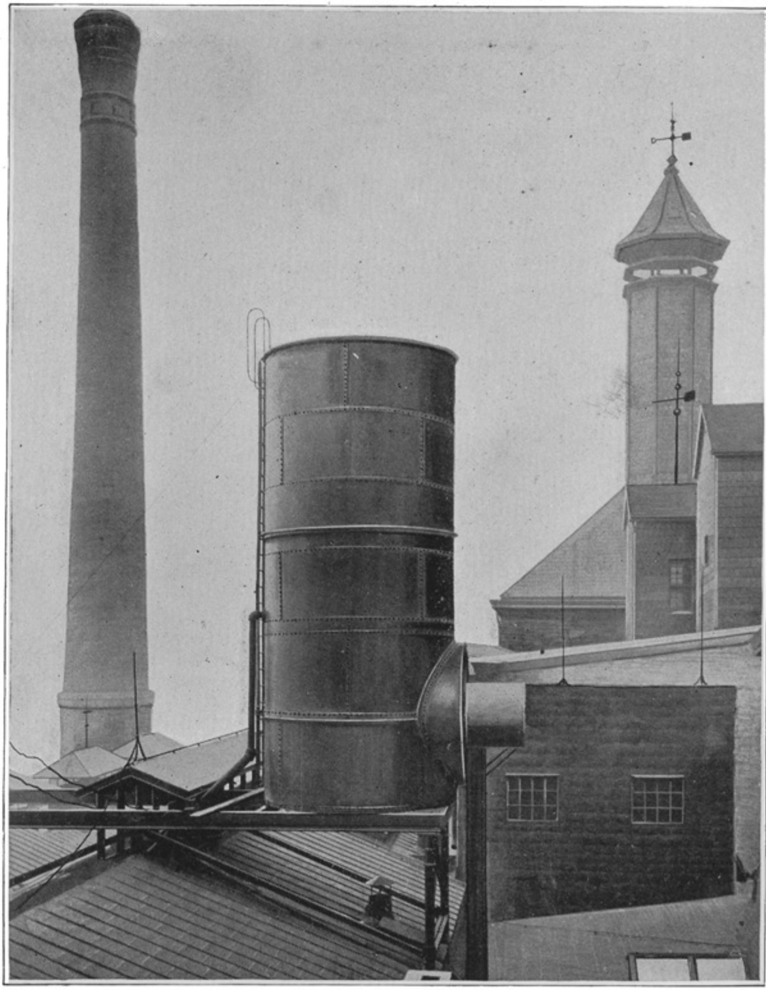
SPECIAL CATALOGUE

THE WORTHINGTON COOLING TOWER

HENRY R. WORTHINGTON

NEW YORK

1897



Worthington Cooling Tower

LOCATED OVER AMMONIA CONDENSER HOUSE

THE WORTHINGTON COOLING TOWER

HENRY R. WORTHINGTON

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To Owners and Users of Refrigerating Machinery:

Your attention is respectfully called to a novel system of water cooling, that forms the theme of this circular.

Appreciating the extreme value of an efficient, durable, and economical means of saving the water usually allowed to run to waste in refrigerating and ice manufacturing plants after it has passed over the various condensers and coolers, we have for several years given the subject careful study and investigation, and take pleasure in offering a thoroughly practical and commercial apparatus that we can fully recommend and guarantee.

A number of our machines in operation for several years have performed their functions through extremes of weather and temperature in a manner highly satisfactory both to ourselves and our customers, and prove by actual service that our apparatus will save from 85 to 95 per cent. of the water required for condensing and cooling purposes in refrigerating and ice making plants, and in locations where the absorption of heat is desirable and there may be a scarcity of water.

We have at our several branch offices competent engineers who will examine plants with a view to applying the apparatus to existing conditions, or advise as to its adoption for prospective enterprises. A list of our branch offices will be found on the title page of this circular.

In asking for our recommendations in the matter of existing plants, or for proposals for the apparatus, please send the particulars of the plant as asked for on page 25.

HENRY R. WORTHINGTON.

January, 1897.

THE WORTHINGTON COOLING TOWER

SAVES THE WATER USED ON AMMONIA AND STEAM CONDENSERS

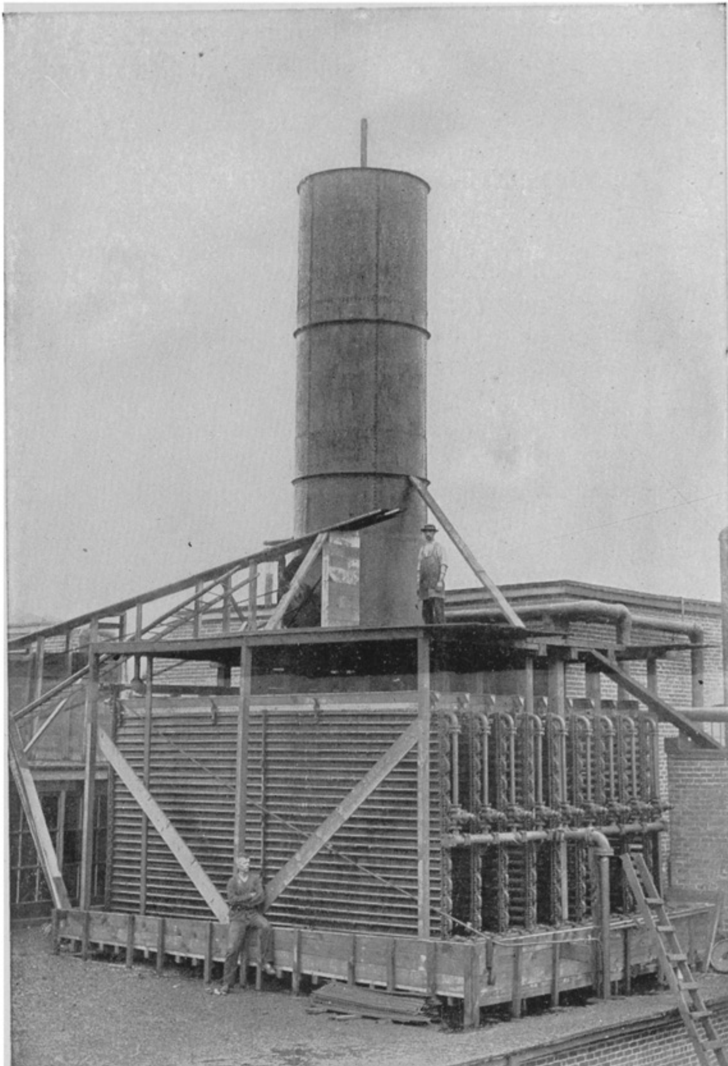
THIS apparatus is the embodiment of an invention of more than ordinary importance, the value of which must be at once apparent to engineers and to owners of plants requiring the removal or absorption of large quantities of heat which may be generated during any process.

