

T H E
ICE INDUSTRY OF THE UNITED STATES,

WITH A

BRIEF SKETCH OF ITS HISTORY

AND ESTIMATES OF PRODUCTION

IN THE DIFFERENT STATES,

BY

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LETTER OF TRANSMITTAL.

NEW YORK, *June 15, 1883.*

Hon. C. W. SEATON,

Superintendent of Census, Washington, D. C. :

SIR: I have the honor to submit herewith a brief report on the ice industry of the United States. The starting point in this report is the amount of ice consumed by twenty principal cities of the country. The statistics of that subject were gathered by the special agents in charge of the census work in those communities. The figures cover the year from October 1, 1879, to September 30, 1880, which was the ice year corresponding the most nearly to the fiscal year for which general census statistics were collected. The winter of 1879-'80 happened to be one in which there was a partial failure of the ice crop in a few States; and the figures representing consumption in the summer of 1880 are, therefore, below the average of good years. However, they are a valuable indication of the ice industry in this country. To the data collected by the special agents of cities is added considerable matter of a general nature, obtained, incidentally, during a tour extending over nearly the whole country. The growth of the ice trade has been rapid during the last ten years. There has been a lack of exact statistics of the business, and ice dealers have long wished that an accurate and comprehensive report might be compiled to clear away exaggerations and remove all doubts as to the real magnitude and extent of the trade. An effort has been made to render this report the basis of a future more elaborate investigation, which will meet this want thoroughly. An acknowledgment is due to Robert Scott, esq., of New York, and Mr. Ballentine, of The Knickerbocker Ice Company of that city, and to the officers of The Louisiana Ice Company and The New Orleans Ice Company, of New Orleans, for valuable aid received.

Very respectfully,

HENRY HALL,
Special Agent.

THE ICE INDUSTRY OF THE UNITED STATES.

THE RISE OF THE BUSINESS.

Ice is one of the natural resources of the United States. Formerly regarded as worthless, of no possible utility whatever, it has come with the progress of the country in population and industry to be esteemed of the highest value and to form an important article of commerce. Its formation in the winter season is eagerly awaited by tens of thousands of men who make at least a part, if not all, of their living in collecting, storing, and distributing it for consumption, and by their employers, who, as is now estimated, have \$18,000,000 of capital invested in the business, and whose profits are dependent upon the harvesting of a fair average crop of ice. The natural supply of ice in the United States is almost beyond calculation. In a good winter, not only are all the myriad lakes and ponds of the Northern States, except a few large and deep ones, frozen over to a depth of from 10 to 36 inches, but so are nearly all the running rivers. The water area thus covered with ice is so large that the supply aggregates several billions of tons. It would be difficult to compute the exact quantity which forms in any given winter, and no useful purpose would be subserved by any such calculation. It is enough that the supply is immensely beyond any possible requirements of the country. How small a body of water would supply the United States with all the ice it now consumes in one year would not be imagined, until after reflecting that a square mile of ice, 12 inches thick, weighs 700,000 tons. As not over 10,000,000 tons of ice are at present required by the country yearly, it will be seen that any little lake having 15 square miles of surface would yield an ample supply of this valuable commodity. It is not the quantity that forms in any given winter, however, which is of the greatest consequence. Interest attaches only to the quantity actually harvested and stored away in ice houses in the different parts of the country. The possession of such unlimited ice resources is of great importance to the United States. It is a remarkable fact that in some localities the communities already pay out as much money for ice in the course of the year as they do for fuel.

The people of tropical countries were the first to make use of ice, and it was natural that they should employ it to promote their personal comfort during the warmer months of the year. The article was, however, beyond the reach of the masses of the people. For many centuries ice was the luxury of the rich. It could only be obtained in small quantities, with much trouble, and at considerable expense. Only those who were in power, or those who were unusually prosperous in business, could afford to consume it. The first attempts at gathering and storing it were in Asia.

In India, the birthplace of so many of what have since become great and world-wide industries, ice was made by artificial means. Water was boiled to free it from the air it contained and was then exposed to the coolness of the night in porous earthen vessels, or in bottles wrapped with wet cloths. The evaporation of the moisture on the outside of the vessels produced intense cold within, and the water froze solid in the course of the night. Ice is still made in Bengal by this process. Shallow pits are dug, about 30 feet square and 2 feet deep, which are filled, to the depth of a foot or so, with sugar-cane, the stems of dried Indian corn, or straw. On this layer of rubbish are placed, at dusk, flat porous earthen pans, filled with water which has previously been well boiled. The dry northwest wind, which blows at night, converts the water into ice through the agency of evaporation; and the ice, being free from air bubbles, is as clear and hard as could be desired. At sunrise a large force of laborers go quickly to work, removing the thin sheets of ice thus formed to a deep pit, into which they are rammed down and left to congeal into a solid mass. The same practice, in principle, is in vogue in China. In the earlier ages of the Romans snow was annually collected on the dry plain of Hannibal's camp, on Mont Albanus, and rammed into cone-shaped pits, about 50 feet deep and 25 feet in diameter at the top. The pit was lined and covered over on top with straw and prunings from trees to preserve the store as long as possible in the summer

season. A thatched roof was placed over the pit and the doorway was well covered with straw when not being used. In summer the solidified snow was cut out with axes and picks and sent down to Rome for use. Snow is preserved in pits and caverns on *Ætna* and *Vesuvius* in substantially the manner just described, even at the present day.

In France, toward the close of the sixteenth century, during the reign of Henry IV, snow came into use for cooling liquors at the tables of the rich. Its sale became near the end of the following century a profitable trade, although never at any time a large one. The lack of rapid transportation on land restricted the trade. It is surprising, in view of the great abundance of shipping in the north of Europe at that time, and the great need of some means of keeping fresh the vast quantities of fish caught at sea by the Dutch, English, and Portuguese, that ice was not brought from Norway and Sweden by vessel to the southern countries. It seems to have been reserved to a later age, however, to ship ice by sea from northern latitudes, to reduce its cost to a point within the reach of all, and to make it an article of common and extended consumption. The experiment was not attempted until the nineteenth century; and indeed the whole matter of gathering and storing up ice in the winter time in northern regions, and the shipment of it by sea and land to points requiring it for consumption, as a regular business, have been the outgrowth of the last eighty years.

The development of the trade is one of the results of the progress of civilization. With increased density of population have come the growth of large cities, the discomfort of living in them in the summer season, a greater luxury of popular taste, and both the inventive ability and the wealth to gratify the new desires which have sprung out of this state of affairs. The demand for cooling drinks and frozen creams, even in the temperate zone, has become immense, and has been a powerful stimulus to the ice industry. Besides that, trades have sprung up, especially in the United States, which can be prosecuted only with the aid of ice, such as the transportation of fresh fish, meats, fruits, vegetables, and milk, and the manufacture and storage of beer, ale, wine, and butter; and these and other industries have led to even a greater consumption of ice than that which is called for by the gratification of luxurious tastes.

The ice trade of North America was created and begun by Frederic Tudor, of Boston, in 1805. The yellow fever was raging in the West Indies. The need of ice was so great that the idea of sending a ship-load thither, as a speculation occurred to Mr. Tudor. A quantity was cut from a pond in the part of Lynn now known as Saugus, belonging to Mr. Tudor's father, and was sent down by wagons to Gray's wharf, in Charlestown, where it was stowed in the brig "Favorite," purchased expressly for the purpose. The shipment of ice has continued to center around Gray's wharf down to the present day, extending, however, in both directions to other wharves. The first cargo amounted to 130 tons, and the "Favorite" sailed with it to Martinique in 1805. Its arrival was heartily welcomed by the natives; but the shipper lost \$4,500 on his venture. In 1807, a second shipment of 240 tons was made by Mr. Tudor, by the brig "Trident," this time to Havana. The enterprise was a novel one, and was regarded with much curiosity by American merchants, the majority of whom were in much doubt as to its probable success. Other occasional shipments were made, but all these early ventures were attended with loss and discouragement. Cargoes wasted greatly before they could be unloaded, and nearly 50 per cent. again before they could be distributed to consumers. The relations of the United States with European powers were complicated. Ships were interfered with and delayed. At one time an embargo was laid, and for two years the country was at war with England. After the close of hostilities, Mr. Tudor secured privileges that crowned his efforts with success. The British government released from certain heavy port charges all ships bringing ice to the islands under their control, and gave the enterprising merchant a monopoly of the trade. Jamaica was at that time the most valuable of the British West Indies; and at the port of Kingston Mr. Tudor established regular ice-houses for the storage of his cargoes, which gave him a solid and permanent footing in the business. In 1815, the Spanish government gave him certain privileges and a monopoly of the Havana trade. The business then became prosperous and profitable.

In 1817, Mr. Tudor sent a cargo of ice to Charleston, South Carolina. Like all the early shipments, it was a small one, not exceeding about 250 tons. Things have changed greatly since that time—single cargoes having been dispatched from northern ports to points southwards exceeding 1,200 tons. In 1818, Mr. Tudor extended his business to Savannah, Georgia. In 1820, he pushed on to New Orleans, and to accommodate his trade he built ice-houses there, to which the cargoes could be transferred immediately upon arrival. New Orleans soon became one of the most important points to him on the coast. The city grew to be the largest consumer of ice in the United States south of Philadelphia within thirty years of the shipment of the first cargo thither.

In the spring of 1833, Mr. Tudor tried the experiment of sending 200 tons of ice by sailing vessel to Calcutta, in India. The waste, during the long voyage of a hundred and eighty days, was about one-half the cargo, and although this loss was charged to the ice actually landed, it was found that ice could be delivered in Calcutta at one-half the cost of that made by the natives. As in the case of the earlier voyages to the West Indies, money was lost on the first venture to the East Indies; but the practicability of the trade was established, and Mr. Tudor persevered in it until it became a profitable source of revenue to him.

In 1834, the originator of this extended trade sent a first cargo to Rio de Janeiro, in Brazil. Until about 1836, the whole business of shipping ice by sea to distant ports was carried on almost exclusively by Mr. Tudor, and his

success earned for him the well-deserved title of the Ice King of the world. About 1837, his success attracted others to engage in the business. They were all at the port of Boston; and that city, being the birth-place of the trade, continued to be the base from which operations were almost exclusively carried on for more than fifty years from the beginning of its history. The port enjoyed the advantage of being able to obtain an abundant supply of the best quality of ice, from ponds in the immediate vicinity, and, by reason of the magnitude of its shipping interests, low freights to every part of the world; the business steadily increased, and was extended to China, Japan, and Australia.