The condensation of steam from steam engines to get the economical effect of a vacuum, and the condensation of ammonia in connection with refrigerating plants, require the absorption of vast quantities of heat, ordinarily accomplished by the use of large volumes of cold water which run to waste after being heated.

Where an ample and inexpensive water supply is not available and must be purchased from a municipality or pumped from a long distance, or from deep wells by deep well or air lift pumps, which are expensive and costly to operate, the expense becomes a serious matter.

The cooling of the condensing water avoids its waste and allows its continuous use at the nominal expense of circulation over the condenser and cooling apparatus.

To accomplish this purpose the Worthington Cooling Tower has been designed and patented; and, after extended and practical use, is offered as an efficient and durable device for saving the water usually allowed to run to waste.



WORTHINGTON COOLING TOWER

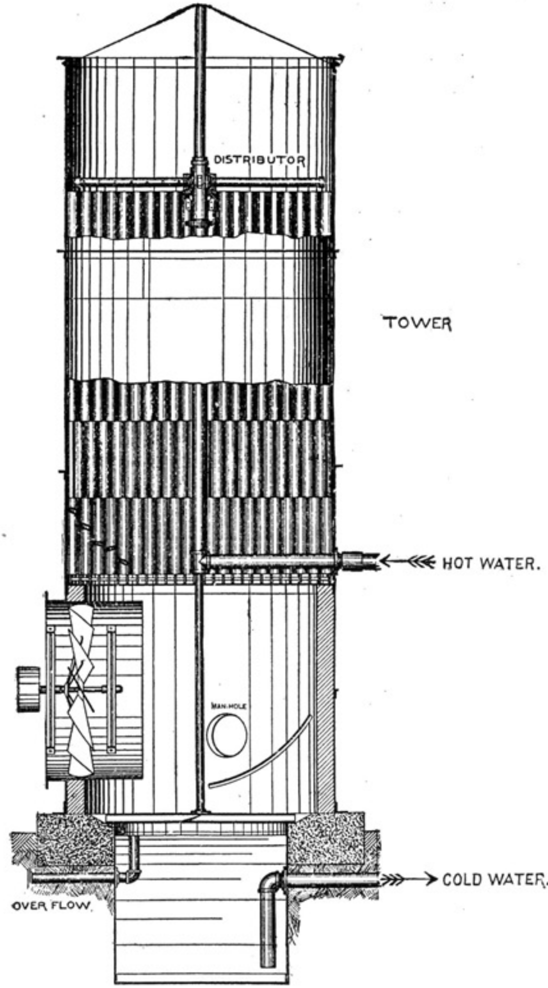
IN CONNECTION WITH AMMONIA CONDENSERS

PRINCIPLES OF OPERATION

THE Worthington Cooling Tower depends for its effectiveness upon the capacity of atmospheric air to absorb and carry off heat and moisture by creating rapid evaporation. Broadly considered, the air becomes the condensing medium in the place of cold water as ordinarily employed, and on account of its general distribution the process can be performed at any place desired. When properly manipulated, as in the apparatus under consideration, air becomes a better medium for condensation than water, not only on account of its abundance, but because of its freedom from foreign materials such as frequently occur in natural water supplies in the shape of ice, stones, fish, weeds and the like. As a condensing medium it is much more desirable than hard or brackish water, or that which comes from mines, as it exerts no corrosive effect upon the pumps nor causes deposits of lime upon the condensers.

The idea of cooling the water from a condenser or other heat-producing source, and re-using it, is an old one and has been tried in many ways. Open ponds or condensing reservoirs, open pans located on roofs of buildings, and other appliances depending upon natural circulation and contact between air and water are in use, but the time and vast areas of surface required make such arrangements impractical in nearly every case, and always uncertain, as they rely totally on favorable conditions of wind and atmosphere for effectiveness.

The object of this apparatus is to supply power plants, breweries, ice factories and other industrial operations, with a cooling or heat-absorbing apparatus, at once simple and com-



WORTHINGTON COOLING TOWER

SECTIONAL ELEVATION

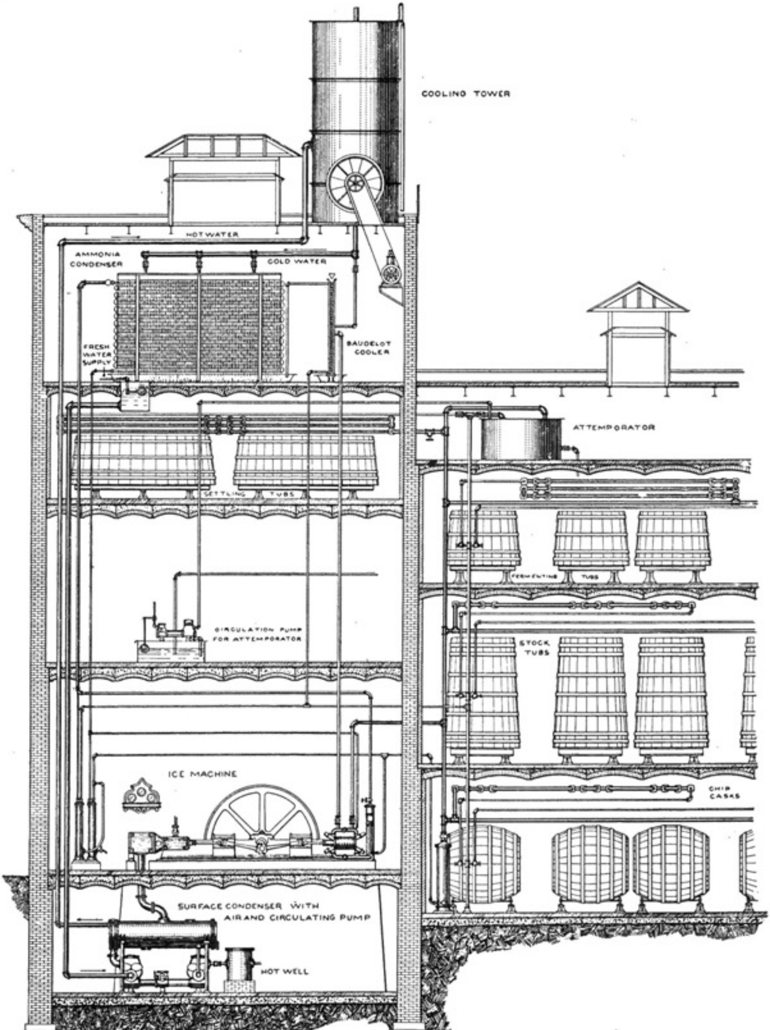
pact in construction, thoroughly durable, and so completely under control as to be practically independent of the changes in wind and weather.

As shown by the cut opposite, it consists of a steel tower enclosing the evaporating surface which is made up of a vast number of tubular or other sectional elements, arranged in courses, each breaking joints with the next. At the bottom of the tower is a fan, and at the top a distributing device. The water to be cooled is pumped, or allowed to run to the top of the tower where, in passing through the distributing device, it is evenly spread over the upper course of the evaporating surface, trickling over the successive courses to the cold water tank at the bottom of the tower.

A rapid circulation of a large volume of air generated by the fan constantly passes up over the evaporating surface, opposite to the direction of the flow of the water. By breaking joints at each course, the most thorough and efficient contact between water and air is assured, giving the maximum evaporation and consequent cooling effect.

The cooling effect of the apparatus depends upon three processes: First, radiation from the pipes and sides of the tower; second, the contact of cool air with heated water; and third, evaporation. This latter is by far the most important, as the evaporation of a pound of water in this way carries off about one thousand units of heat. As quite a proportion of the cooling is due to the first two processes, the only water required in the operation of the apparatus is that which compensates for the evaporation.

The floor space required is not excessive, as a tower to cool all the water used in a 100 ton ice making plant can be placed in a space 20x25 feet, including the room required by the engine which operates the fan.



WORTHINGTON COOLING TOWER

AS APPLIED TO DIRECT EXPANSION REFRIGERATING SYSTEM

COMMERCIAL VALUE OF THE WORTHINGTON COOLING TOWER

IN a paper read by Prof. James E. Denton before the American Society of Mechanical Engineers (Vol. XII, page 326), on "The Performance of a Seventy-five Ton Refrigerating Machine of the Ammonia Compression Type," careful records of a test showing an ice melting capacity of 74.8 tons per 24 hours, show a cost of 16.6 cents per ton of refrigerating capacity for coal, and 12.8 cents for water, or a total of 29.4 cents per ton of refrigerating capacity, at a time of year when the cooling water averaged 44.5° Fahr.

By the application of a cooling tower to this plant, the amount of water consumed could be reduced at least 90%, reducing the total cost for coal and water per ton of refrigerating effect from 29.4 cents to 17.8 cents, or a saving of 40%. At a somewhat increased first cost, a tower of sufficient capacity to condense the steam from the steam engine actuating the compressor could have been installed. This would have reduced the coal consumption by at least 20%, bringing the cost for coal and water down to 14.5 cents per ton of refrigerating effect or over 50% saving, at a time of the year when the water consumption was least. In the summer time, when hydrant water is warmer, the percentage of saving is much greater than the above figures show, and it is certain that no better investment could be made by refrigerating establishments not enjoying a free water supply or obliged to pump from artesian wells, than the installation of a Worthington Cooling Tower.