In 1842, Gage, Hittinger & Co., of Boston, sent a cargo of ice in the bark "Sharon" to London, England, a city then dependent upon shallow ponds and a reservoir for an uncertain and limited supply of not very good ice. It is said that the fancy iced drinks, so common in the United States, were then almost unknown in England. In order to promote the consumption of the article he had to sell, Mr. Hittinger exported several competent bar-tenders from the United States to England, and introduced fancy drinks there. A Salem man afterwards chartered a ship to take 1,000 tons of ice to England at \$10 a ton. Many ventures were made in this direction, and for a number of years American ice controlled the London market; but this branch of trade did not always produce satisfactory results. Norway ice could be landed in England at smaller expense, and although American efforts to compete with it were continued, they have finally ceased within two or three years. In 1880, Norway even exported a few cargoes of ice to America, on account of a brief prevalence of very high prices here. Many large fortunes were made in Boston by the early adventures in the ice trade. Frederic Tudor bequeathed over \$1,000,000 to his heirs at his death, as the result of his energetic prosecution of the business he originated. He also left a large and established business to the Tudor company which succeeded him. The following table, prepared in 1857 by Mr. Tudor, will show the progress of the export trade of Boston down to about the outbreak of the late war:

Years.	Number of cargoes.	Quantity.
		<i>Tons.</i>
1800.....	1	130
1810.....	0	1,200
1820.....	15	4,000
1830.....	45	12,000
1840.....	175	65,000
1850.....	363	140,000

Mr. Tudor used to claim that the ice trade to Calcutta and the East Indies was one of the important forces that preserved the general commerce with that part of the world almost exclusively to Boston. He was of the opinion that it would have done the same in the commerce with China if the latter country had been in a more quiet condition. In a short report to the Boston board of trade in 1857, signed by Mr. Tudor and Timothy T. Sawyer, it was stated further:

The freights paid to India amount to from 10 to 15 per cent. of the earnings [they were from \$5 to \$10 per ton] for the whole run of the ship out and home; and it is earned without cost or deduction to the charterer or ship-owner. So with vessels bound into the Gulf of Mexico. They take 50,000 to 60,000 tons annually, from which portion of the business the owners derive on the average \$120,000 freight money, the shippers paying the expense of loading and discharging the cargoes. * * * This trade, founded on an article of no value, produces now a gross sale, at home and abroad, approaching \$1,000,000, and calls into use other articles before worthless. For shavings, sawdust, and rice chaff, probably \$25,000 are annually expended by the several companies now engaged in shipping ice. The planing mill which used to be troubled or burnt down by its shavings now has competitors to pay for them; and the saw-mill in Maine, to some extent, finds a customer for what is in its way. These small things, which formerly were a subject of cost to get rid of, now produce income. The average rate of freights for ice shipped at Boston is \$2.50 the ton clean and clear to the ship-owner; therefore he received from this trade last year \$365,000 (a large interest), and probably *more profit* than any other interest whatever in the business. Railroads and wagons were paid \$100,000; laborers, \$160,000; towns for taxes for ice privileges and ice in store, \$1,500; and wharves, \$20,000 to \$25,000. There are 93 wagons and about 150 horses employed in distributing ice in Boston and vicinity; 60,000 tons are thus retailed, supplying 1,800 families, hotels, stores, and factories. The benefit of ice to steamers and passenger ships may be considered, as it has caused the nuisance of live stock at sea to be discontinued; ice preserves the fresh provisions. There are several manufactures which derive aid from ice. We hear no more of winter-strained oil, it being now better strained in summer than in winter. Salt and ice make the freezing mixture in August. The fisherman is beginning to half load his boat with ice going to Massachusetts bay, and returns with the fish as fresh as when first caught. * * * The ice trade was born here in Boston, and has been growing and extending itself with no successful competitor for more than half a century, and there is reason to think it is yet in its infancy.

It may be stated here that the exportation of ice grew to such magnitude as to warrant the construction of three fine wooden barks by the Tudor company a few years ago for their own trade. These vessels were the "Ice King," the "Iceberg," and the "Ice-land," each of 1,200 tons register. They did good service for several seasons; but in 1880 the company was compelled to abandon its East India business on account of the manufacture of ice in the ports to which they had been trading for nearly half a century, and the vessels were sold.

As indicated in the foregoing report, the exportation of ice from Boston was accompanied by the growing up of a local trade as well. In order to preserve a part of the crop for summer use at home, Mr. Tudor stored it, as

indeed did all the early ice men in this country, in subterranean vaults or cellars, excavated usually from hillsides in the vicinity of the ponds. In this he followed in principle the ancient custom of the Romans. Sometimes all that was visible of the ice-cellar was the roof that covered the top of it. The door was through the roof, sometimes at the edge of the cellar. Later this form of storehouse was departed from so far as to leave three sides of the vault buried in the slope of the hill, the front of the house alone being visible.

Most of the modern improvements in facilities for cutting and storing ice are due to the inventive genius of Nathaniel Wyeth, the foreman of Mr. Tudor, and to John Barker, also in his employ; and it was owing to the first named of these progressive men that the old-fashioned vault was finally abandoned in favor of regular ice-houses, built first of brick and then of wood, and planted at the water's edge. Mr. Barker and Mr. Wyeth also invented a number of handy tools for use on the pond. The original outfit for ice-cutting consisted of little more than a number of axes, a few long cross-cut saws, each with one handle, and a few ice-hooks. Porous ice or snow was cleaned off either with axes or a rude hand-machine called a scrape. The taking out a supply of ice was a laborious process, usually consuming the whole winter. In place of the clumsy implements of the infancy of the business, horse-scrapers, ice-plows, chisels, breaking-off bars, hooks, etc., of various descriptions were invented, about 60 in all, which greatly simplified and lightened the work on the pond. These tools, modified year by year in the light of experience, and finally supplemented by introducing steam-power and an endless apron to elevate the cakes from the pond into the ice-houses, have completely revolutionized the whole business. By their aid 100,000 tons can now be cut and stored in the time formerly occupied in taking out 10,000 tons, not only increasing the certainty of harvesting a sufficient crop, but reducing the cost of the commodity to the consumer.

There is on record one earlier shipment of ice than that made by Mr. Tudor from Boston. It is said that in 1799 a gentleman in Charleston, South Carolina, chartered a vessel to go to New York for a cargo, and that the ice was cut on his order on a pond near Canal street and Broadway. No trade resulted from this pioneer enterprise, however. The early ice-cutting of New York was done for the benefit of a few marketmen who needed the means of preserving their meats for the wants of the population. A pond in the suburbs answered all purposes for many years. Afterward some ice was cut on Rockland Lake, the purity of whose water made its ice especially preferred. All the appliances of the early days were rude. The ice was taken out in cakes of irregular sizes, and was hauled away to the river on carts having wheels cut from logs of wood. It was sent to New York by sloop and tumbled ashore, there to remain until the cargo was landed, when it was hauled away to the storehouses. This primitive way of doing business answered until after the city began the career of expansion and activity following the opening of the Erie canal. More systematic methods were necessary, and various companies were formed with large capital, which operated at Rockland, Greenwood, Croton, and other lakes, and on the Hudson river above Poughkeepsie. Chief among the companies was the Knickerbocker, whose founder made a fortune like that of Mr. Tudor in Boston. This large and strong concern ruled the New York market for a period of twenty-five years. Its managers adopted all the newest inventions in the business and operated on a very large scale. They extended their trade to Brooklyn in time, and they are now the principal medium of supplying the two cities with ice. Of late years, a large number of new companies have come into the business.

In Philadelphia, the ice trade had an origin somewhat similar to that in Boston, except that the sick whose comfort was had in view were not residents of a foreign land, but were patients of the Pennsylvania Hospital. The managers of that institution laid in a yearly supply of ice along in the first part of the century, and often having more than enough for their own purposes, they advertised the surplus for sale. In 1811, Daniel George engaged in the business as a regular trade. Others followed him, and about 1820 something over 1,000 tons was being cut yearly for the local uses of the city. Two houses, each storing about 500 tons, are known to have been in existence in 1821, one owned by William Lee, the other by Henry Molier, both deep cellars covered over, and one at least of them built of brick. Some of the ice was delivered to consumers; but in the main the trade was carried on by offering it for sale from the ice-house. Small lots of ice were exported about this time, and fishermen began to buy it to keep their fish fresh until they could bring their catch to market. Twenty years later, the trade had grown to 7,000 or 8,000 tons yearly. In 1839-'40, an impulse was given to the business by Charles Carpenter, the founder of the Carpenter Ice Company, whose energy led to the harvesting of, annually, larger crops. In 1841-'42, the local supply failed, and Mr. Carpenter imported what he required from the northern coast. He passed by Boston and bought what he wanted in Halifax and other British American ports, bringing back huge cakes of thick, clear ice, weighing from 400 to 500 pounds apiece. The same year the Knickerbocker Ice Company, now one of the great concerns of the country, was founded by two old ice-men from New York, D. B. Kershaw and Horace Dennett, who brought to Philadelphia the labor-saving tools and the systematic delivery of ice in wagons. They erected in that year a 5,000-ton storehouse, and Mr. Carpenter built one of 1,000 tons. From that day to this the ice business of the city has been steadily expanding, until it has reached a total cut of about 1,000,000 tons yearly.

Following the lead of the eastern cities, all the communities of any size inland took up the gathering and distribution of ice as soon as their population was large enough to promise the consumption of 1,000 or 2,000 tons yearly. All the cities and many of the villages of the north adjacent to waters that freeze in the winter time now

have ice-houses of sufficient capacity to carry along all the ice that will be needed the following summer. The large cities have all grown into great markets for ice; and numerous small communities in the regions tributary to them, favorably situated for harvesting good crops, have developed a large industry in cutting and storing and selling the ice to the dealers of the larger cities.

The introduction of the use of ice into certain industries has been an important factor in building up this business. Take, for instance, the breweries. The brewers comprise the largest single class of consumers of ice in the United States. They have found that the use of ice for cooling the wort and regulating the temperature of the fermenting and storage rooms enables them to run their establishments the year around. It was the practice formerly to suspend operations in the summer time and make beer only in the cold weather. By running summer and winter both, the capacity of the brewery is nearly doubled. In fact it is in large part due to the use of ice that the manufacture of beer has developed so rapidly in the United States during the last twenty years. A large brewery will consume from 15,000 to 40,000 tons of ice a year, a small brewery from 1,000 to 10,000 tons.

Similar facts exist as to the meat-packing establishments, which have grown up so numerous in the west during recent years. They need ice to run to their full capacity, and by running the year around they give an immense amount of business to the ice companies. The growth of the business of transporting fresh meats, fish, fruits, vegetables, and milk has also added to the consumption of ice. In fact, ice having nearly doubled the product of these outside industries and trades, they have, in turn, fully doubled the product of the ice industry. The exact consumption of ice in the whole country cannot be reported, but it is the decided impression of leading ice men that if the exact facts could be known it would be found that the brewers, packers, and carriers of fresh provisions now consume more ice than do families, hotels, saloons, and ice-cream establishments.

A large ice business has grown up in the south since Mr. Tudor sent his first experimental cargoes to Charleston and Savannah. The supplies all came from the north at first, but during the last fifteen years a large business has grown up in the manufacture of artificial ice. Natural ice continues to be sent to the seaports of the south by northern operators, but inland at the south the trade is local and now almost wholly in artificial ice.

The following are the statistics of the trade in twenty principal cities in 1879-'80:

Name of city.	Tons harvested.	Tons sold and consumed.	Value of amount sold for consumption.
Boston, Massachusetts	600,000	381,000	\$1,025,000
Providence, Rhode Island	41,000	33,000	320,000
New York, New York	1,885,000	959,500	6,100,000
Brooklyn, New York	528,000	334,500	1,000,000
Albany, New York	121,500	90,500	400,000
Troy, New York	52,000	43,500	235,000
Buffalo, New York	100,000	96,000	325,000
Jersey City, New Jersey	51,000	33,550	270,000
Newark, New Jersey	80,400	52,000	300,000
Cleveland, Ohio	140,500	120,800	320,000
Cincinnati, Ohio	283,000	200,900	1,200,000
Chicago, Illinois	710,000	570,700	2,400,000
Detroit, Michigan	105,850	138,450	605,000
Indianapolis, Indiana	70,500	61,250	625,000
Louisville, Kentucky	43,000	35,100	330,000
Saint Louis, Missouri	270,000	205,610	1,400,000
Philadelphia, Pennsylvania	700,000	377,000	1,050,000
Baltimore, Maryland	165,000	124,100	1,200,000
Washington, District of Columbia	75,000	53,400	600,000
New Orleans, Louisiana	55,000	31,530	315,000

The total yearly harvest and consumption of ice in the United States are not clearly known. They can, however, be conjectured. Twenty leading cities with a total population of 5,930,000 inhabitants consumed 3,961,000 tons of ice in the census year. Besides those 20 cities, there are exactly 200 communities in the ice belt of the country having more than about 9,000 population each, and thus large enough to warrant a local business in the cutting and sale of ice. These 200 communities have a total population of 4,510,000. The consumption in the large cities averages almost exactly $\frac{2}{3}$ of a ton of ice per head of population. In the smaller communities, the consumption would be less, owing to the greater simplicity of life and lack of industries dependent upon ice, and would average not more than about $\frac{1}{4}$ of a ton per capita, according to the best data I can obtain. This would indicate a consumption of from 1,000,000 to 1,250,000 tons per year in the 200 smaller communities referred to. In communities of less than 9,000 population there is some gathering of ice by individuals, but the aggregate in the United States would be small. Appearances indicate a total consumption of ice in the United States, in the census year, amounting to 5,000,000 to 5,250,000 tons. The harvest would be (allowing for waste) about from

7,800,000 to 8,200,000 tons. These figures are presented not as a result definitely ascertained by complete statistics, but as an estimate based upon the best information at hand, and in response to the demand for such an estimate from the persons engaged in the ice business of the country.

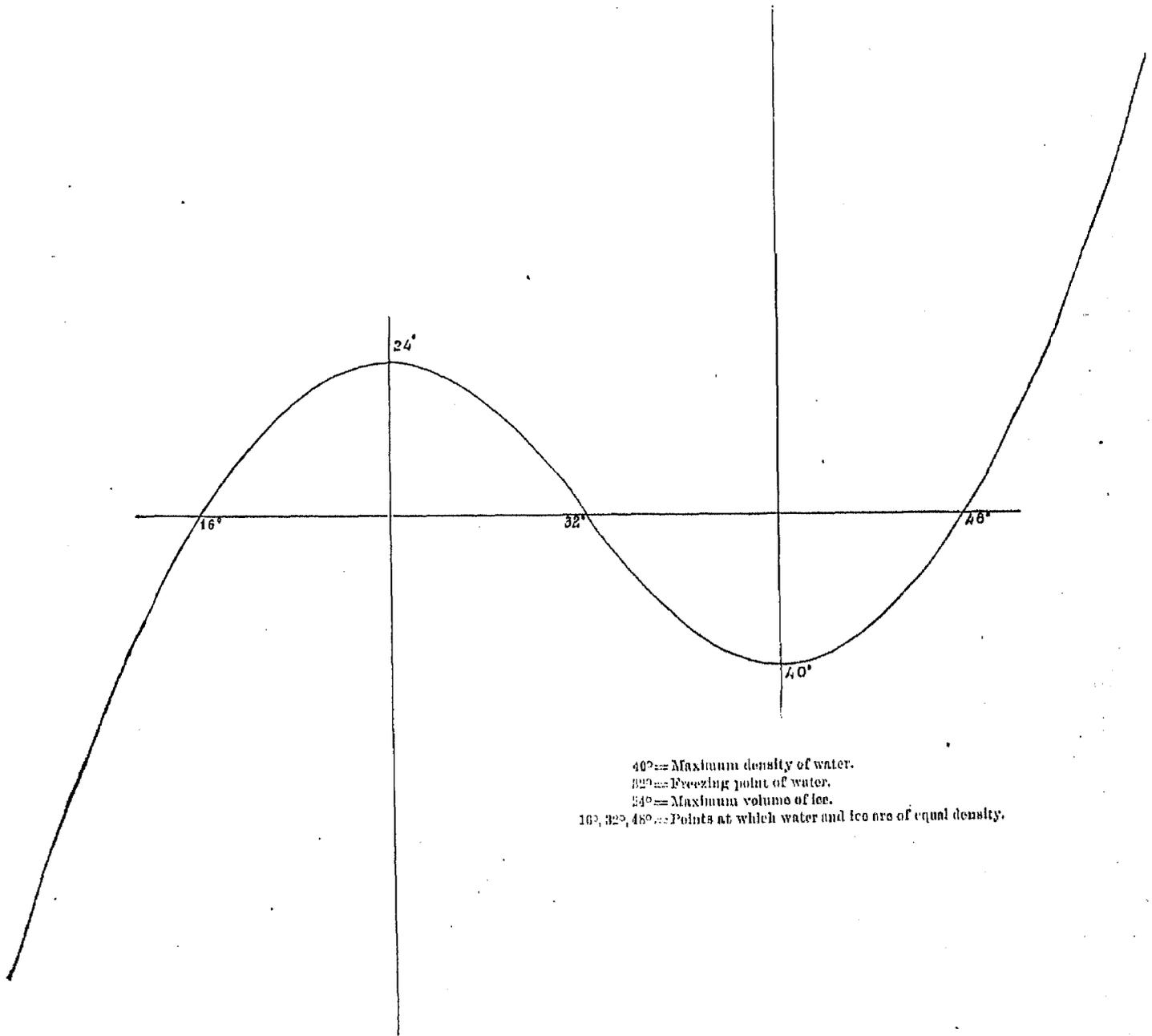
The months in which ice is usually cut are January, February, and March. Consumption takes place chiefly from May to October, both inclusive. The demand begins early or late, and is more evenly distributed through the year, according to the latitude of the city and the character of its industries. In the north 80 per cent. of the consumption is between May 15 and October 15 of each year. The following table shows the percentage of consumption by months of the several cities named, as exhibited in the returns for 1880:

Month.	Boston.	New York, Knicker- bocker Ice Com- pany.	Philadel- phia, vs. rious com- panies.	Baltimore.	Cleveland.	Cincinnati.	Chicago.	Detroit.	Saint Louis.
January	1.9	3.5	2	2.7	1.7	3	5.5	0.2	4.4
February	1.9	4.7	2.2	3.1	1.6	3.8	3.2	0.4	10.2
March	3.1	0	2.8	7.2	3	5.5	3.1	0.6	12.7
April	3.9	0	5.1	7.6	5.8	7.8	5.5	1.3	11.8
May	11	0.4	11.4	9.2	11.8	10.3	9	3.2	8.0
June	11.7	12	13.4	12.4	13.7	12.5	11.8	14.5	11.0
July	19	18	19	17	18.5	14	10.1	32.1	14
August	17.6	13	17	14	18.5	16	15.3	30.8	13
September	13.0	10.5	13.2	10.1	16.8	14.1	12.4	11.6	9
October	9.2	8	7.3	10.4	4	5.5	8.9	2.6	2.4
November	4.4	3.5	3.8	3.0	2.9	4.4	4.2	1.9	1.3
December	2.4	3	2.8	2	1.7	3.1	5	0.8	1
	100	100	100	100	100	100	100	100	100

HARVESTING AND MANUFACTURING.

The general law of the formation of ice is that freezing takes place when the temperature of water is reduced to 32° Fahrenheit. Salt water does not freeze until it is cooled to 28°. Water does not need to be still to freeze. On the contrary, when absolutely motionless, water can be reduced to a temperature of 15° before the formation of a particle of ice, a slight agitation then, however, causing crystals to appear at once. In a lake, pond or river the whole body of water cools down to 40°, its point of maximum density, before freezing over. It has been discovered by the United States Signal Service officers that the water usually stands at that temperature for several days before the formation of ice. When the lake or river has cooled to 40°, and the atmospheric air stands at 32° or less, ice forms on the top of the water during any few hours when the surface is not ruffled by a breeze. Crystals shoot out in every direction. The interstices are filled with other crystals, until a thin film of solid ice is formed, and then by the same process the film grows thicker and thicker with each succeeding day during which the temperature of the body of air above remains below 32° Fahrenheit. The colder the weather and the steadier the freezing, the denser and clearer the ice, especially if upon the surface of a river. So that in the more northern latitudes and on the rivers, as in the states of Maine, Vermont, northern New York, Michigan, and Wisconsin, the ice is usually harder, clearer, and slower to melt than that which is formed on the southern edge of the frozen region. The hardest ice in the world, and the slowest to melt, is that formed on the tops of high mountain peaks, where it is exposed to severe and protracted cold.