Where fuel is at all expensive, the saving by condensation is a very considerable amount. Ordinarily, non-compound non-

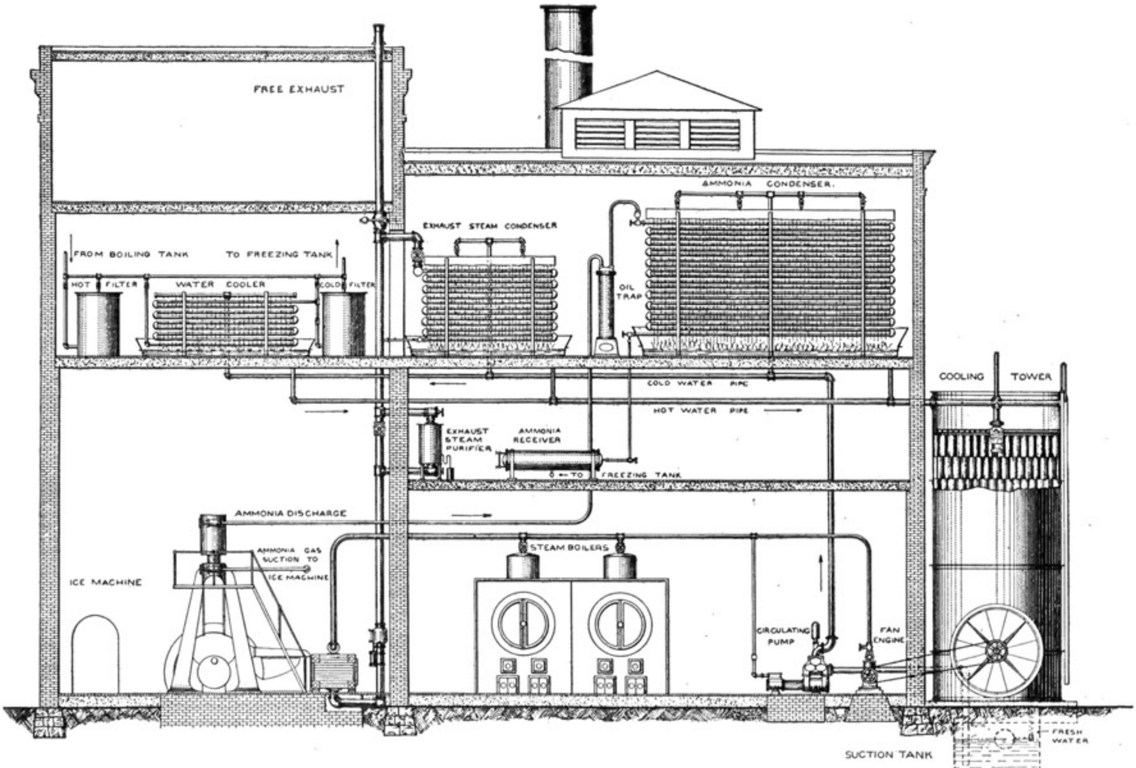
WORTHINGTON COOLING TOWER
IN CONNECTION WITH ICE MANUFACTURING PLANT

condensing engines are used to actuate the compressors. By the use of a tower of sufficient capacity to condense the steam, as well as to condense the ammonia, a compound condensing or, in large plants, a triple-expansion condensing engine could be used with a consequent reduction of from 30 to 50 per cent. in the fuel required per ton of refrigerating effect. The attention of those who are preparing to install new or overhaul old plants is especially called to this very important application of the Worthington Cooling Tower.

The fuel saving benefits of condensing can be obtained without any additional expense for water, as the water obtained by condensing the steam which comes from the engine more than compensates for the evaporation in the tower. As a matter of fact, in the case of a tower recently installed, where the steam engine is run condensing, less water is required to condense the steam and the ammonia than to condense the ammonia alone when the engine is running non-condensing, and the tower has to cool only the water required for the ammonia condenser.

Assuming average practice in refrigerating plants, the water used on the ammonia condensers averages the year around two gallons per minute per ton of refrigerating capacity, or 2880 gallons per day per ton, which at five cents per 1,000 gallons, a fair price, amounts to 14.4 cents per ton, or for a 100 ton machine $14.40 per day. By the application of a cooling tower at least 90% of this can be saved, amounting for such a machine to, say, $13.00 per day, which is 6% on nearly $80,000.

In the summer time, when the service required of refrigerating machines is usually most severe, the temperature of the cooled water coming from the tower is often 20° lower than the temperature of the air, giving circulating water considerably cooler than that available from the city water mains.



WORTHINGTON COOLING TOWER

AS APPLIED TO AMMONIA AND STEAM CONDENSERS IN AN ICE MANUFACTURING PLANT

THE WORTHINGTON COOLING TOWER

FOR AMMONIA CONDENSERS ONLY

ON page 10 we illustrate the application of the apparatus to the ammonia condenser only, showing the tower on the ground. The water, after being cooled, is pumped again to the top of the condenser, whence, after being heated, it flows down over the tower.

By means of a ball and float valve, the small amount of water required to make up for that evaporated during the process of cooling is automatically furnished to the suction tank.

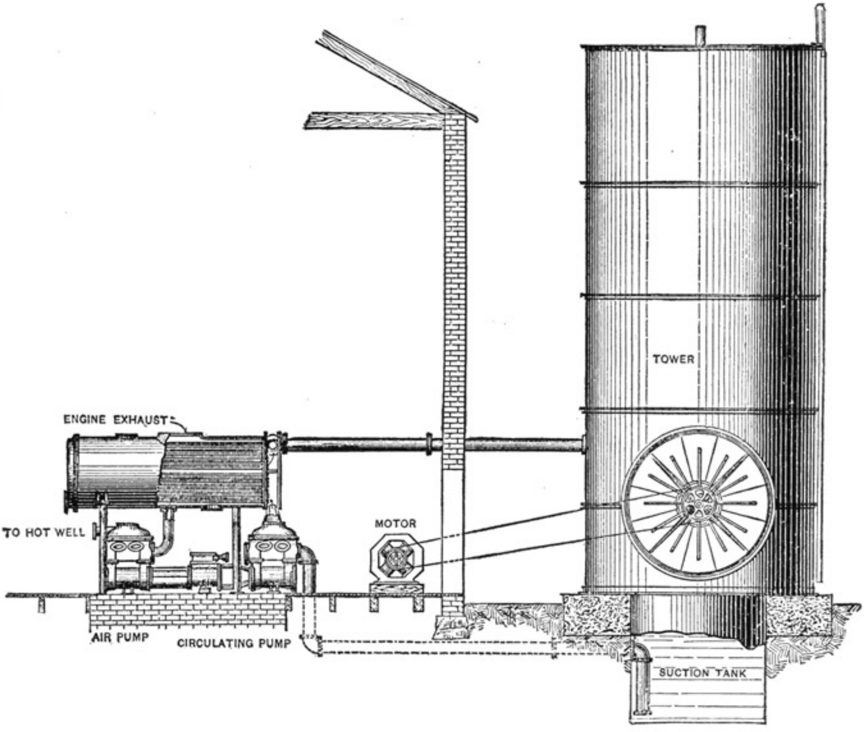
If the conditions are such as to prevent the location of the tower on the ground, it may be put on the top of the building, as shown on page 8, or at any convenient place, the construction and materials being such as to bring the weight of the entire machine well within 150 pounds per square foot. The cut on page 4 shows such an arrangement, as in use at an ice and cold storage plant since June, 1895.