It was long supposed that ice was an exception to the general rule governing the expansion and contraction of bodies near the melting point. In the light of later science it has been disclosed that the phenomena which occur in ice are characteristic of all solid substances, although in ice there is an exaggerated exhibition of it. Considering frozen water as a solid substance, its performances are strictly the same as those of other solids. When the temperature of any fusible substance is raised it expands in volume until it reaches a certain maximum point. As the temperature increases the volume contracts until a point of maximum density is reached, after which, with increased heat, the volume will expand again until the substance changes into vapor, at which point there is a further large expansion. Ice at 100° below zero is intensely hard and compact. At 16° ice is of the same volume and density as at 32°. From 16° it expands with heat until 24° is reached, when it contracts again. At 32° it melts, but still contracts in volume, until the temperature rises to 40°, when it begins to expand, and then goes on expanding almost indefinitely. True ice of 16° temperature, perfectly pure and free from all trace of air, will sink in water of more than 48°. The changes in volume near the melting point can be represented by a diagram, the curves being true parabolas, as follows:



CURVE OF CONTRACTION AND EXPANSION OF WATER NEAR THE FREEZING POINT.

The fact that ice continually changes in volume with the temperature of the weather is illustrated to those who live in the neighborhood of ponds and lakes by the continual booming of the ice during changes of weather. On a clear cold night the whole body of the ice contracts, and cracks are rent in it with such force that there is a report like the discharge of a cannon. Again, in the spring time, when the temperature is rising, the whole field of ice expands, and either shoves up on the shore with a force that cuts down trees or it lifts and breaks here and there again with a booming sound like a distant battle of artillery. Young people who are skating at night when the ice is booming are often mystified and alarmed at the phenomenon.

The waters preferred for ice-cutting are small deep lakes away from towns, where the water is pure, and rivers which are not contaminated by the drainage of towns and cities. Pond ice is apt to be full of white streaks, composed of minute bubbles of air, and the presence of air is disadvantageous, as it renders the cakes porous and liable to waste rapidly both in the ice-house and in the wagons, cars, and ships in which it is distributed. A current through a pond makes the ice better and the pond a more desirable place to cut. As a rule, the clearer and more transparent the cakes the denser and more lasting is the ice. There is no better product in the country than that which is taken from the rivers of Maine. The streams come down from forest lands and the ice usually forms on them at a temperature nearer to zero than to 32°. Opaque ice usually indicates the presence of air, but this is not always the case. When snow falls on good clear ice only a few inches thick, and there is doubt about the continuance of cold weather, the field is often sunk or overflowed by boring holes 3 or 4 feet apart, so as to admit the water to the surface of the whole field. By coming directly in contact with the cold air the mingled ice and snow quickly freeze, producing often a total thickness of cake sufficient for immediate cutting. Ice thus made is often opaque, but is not considered as necessarily inferior on that account. It shows good lasting qualities. On account of the appearance of the ice of this character, however, it is never harvested, except in emergencies. A deep lake is preferred to a shallow one, and a deep gentle river to a lake, because of there being less air in each case successively in the ice formed. There is always air in water, but in a deep lake the water cools to the freezing point more slowly than in a pond, giving the water more time to part with its air; and in a river the current carries along the minute air bubbles and to a great extent prevents them from being entangled and locked up in the crystals of the growing ice. These points were formerly not much regarded, but in the light of the experience of the last fifty years the companies now keep them in view in locating the scenes of their annual operations.

As a rule, ice-cutting in the United States takes place in the months of January and February, and in the early part of March. When ice is thick enough for operations to begin it is scraped, if covered with snow, and, if rough and wavy on the surface, is sometimes planed. When snow continues to fall the ice is often scraped from 6 to 8 times. This work is performed with machines drawn by teams of horses. There is no fixed rule as to the thickness ice must attain before being cut. It depends entirely on circumstances. On the lower boundary of the frozen belt, as for instance on the Hudson river, in Pennsylvania, Maryland, and throughout the Ohio river valley, the uncertainty of settled weather, especially if the season be late, makes it advisable to cut as soon as ice 6 inches thick is obtainable. Further north the companies usually wait for a thickness of ten or twelve inches. In Maine 15 inches is thick enough, although during the winter much ice is harvested from 20 to 30 inches in thickness. Ice sometimes forms 3 feet thick, but the cakes are then too heavy to handle economically. When the snow has been cleared away the field is "prospected" for the best point to begin cutting. Holes are bored and a measuring rod is inserted to test the thickness. The rod is marked off in inches, like a pocket rule, and the lower end is turned off at a right angle to hook on to the bottom of the ice. It pays best to cut the thickest ice, even if a smaller quantity of it be gathered; and, all other things being equal, the preference is given to that part of the field above the ice-house, if on a river, in order to gain the help of the stream in floating the detached ice down to the house. The further away from the house the cutting takes place the more the time, labor, and money required to harvest the crop, especially as the channels for floating the cakes to the house are always apt to freeze up over night, and the longer they are the more the trouble of keeping them open.

When the scene of operations has been chosen, the field is immediately lined off into squares. Two straight lines are run, as in land surveying, at right angles to each other, a surveyor's theodolite being the best instrument for the purpose. The lines are marked on the ice with the straight edge of a plank. The real work then begins. The first of the ice-tools proper comes into requisition. This is the marker, an implement like a low plow, with eleven cutting teeth, one behind the other, each tooth a little longer than the one in front of it. Drawn by a horse, the marker is steered by the plow handles along the course of the straight line scratched on the ice, which it sinks at one cutting to the depth of 3 inches. The marker is then turned around, a sliding guide is placed in the line just made, and the marker is drawn back across the field again, cutting a fresh seam, 3 inches deep, at a distance of 22 inches from the first one. The guide regulates the size of the blocks, the regular width being 22 inches. When the field has been lined off in one direction a fresh set of lines is run in at right angles, dividing the whole field into squares usually of 22 inches. If the ice is thin the field is often lined off in blocks 22 by 30 inches. A favorite size for the New York market is 32 by 22 inches. In Maine and in Massachusetts the blocks are often 22 by 44 inches, and sometimes 44 by 44 for convenience in shipping to distant ports.

The next implement used is the ice-plow, the most important one connected with harvesting the crop. It is made on the same principle as the marker, except that no guide is necessary. It is constructed of six different sizes, governed by the thickness of the ice and the depth to which it can be safely and usefully cut. The sizes are respectively 6, 7, 8, 9, 10, and 12 inches, and the number of teeth varies from 5 to 8. The object of the plow is to cut the ice-field to about two-thirds the depth of the ice into cakes and blocks which can be readily detached with hand-tools and floated off to the ice-houses. The work is done by horse-power, the teams being attached to the plow with about 10 feet of tug-rope. The plow is run through the grooves cut by the marker, each passage of the plow sinking the groove 2 inches. It is run back and forth until the requisite depth is reached. A channel is then opened through the field to the ice-houses, and the process of storing begins.

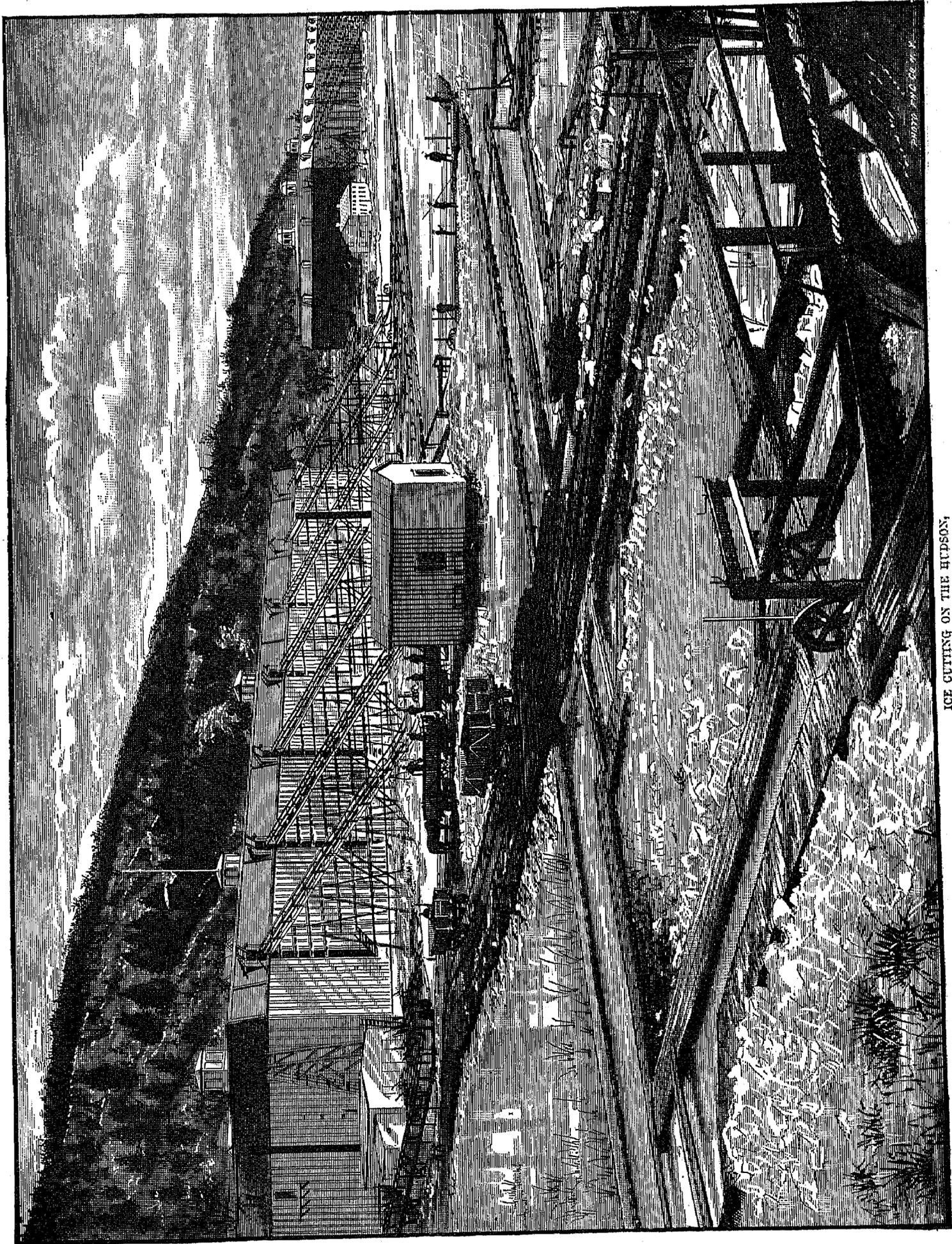
The ice next to the channel is, however, first planed by horse-power with a machine consisting of two parallel smooth blades, which run in adjoining grooves in the ice, and carry between them a knife, set, as in a carpenter's plane, to cut to any required thickness up to about 3 inches. A seat is rigged up for the man who drives the horses so that his weight may keep the plane steady in the grooves. This implement is made in the best possible manner, in all its parts, and care is especially taken to fit into it a knife of the best cast steel.

The favorite plan is to begin detaching the ice from the field at the farthest end of the channel. A steel saw, from 4 to 5 feet long, is used (sometimes a breaking-off bar or chisel), and a sheet consisting of about a dozen squares of ice is separated from the field and started down the channel. After a space has been cleared the ice is sawn off into large rafts, 12 by 30 cakes in size, which are separated into sheets on reaching the channel. The most approved plan of getting the rafts to the channel, and the sheets to the house, is by towing them with a team of horses, or even with a single horse; but sometimes an ice-cutter will walk out on the floating raft and pole it along to its destination with a fool called a hook, consisting of a long, light wooden handle, fitting at its extreme end with a spike on one side for pushing and a hook on the other for pulling. Sometimes the channel is lined with men armed with hooks, who pole the detached pieces along without leaving the main field. When horses are the motive power a tow-line is used having a grapple which catches the after end of the sheet. When the floats arrive at the ice-house they are separated by light breaking-off bars, either into single cakes or into squares of four cakes each, for hoisting into the house and stowing away. It is a common practice with firms owning large houses to make plank walks or landings out along the sides of the channel near the shore, and at the foot of the inclined planes, for the ice-men to stand upon while wielding the tools by whose aid the ice is separated into cakes and pushed along to the planes.

The house into which the cakes are now hoisted is quite a different affair from the covered pit or cellar, or the hill-side cave of from sixty to eighty years ago. It is sometimes of brick, but usually of wood—a large, barn-like structure, planted at the edge of the pond, lake, or river, in a location which is dry and well exposed to the sunlight and air, and where also it is readily accessible by barge or schooner, if its contents are destined for shipment to distant markets. Damp localities are avoided. One of the worst enemies of ice is moisture. The outside of the house is painted, or whitewashed, a glaring white, to reflect as much as possible the rays of the sun in summer; and the walls and space under the rafters are so arranged as to be almost impervious to the heat of the outer air. These long white buildings are conspicuous objects in the landscapes of the Hudson and Kennebec rivers. The size of the house is governed in part by the producing capacity of the body of water at whose edge it stands, and in part by the magnitude of its owners' business. It is usual to divide the houses into "rooms" from 30 to 35 feet square, each holding about 700 tons of ice, the rooms being 30 feet high, and a ton occupying 42½ to 45 cubic feet of space. Rooms are often large enough, however, especially in Maine, where three or four are thrown into one, to hold from 2,500 to 3,000 tons of ice. In a few cases a room has been made to hold from 4,000 to 5,000 tons. A medium-sized house is one which will store 10,000 tons. A large one will accommodate 60,000 tons. As ice will waste from 10 to 25 per cent. in an ordinary house, especially after it is opened, and as there is a total waste in all of 40 to 55 per cent. before reaching the consumers, it is usual to build with a capacity a third larger than the quantity which is expected to be sold in the course of the year. The cheapest lumber that can be bought is usually employed in construction. Spruce, hemlock, and white pine are the favorite woods, with pitch pine for sills, and hard wood in the main rafters. The roof is shingled with cedar, or some other good quality of shingle. About 175,000 feet of lumber are required for a 10,000-ton house. The frame of the house is erected after the usual fashion of frame buildings, and is generally of spruce, where it can be had. It is boarded up inside with hemlock, and outside with white pine, the spaces between forming an air-chamber clear around the house, which, when ventilated as it ought to be, keeps the house dry. In the majority of houses the frame is not sided up outside at all; but experience has led, especially in the warmer localities, to the boarding up of both sides of the frame, and the practice is a growing one. The roof is built in such manner as to have plenty of loft room. On the side of the house toward the water there is a doorway in each room, extending clear from the eaves to the foundation. As the house is filled with ice this doorway is closed up, five or six feet at a time, until it is sealed clear to the eaves. Preparation is made for stowing away the ice by packing the walls of the house. Light studs, about 3 by 8 inches in thickness, are placed against the matched hemlock or pine boarding, which covers the frame of the building, and these studs are in turn boarded up to the eaves with matched stuff. In the best houses felt or manila paper is tacked over the studs, before the boards are put on, as an additional safeguard. The space between the studs is then filled with dry

sawdust, charcoal, shavings, or any other non-conducting clean refuse that is easily obtainable. The floors are of earth, covered with charcoal or sawdust, and then boarded over. Proper drains are made across the floor of the building to carry off the drip from the store of ice. A narrow inclined plane is next built from each room into the lake or river for hoisting the ice into the house. The proper angle of pitch is from 40° to 45° . The inclined planes are simply, but stoutly, made, with strong side timbers, secured to each other by cross-pieces, which are floored over with battens, the spaces between the battens allowing the water to drip from the cakes of ice to the ground below as they come up the plane. The battens are sometimes faced with strap iron. The elevating is done by an endless chain driven by steam-power. This chain carries a series of wooden hold-bars, or buckets, whose mission is to catch the cakes of ice, one by one, as they are poled up to the inclined plane in the channel below, and draw them steadily and swiftly up the plane until they reach the proper point for delivery into the house. Every five or six feet in height from the ground there is a delivery run, or shoot, built like the inclined plane, open, leading from the plane into the house, and these are made use of, in turn, one after the other, as the rooms fill up, until the last one is reached at the top. The runs are usually iron on the face of the battens.

Two systems of elevator-chain are in use, the overshot and the undershot. In the overshot, the chain carrying the hold-bars moves up the inclined plane, then over a wheel, and down perpendicularly to the ground, and thence horizontally to the water. In the undershot, the chain returns to the water down the top of the railing of the inclined plane. Both systems have their advocates. Driven by an engine of about 20 horse-power, these elevators have a capacity of raising about 175 tons of 12-inch ice an hour, which is as fast as one man can feed from the channel and 20 men stow away in the house. The chain moves at the rate of 100 to 110 feet per minute. When speeded, and when the ice is thicker than 12 inches, from 400 to 500 tons can be raised in an hour; but, in that case, a large force of men would be required to feed and stow away. The ice is packed away in the house in regular layers, the cakes being kept slightly apart, both to allow the water in melting to run away, and also to prevent the cakes from freezing into a solid mass. Near the top of the house, they can be placed in direct contact. When the house is full, the loft under the roof is filled with hay to protect the store from the heat of the sun in summer. It is surprising how long ice will keep in a house properly built, packed, drained, and ventilated, into which the ice has been put hard and dry, and which is closed for the season in freezing weather. There is always some waste, amounting at times to from 10 to 25 per cent.; but in a first-class house, in which attention has been paid to every detail, ice will keep for two or three years, with no more waste than that during the whole period. It may be mentioned incidentally that the cost of wooden ice-houses, with machinery, is from 75 cents to \$1 per ton of capacity, according to the local abundance of timber and rate of wages. The cost of brick houses, with machinery, is about \$2 per ton of capacity.



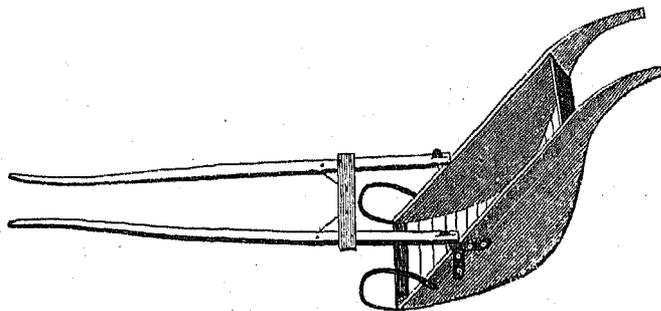
ICE CUTTING ON THE HUDSON.

Returning now to the ice pond: The ice was left floating in the channel, broken into cakes of the right size for storing. The steam-engine propelling the elevator apparatus is started, the engine being generally placed in a shed at the foot of the ice-house. One or two men pole along the cakes to the inclined plane, where they are caught in succession by the hold-bars and carried up to a trap which admits them to the first shoot or delivery runs leading into the house. This shoot is set at a slight pitch toward the house, and the heavy cakes slide down with great rapidity, one after another, covering the floor of the room in every direction. A force of men inside quickly catch them with pole-hooks and arrange them in regular array until they cover the floor. Another tier is then made, and another, until the height of the shoot is reached. Operations are stopped long enough to close the trap at the entrance of the shoot. The trap leading to the next shoot above is opened; and the process is repeated until the house is full. As already indicated above, a smart man or two feeding the cakes upon the elevator will keep from 15 to 20 men busy inside one room, stowing them away; and to keep them all busy will require about 100 men with 10 or 12 teams of horses, at work out on the pond scraping, plowing, and breaking up the field.