THE WORTHINGTON COOLING TOWER

AS APPLIED TO AMMONIA AND STEAM CONDENSERS

ON page 8 is shown an arrangement for cooling and re-using the water for condensing the steam end of the compressor in a surface condenser, getting the fuel saving benefits of a vacuum as well as condensing the ammonia.

An important feature in the use of this apparatus is the reduction of the ammonia condensing pressure, and the consequent reduction of horse-power required for operation of the compressor.



WORTHINGTON COOLING TOWER

IN CONNECTION WITH SURFACE CONDENSERS

Our experience has shown that the temperature of the cooled water often averages lower than that of hydrant water as usually supplied by municipal plants.

Increasing the amount of water circulated over the ammonia condenser results in a corresponding decrease in the condensing pressure of the ammonia and a resulting decrease in cost of operation of compressor. The diagram on page 20 shows the rapid decrease in ammonia pressure, corresponding to a slight decrease in the condensing temperature.

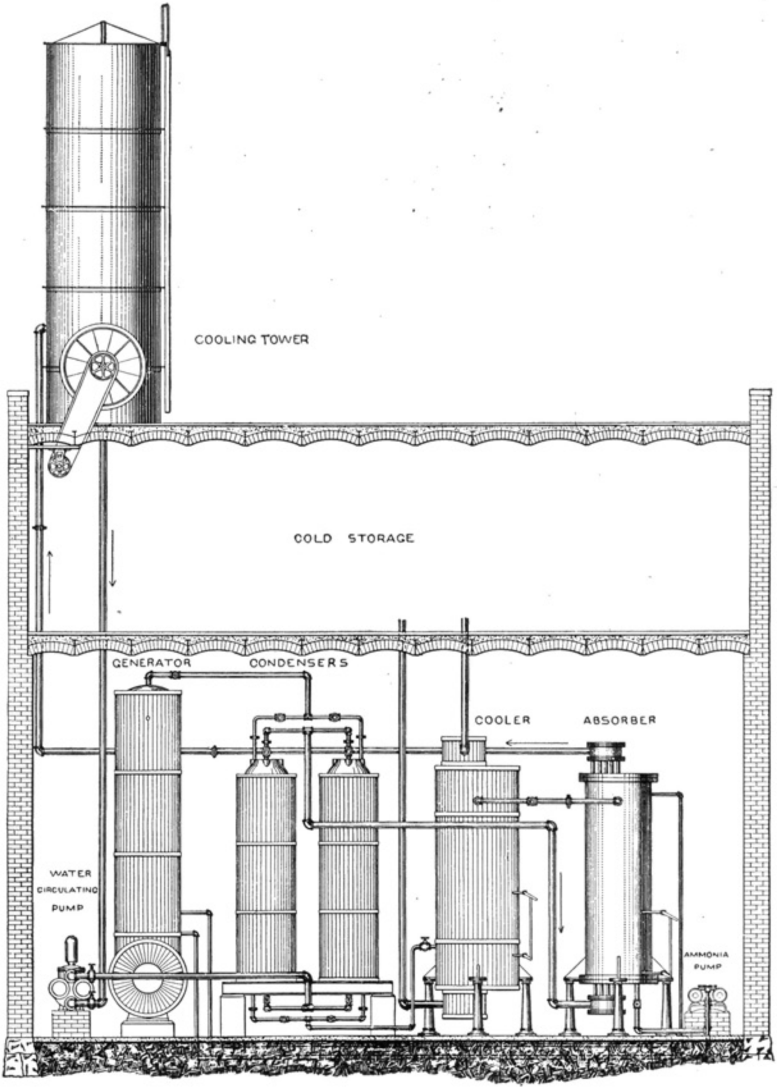
Among the many successful towers which we have in operation is one in use at an artificial ice plant in St. Louis, Mo., manufacturing 100 tons of ice daily. Observations made every two hours in the 24 for fifty-four days, from August 1st to Sept. 24th, 1896, and carefully averaged, show that the average temperature of the water coming from the Worthington Cooling Tower in service at that plant was 2° below the average temperature of the air, and 5½° below the average temperature of the water supplied from the city mains.

During the period of the observations the temperature of the air was as high as 105° Fahr. The total consumption of water for all purposes in the plant was less than 80,000 gallons per day.

Without the cooling tower the consumption would have been not less than 600,000 gallons per day.

The above performance is fully equalled by a number of other plants which we have in operation, and shows the appliance to be thoroughly practical and efficient.

In this case the adoption of the Cooling Tower permitted the location of the plant in a portion of the city giving the most convenient and most economical facilities, taking into consideration delivery to customers and haulage of fuel and ashes.