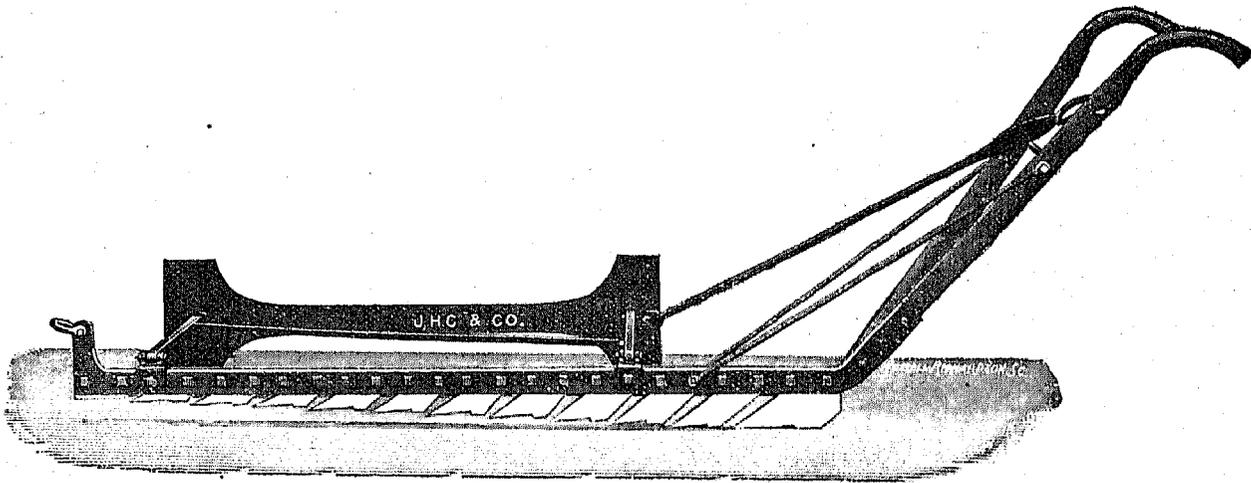
One of the important details of work out on the pond is to take care that water does not flow into the grooves cut with the plow when a raft is detached. In freezing weather all the work of the plow would be undone, if that were permitted. To prevent it, calking irons (long bars fashioned at one end into a chisel) are used to stop up the ends of the grooves with ice chips. Another matter requiring attention is keeping the channels to the house open over night. Each ice man has his own plan for accomplishing this result. Some clear the channels of all the refuse ice at night and leave them full of new sheets to be towed to the house in the morning; they can be easily broken out and sent along. Sometimes the men turn the sheets over before leaving them, so as to prevent the grooves in them from filling with water and freezing. Some foremen leave no ice in the channels at all at night, but run the risk of their freezing over, and then set their whole force at work in the morning for an hour or two clearing out the channels for the resumption of operations. Sometimes the channel is kept open by towing a block of ice back and forth all night. Another feature of work on the pond now is the rapidity with which business is pushed after cutting has begun. The reasons for haste are the liability of the open water to freeze over, the danger of changes of the weather, especially of rains, and the general economy of quick work. It is not unusual in the states, where the ice is thin and liable to be spoiled by a change of weather, to rush matters so fast as to fill the houses in from six to twelve days. In the regions where severe and settled weather can be depended upon the crop is usually harvested in from fifteen to thirty days. In all cases, however, it is the practice to push the work with energy. The employment of a large force of men is accordingly called for. To fill a 25,000 ton ice-house, about 100 men with 10 or 12 teams are ordinarily engaged, and sometimes about double the number. After the house is filled the ice is covered with sawdust and the house is closed up as before stated.

The tools now used by the ice-men show a remarkable appliance of inventive genius. The pioneer ice-cutters had nothing except the ax and a large cross-cut hand-saw. With such simple implements they were a long time in harvesting even a small quantity of ice; and when they had brought it ashore they were without convenient facilities for transferring it to the storage-house. For fifteen or twenty years a great many new implements were experimented with. Some were failures. Many had merit. Plows were finally thought of. They were at first made with wooden beams, the teeth being iron, tipped with steel, and widened or upset at the points. One alteration after another was made in the plow. Chip spaces were cut in the narrow teeth, so as to let the plow run to its full depth in the groove, leaving only the heel and toe of each tooth to be filed. Improvements were made in the curves of the teeth, and plows were then made of solid iron and steel. The patent clearing-tooth was invented as late as 1872. Among the devices brought out was a patent gig or light wooden frame, swung on a rope and pulley for elevating ice into the house or transferring it from car to ship. Previously the only means was the common pulley and rope and a pair of tongs, worked by horse-power. Both devices have since been nearly superseded by the endless-chain elevator, worked by either steam- or horse-power. The endless chain has also been applied within a few years to the handling of ice on wharves, especially in Philadelphia, where the blocks of ice taken out of vessels are carried along the wharf by the chain and buckets and up an inclined plane into the store-house. Leaving aside the machinery for elevating ice, the ice-tools of the present day are 60 in number. The majority of them are used at the ice-pond, the rest by the retail dealers in distributing ice to consumers. The principal tools are the following:

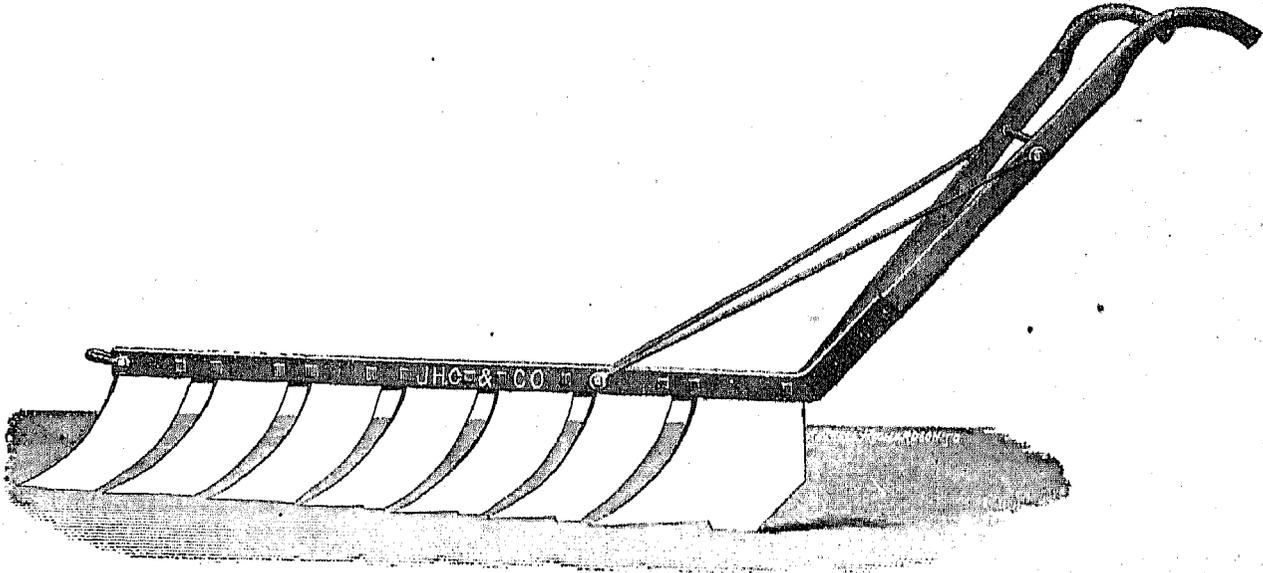
1. Scrapers for clearing away the snow; 2 styles.



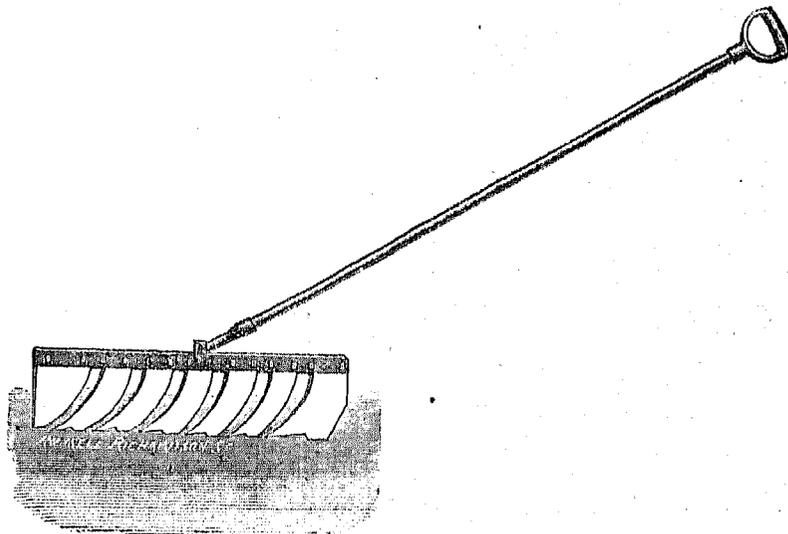
2. Cast-steel ice-marker with swinging guide.



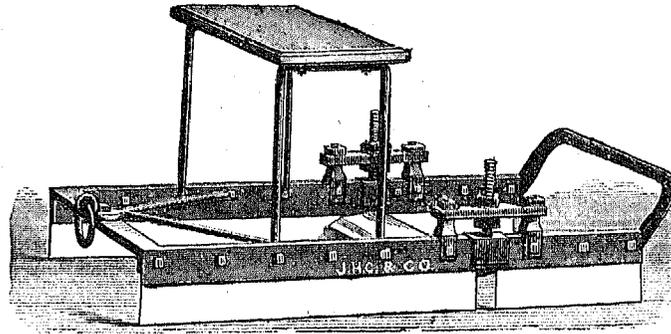
3. Ice-plow, cast-steel, made of various sizes, with 5, 6, 7, and 8 cutting-teeth, to cut anywhere from 6 to 12 inches deep.



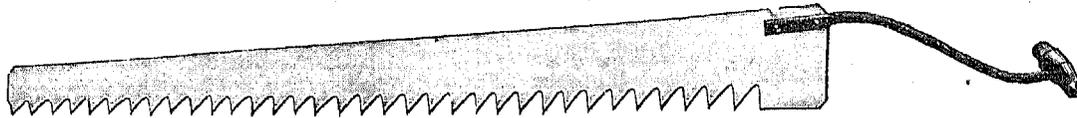
4. Hand ice-plow, 6 inch.



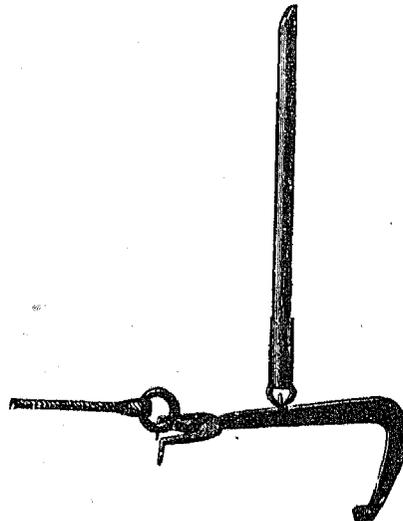
5. Ice-plane.



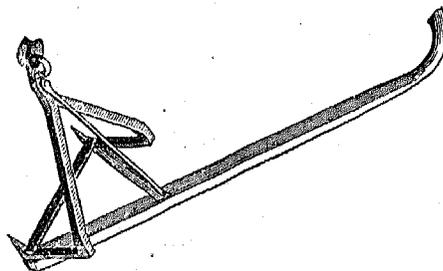
6. Ice-saw, for opening channels and separating the rafts and sheets from the field; also used by small firms who cut without the aid of a plow.



7. Grapple, for towing rafts and sheets by horse power along the channels, and also used for hauling blocks up the inclined plane by horse-power when no endless chain is used.



8. Jack-grapple, used for the same purposes as the last.



9. Breaking-off bar, the ice-cutter's handy tool; the broad blade is for detaching large sheets, the small blade for splitting off the smaller blocks.



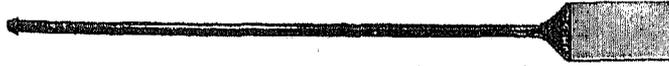
10. Calking-bar, for filling the grooves in the ice with snow or chips to prevent the flooding and freezing up of the grooves.



11. Bar or packing-chisel, for loosening and trimming cakes.



12. House-bar, for separating the smaller cakes from each other.



13. Fork-bar; a tool coming into use in place of the breaking-off bar.



14. Splitting-chisel; a light serviceable tool for separating the sheets into cakes.



15. Canal-chisel; the same as the last, except longer; for use when the operator stands on a raised platform.

16. Ring-handle chisel; useful in cutting holes in the ice to flood the field, the ring preventing the tool from slipping from the operator's hand and being lost.



17. Floor-chisel, much used in storing ice, for trimming the blocks.



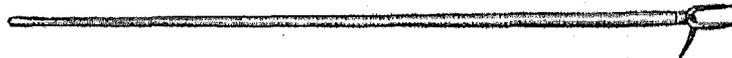
18. Starting-chisel, or curved tool, for loosening up the blocks in the house one from the other.



19. Ice-hook, a light, handy, and indispensable tool for pulling and shoving cakes of ice, having handles from 4 to 10 feet long.



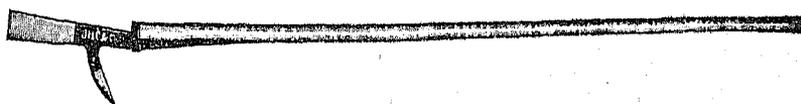
20. Float-hook; the same as the last, except that the handles are from 12 to 16 feet long.



21. Line-marker, for cutting a groove for the ice-marker to follow.



22. Hook-chisel, for splitting blocks of ice, and for handling them on the elevator.



23. Scoop-net, for clearing the channels of broken ice; the net made of light chains.



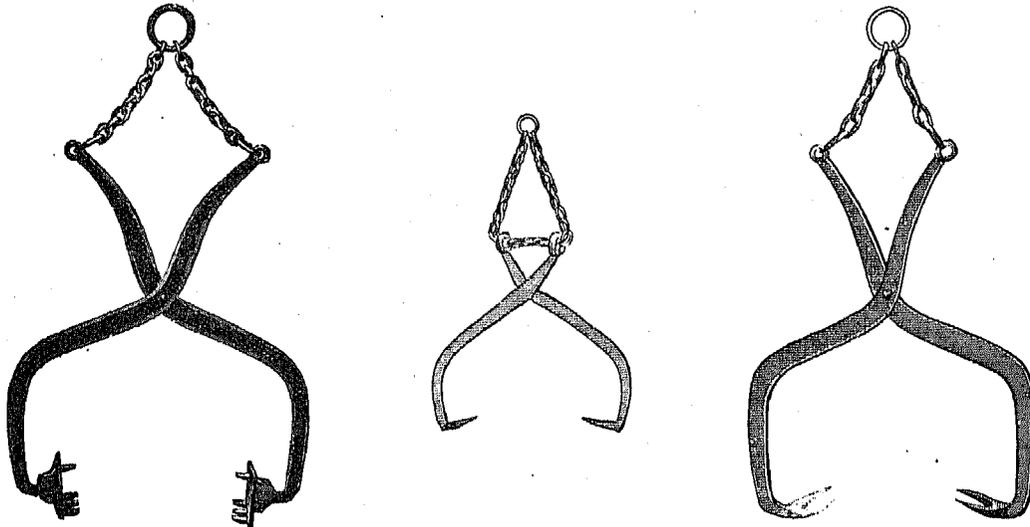
24. Elevator-fork, used in place of an ice-hook for feeding ice to the elevator.
 25. Ice-auger, for boring holes to test the thickness of the ice.



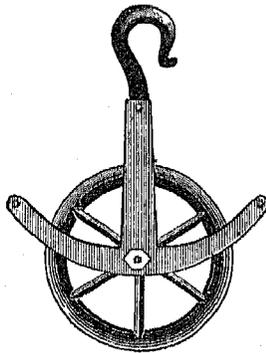
26. Measuring rod, for testing the thickness of the ice.



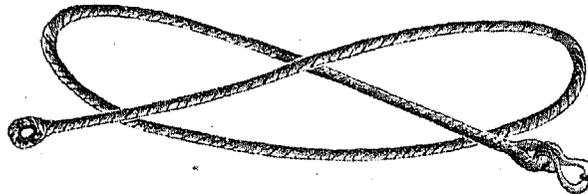
27. Hoisting-tongs, for hauling blocks up the inclined plane, and for loading and unloading vessels; in three patterns.



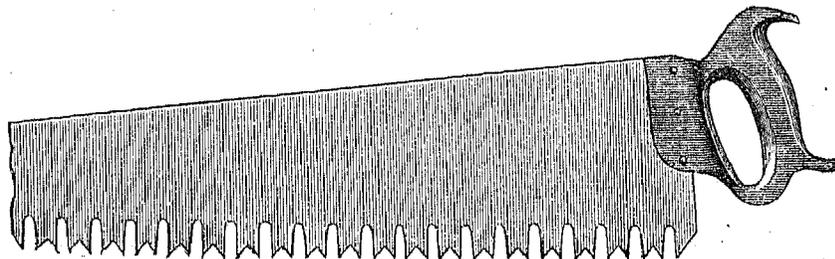
28. Hoisting-gin, used in place of a wooden pulley when the house is filled by horse-power.



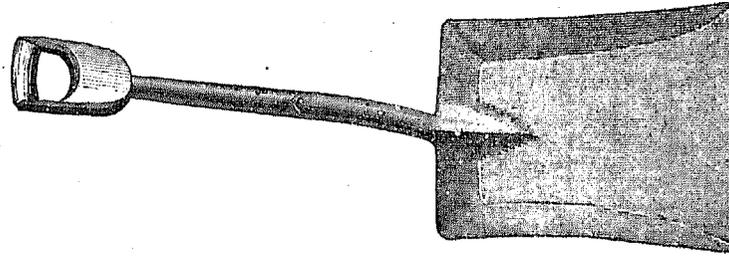
29. Plow-rope, 10 feet long, of 3-inch manilla cordage.



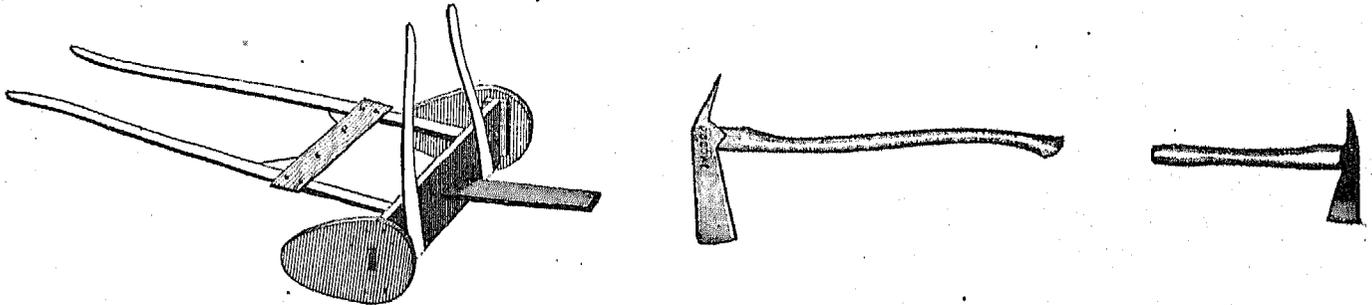
30. Hand-saw for cutting blocks into smaller pieces.



31. Snow-shovel, for handling sawdust, snow, broken ice, etc.



The tools not specified above are principally small implements used in the sale of ice, such as axes, forks, picks, scales, etc. For a moderate business in ice-cutting, as, for instance, the filling of one or two houses, an



outfit of tools will cost from \$500 to \$1,000. The large companies, however, often have \$10,000 invested in these implements. The thousand-dollar outfit would include 10 scrapers, 2 markers, 6 plows, 6 hand-plows, 2 planers, 4 saws, about 45 bars and chisels of the different patterns, about 100 ice-hooks, 24 float-hooks, 4 scoop-nets, 4 elevator-forks, an auger, a measuring-rod, 4 pairs of tongs, and about 4 hoisting-gins.

Experiments have been made during the last ten years with an implement, which has not, as yet, been made a success. This is a circular saw, driven by steam-power, for sawing out the ice from the field. So far, no machine has been produced light and handy enough to work with to advantage out on the pond.

In transporting the crop to market resort is had to railway cars or to ships and river boats, according to the location of the houses. In Maine, whose ice is cut principally for transportation to markets beyond the limits of the state, the loading is done on three-masted schooners and barks, and a few medium-sized ships, which have survived their usefulness for the carriage of finer commodities. Sawdust, shavings, marsh hay, and cheap lumber are used for dunnage, and the hold is closely sealed up until the arrival of the vessel at its destination. To Boston the ice is brought down from the ponds in railway cars to depots on the wharves. It is then transferred to schooner for the southern and West Indies trades, and to larger vessels for shipment to more distant ports.

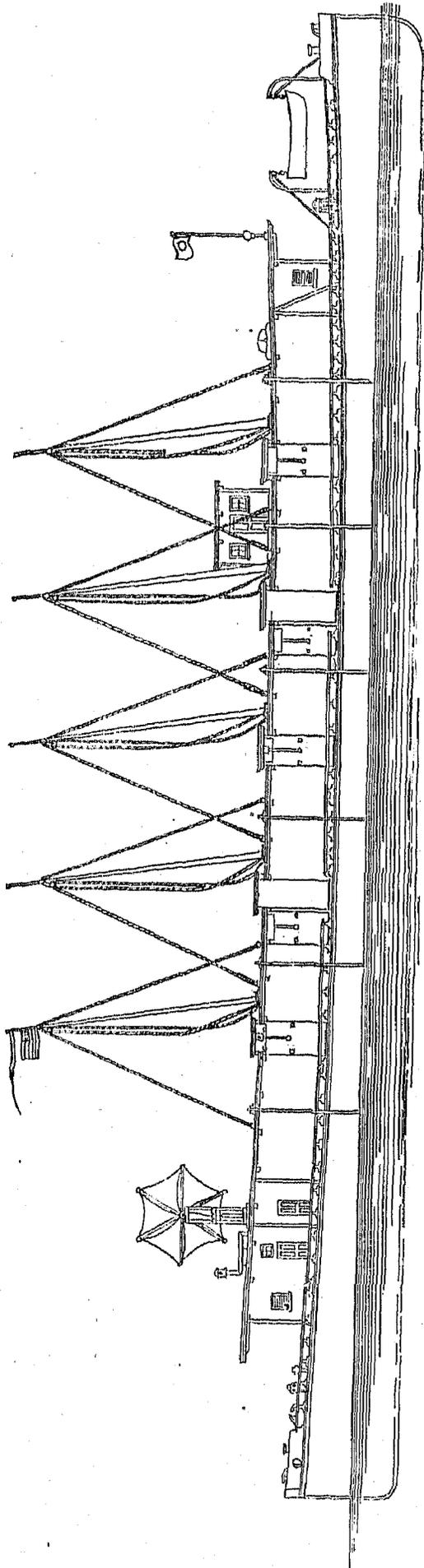
On the Hudson a large fleet of barges, built especially for the trade, are employed. There are about 100 of them at present. They vary from 110 feet in length, 26 feet beam, and 9 feet in depth, registering 325 tons, to boats 140 feet long, 34 feet beam, and 10 feet in depth of hold, registering 750 tons. They carry from 400 to 1,100 tons of ice. The barges are built with white oak frames, are planked and decked with yellow pine, and housed with white pine. The hulls are alike at both ends, rather bluff, flat on the floors, and in general bulky and capacious. A cargo-house covers about three-quarters of the length of the deck. The cargo is stowed both in the hold and in the house.