WORTHINGTON COOLING TOWER

IN CONNECTION WITH THE ABSORPTION SYSTEM OF REFRIGERATION

THE WORTHINGTON COOLING TOWER
AS APPLIED TO ABSORPTION MACHINES

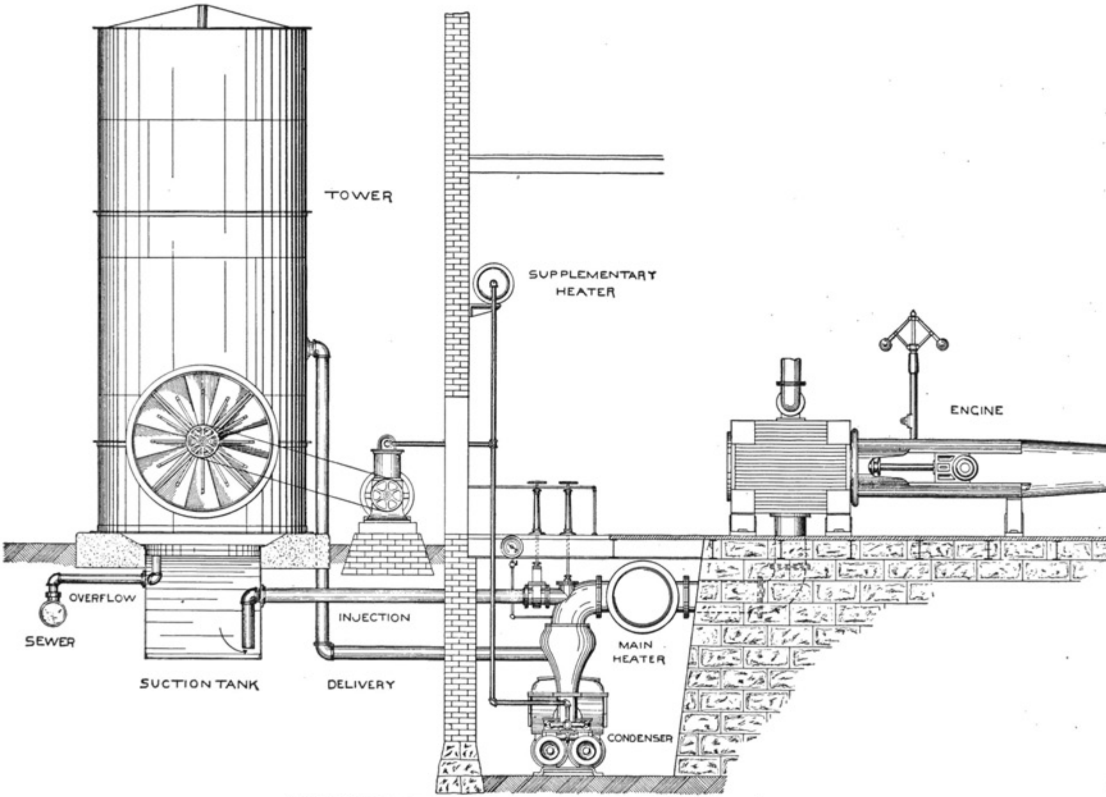
WE show on the opposite page a sectional elevation of a plant using the absorption system of ammonia refrigeration, with the Worthington Cooling Tower applied for cooling the water used in the condenser and in the absorber.

In absorption plants in which no mechanical compressor is used, in addition to the heat which must be removed from the ammonia condenser, a considerable amount is generated in the absorber, where the ammonia gas, after leaving the cooler, mixes with the weak liquor. Usually the cooling water, after leaving the condenser, passes through the absorber, where it gathers additional heat. The Worthington Cooling Tower makes possible all of the advantages of the absorption system without regard to the location or volume of the water supply.

THE WORTHINGTON COOLING TOWER
IN ICE MANUFACTURING PLANTS

WHEN room may not be conveniently available for locating the tower on the ground, it can be placed on the roof of the building as shown on page 8, which is an arrangement for cooling the water required for condensing the ammonia, and in addition giving the fuel saving benefits of a vacuum by means of a surface condenser. The air pump discharge being pure distilled water may be utilized in feeding the boilers, an especial advantage where the available water supply is impregnated with scale-producing substances.

In ice manufacturing plants the volume of water ordinarily consumed is a considerable amount, including that required for cooling the ammonia condensers, condensing the steam, and cooling the distilled water previous to being filtered and run into the freezing tanks. We give on page 12 a sectional elevation



WORTHINGTON SELF-COOLING CONDENSER

SHOWING TOWER IN YARD

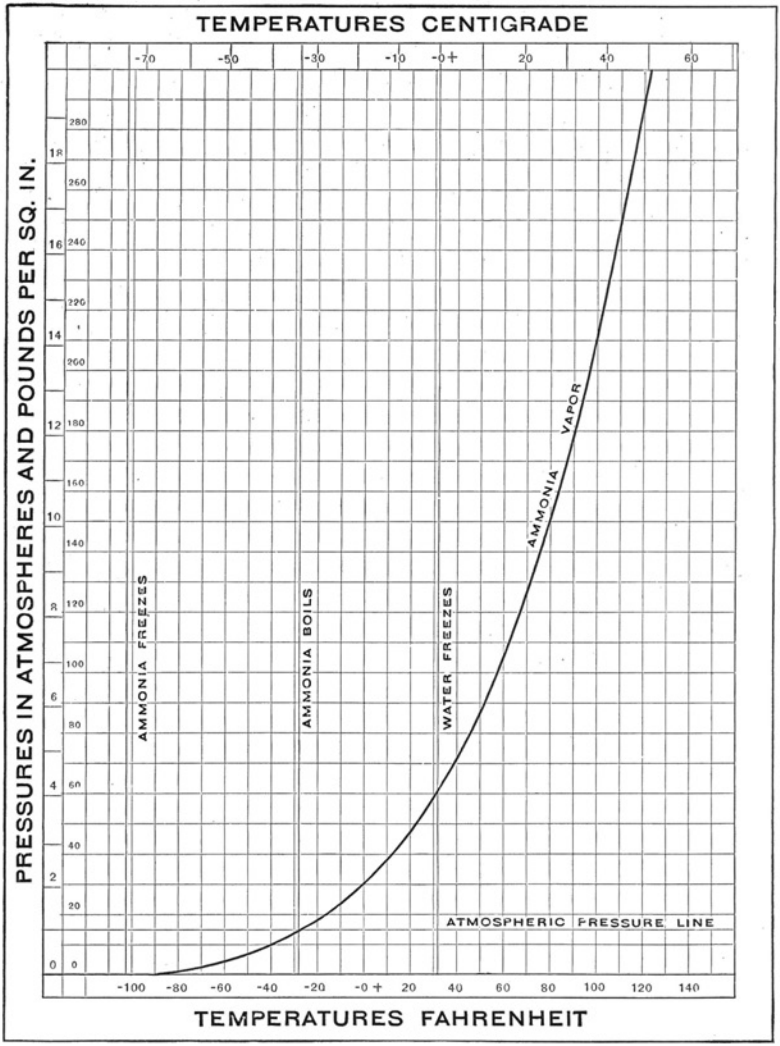
showing the application of a Worthington Cooling Tower to an ice manufacturing plant In starting the plant the suction tank under the tower is first filled with water from city mains or other source of supply. The circulating pump is then started, and taking suction from the suction tank forces water through the cold water distributing pipe system, from which it is delivered to the ammonia and steam condensers as required, and by the hot water return pipe system is gathered from the pans, runs by gravity to the distributor at the top of the tower, down the evaporating surface against the air blast, is cooled and collects in the suction tank ready for use again. A slight loss of water due to evaporation during the process of cooling in the tower, tends to lower the level of water in the suction tank, operating a float valve, and automatically furnishing water required to compensate for the evaporation losses.

The water required to compensate for the evaporation is automatically supplied to the suction well beneath the ammonia condenser through a ball and float valve.

The amount of water required is about one pound for each 1,000 heat units removed from the condensers and coolers, or about 10% of the amount ordinarily used.

Attention is called to the arrangement on page 8 by which the head from the suction well to the circulating pump is utilized, making the net head against which the circulating pump is operated the distance between the top of the tower and the water level in the suction well, at the same time allowing the convenient location of the condenser and air and circulating pump in the basement below the engine room, or on the engine room floor.

The air pump discharge may be utilized to compensate for tower evaporation, by returning it to the water circulating system by means of a small pump in case its use to feed the boilers may not be convenient or expedient.



DIAGRAM

SHOWING PROPERTIES OF AMMONIA VAPOR

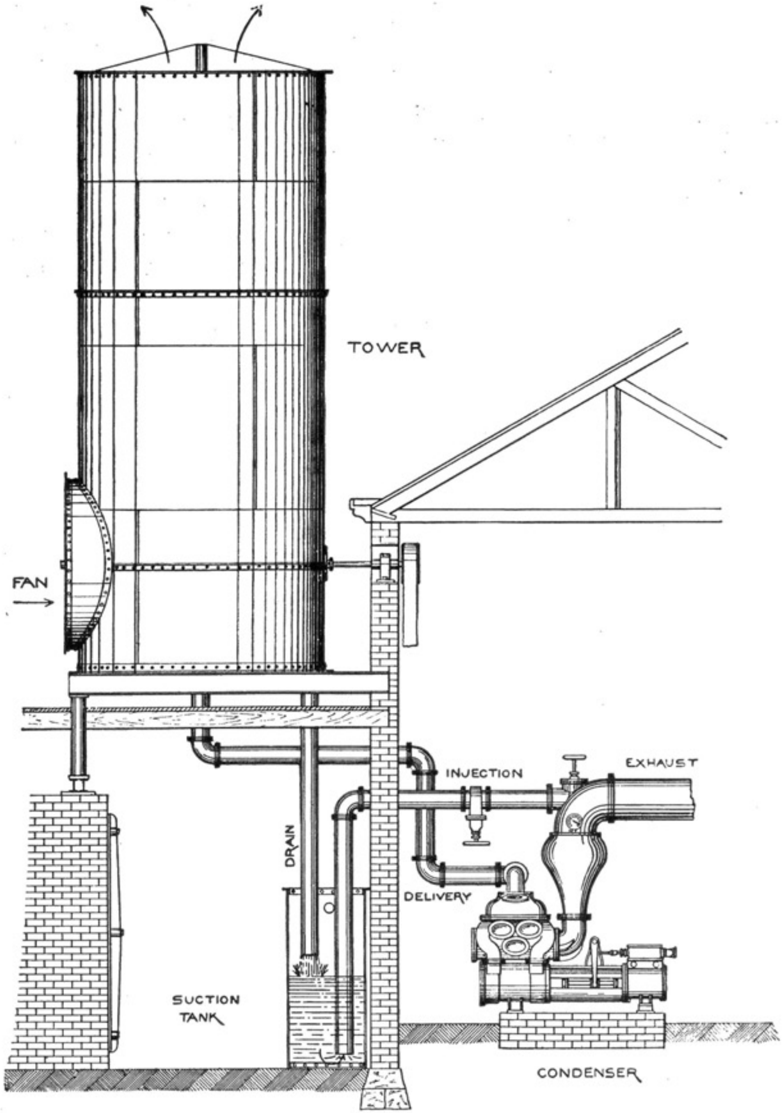
FUEL SAVING BY REDUCTION OF CONDENSING PRESSURE

WE have already referred to the reduction in ammonia condensing pressure which may be obtained by the use of the Worthington Cooling Tower by increasing the amount of water circulated and, consequently, decreasing the temperature at which the water leaves the ammonia condensers. By reference to the curve of ammonia pressures and temperatures given on page 20, it will be noted that a slight decrease in the temperature of the ammonia condenser is accompanied by a very rapid decrease in the pressure at which the ammonia condensation takes place. The following table will show approximately the decrease in power required to operate a compressor where there is a decrease in the condensing pressure.

TABLE SHOWING DECREASE IN COMPRESSOR HORSE-POWER BY REDUCING CONDENSING PRESSURE

Condenser Pressure	Temp. Water off Condenser	Relative Compressor Horse-Power
210 pounds (gauge)	105° F	1.
190 " "	98° F	.875
150 " "	90° F	.75
105 " "	70° F	.52
90 " "	65° F	.45

With a condensing pressure of 150 pounds (gauge), which may be obtained when the water comes from the ammonia condenser at 90°, the horse-power at the steam end of the compressor is but 75% of what it would be for a given refrigerating effect if the condenser pressure were 210 pounds per square inch, which is obtained with an increase to only 105° in the temperature of the water coming from the condenser. The fuel saving on account of this reduction in pressure is a very considerable item where the cost of refrigeration is carefully considered, and is made available by the use of the cooling tower.



WORTHINGTON SELF-COOLING CONDENSER

SHOWING TOWER ON ROOF OF BOILER HOUSE

THE WORTHINGTON SELF-COOLING CONDENSER

THE use of the Worthington Cooling Tower for cooling the water required for condensers running in connection with steam engines has come to be very extensive. We show on the opposite page a combination of the cooling tower and an independent jet condenser.

The production of a vacuum by the Worthington Self-Cooling Condenser may be used to benefit steam plants in the following various ways:

1st. By increasing the power with the same fuel consumption.

2d. By saving fuel with the same output of power.

3d. By saving the boiler feed water required, in proportion to the saving of fuel.

4th By furnishing pure boiler feed water entirely free from lime and other scaling impurities.

5th By completely removing the noise of the escaping exhaust steam.

6th. By permitting the boiler pressure to be lowered ten to twenty pounds without reducing the power or the economy.

7th. By reducing the number of boilers necessary to produce a given power, and consequently the wear and tear.

8th. By making it possible to obtain the highest economic results of modern practice with compound and triple expansion condensing engines in any locality whatever.

A special catalogue of the Worthington Self Cooling Condenser will be furnished on application.

FOR PROSPECTIVE PLANTS

WHILE the convenience of transportation, cost of fu[illegible]-tion of consumers and other important points, l[illegible]ely govern the location of industrial plants, the question of w[illegible]r supply is by no means the least important. Where la[illegible]ge quantities of heat are to be removed by the circulation of water, it is one of the most important items, and frequently forces a location in many respects expensive and inconvenient.

By the use of the Worthington Cooling Tower the amount of water required for cooling and condensing purposes is but about 10% of that required without its use. Consequently, the consideration of water supply becomes an unimportant factor in the location of new plants.

We would be pleased to submit estimates for the appliance of this apparatus to any given set of conditions, and guarantee the amount of water required to reach the desired re[illegible]s, and the amount of power required for the operation of th[illegible] the tower. Plans and specifications fully illustrating th[illegible]tus, the space and the pipe connections required, and its [illegible]tion to any set of conditions, will be furnished upon appl[illegible].

Condensation improves the economy of the [illegible]gine by reducing the amount of steam, and consequently the amount of fuel for a given output of power; or it will increase the power exerted by an engine with the same steam pressure and same point of cut-off; or a part of the gain may be used for increasing the power, and part to improve the economy. The gains by the use of a vacuum vary according to the type of engine or engines to which the condenser is attached.

DATA REQUIRED FOR ESTIMATES FOR ICE AND REFRIGERATING MACHINES

1st. Is the machine of the absorption or compression type? Give name of manufacturer.

2d. Give capacity of machine, either in tons of ice-melting effect per 24 hours or, if an ice manufacturing plant, give capacity in tons of ice manufactured per day of 24 hours. If both refrigerating and ice making, give relative output of each.

3d. Give diameter and length of stroke of the steam cylinder, and number and diameter of ammonia compressor cylinders and state whether they are single or double-acting.

4th. Give source of water supply.

5th. If plant is one already installed, give number of gallons of water used on ammonia condensers, on compressor jackets, and on steam condenser if one is used.

6th. Give temperature of water going on condensers, also of that coming off condensers, both during winter months and during summer months.

7th. What ammonia suction and delivery pressures are used?

8th. If it is desired to condense steam end of compressor, send indicator cards or give steam pressure, point of cut-off, and the number of revolutions per minute made by compressor.

9th. Are ammonia condensers of the submerged or open air type?

WORTHINGTON PUMPING MACHINERY

IN addition to the Worthington Cooling Tower described in the foregoing pages, Worthington Steam Pumps, Power Pumps and Electric Pumps for every variety of service, also Condensers, Meters and Hydraulic Machinery generally are manufactured by Henry R. Worthington, and illustrated and described in their various publications. Among these are Special Catalogues descriptive of Worthington Power Pumps, Mine Pumps, Marine Pumps, Electric Pumps, Jet and Surface Condensers, Self-Cooling Condensers, Water and Oil Meters, Steam Accumulators, Water Works Pumping Engines, etc., etc.

A General Catalogue or any Special Catalogue will be furnished on application.

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HENRY R. WORTHINGTON
HYDRAULIC WORKS

Established 1845