In the side of the cargo-house there are from three to five doorways which, in the form of hatchways, are extended part way across the roof. Masts extend about 30 feet above the top of the house, raking so that their tops are each over a hatchway. They are used for derricks in loading and discharging cargo. A small windmill revolves above the top of the roof, and drives a pump for clearing the hold of water from the melting ice. The barges are made up in fleets of from 6 to 12, and are towed to New York by a harbor tug. The building and repairing of these boats make much work for the shipyards of the Hudson.

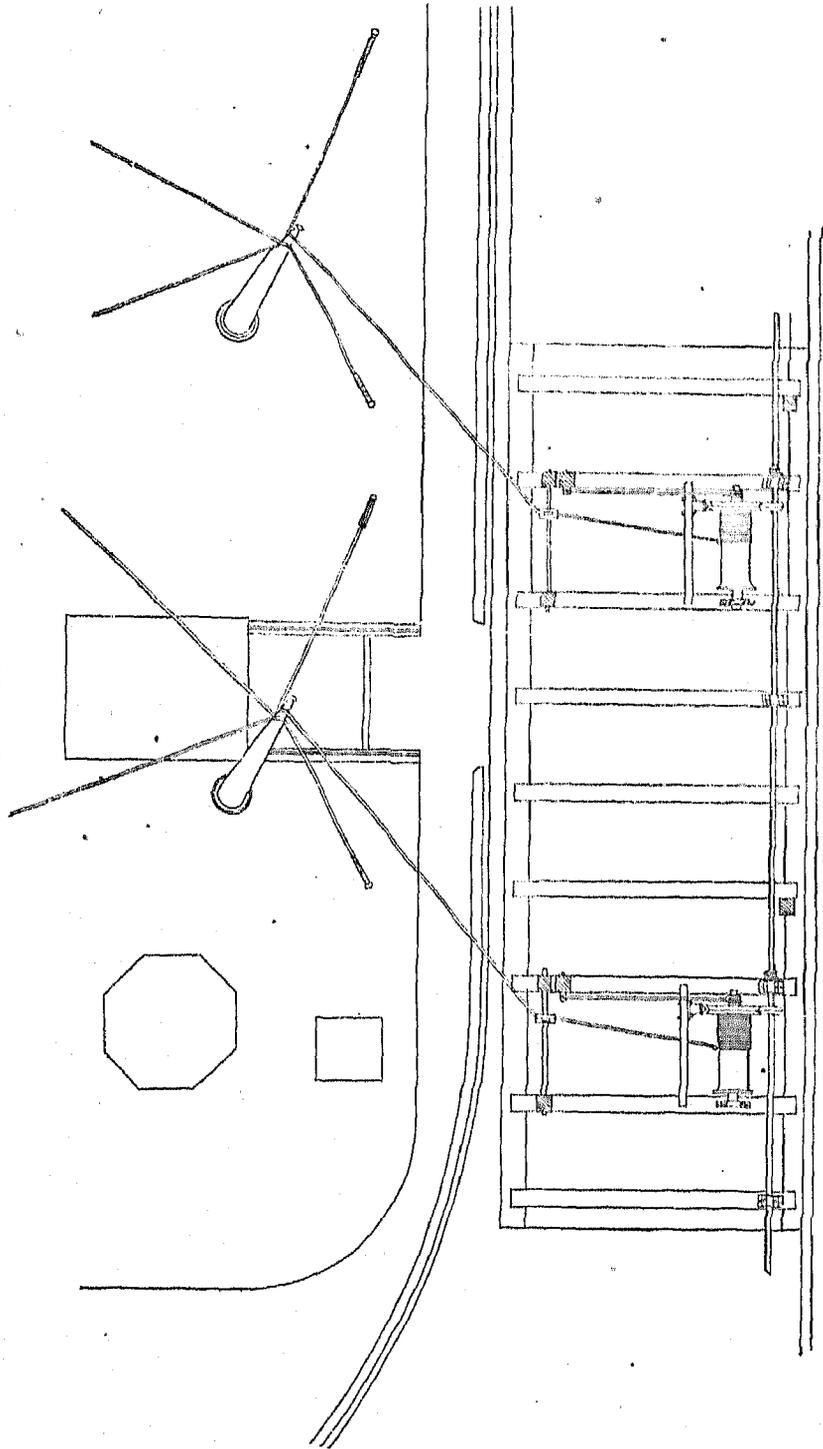
The Knickerbocker Ice Company unloads its barges at some of its large depots by steam-power. A line of shafting on the wharf works a drum around which is coiled the end of the rope used in hoisting the blocks out of the boat. The drum can be thrown into and out of gear as occasion requires. The ground plan of this invention is shown in the illustration.

On the upper Mississippi ice is despatched to market both by railway car and by river barges, the latter carrying up to 1,200 tons each.

The production of cold by artificial means began at a much earlier date than is commonly supposed. In India, Arabia, China, Egypt, and other eastern countries, porous earthen vessels were used for keeping water cool by the agency of evaporation from the surface of the vessels; and it has already been told on a preceding page how



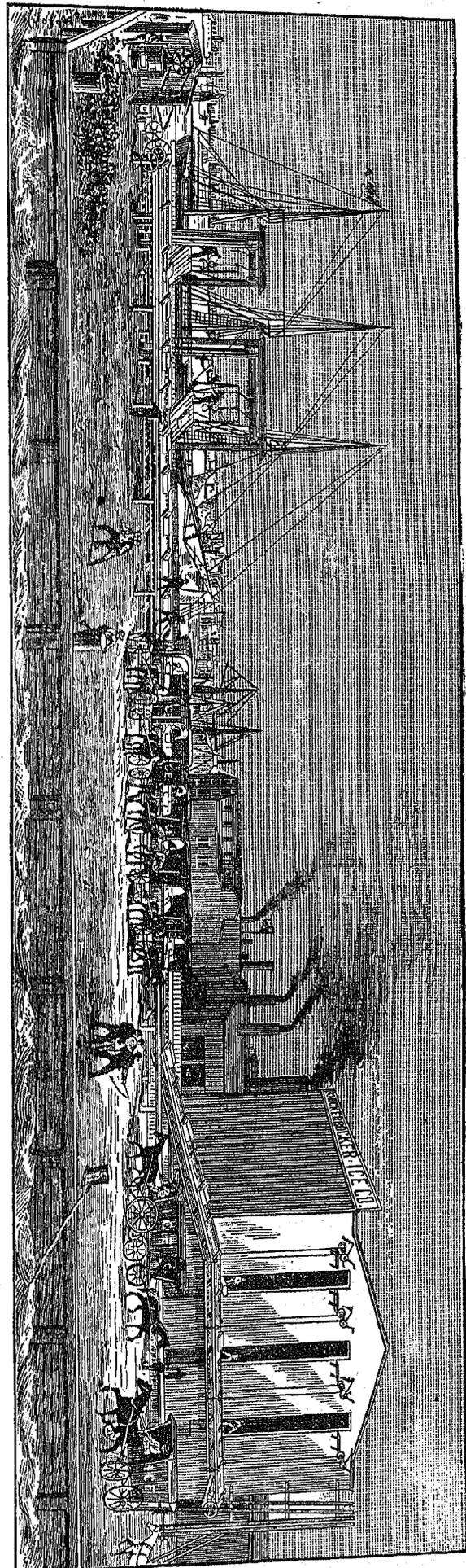
ICE-BARGE.



DERRICKS AND GEAR FOR UNLOADING.

the same idea was applied in very ancient times for the production of ice itself. Wine bottles were kept cool by wrapping them in wet cloths, handsomely ornamented when the bottles were in actual use on the table. After snow and ice came into popularity a simple cooling mixture was made by adding salt to those substances. The salt hastened their melting and extracted the heat of the bodies to be cooled more rapidly than either snow or ice would do it alone. Ether was also known at a very early date to produce cold by evaporation. In India, owing to the cheapness of niter, it has been common to use a solution of niter and water as a cooling mixture for wine. The record of definite attempts to produce freezing mixtures in a scientific manner begins with the Italians in the sixteenth century. Lord Bacon took much interest in the experiments made in his time; and in 1795, as a result of the studies of Mr. Walker, of Oxford; England, a number of tables of freezing mixtures were printed in the Philosophical Transactions of that year. Professor Leslie, of England, produced a considerable degree of refrigeration on the principle of exposing in the exhausted receiver of an air-pump sulphuric acid, a substance rapidly absorbing vapor. The problem of freezing by artificial means interested a great many minds at the same time, both in England and on the continent. Among other plans tried was the purely mechanical one of placing a quantity of water in the receiver of an air-pump and exhausting the air by powerful machinery, the slow evaporation of the water producing cold intense enough for the purpose. In 1834 an American in London, Jacob Perkins, patented a machine for ice-making, by the evaporation of sulphuric ether under an air-pump. The machine was afterwards improved by Professor Twining, of New Haven (1850); Harrison, of Australia (1857); Siebe, of London (1862); and later by Siddeley and Mackay, of Liverpool and London. When attention had been briefly turned to the use of volatile substances other liquids than ether were sought for; and during the last forty years a great many experiments have been made with a wide range of substances. The French have been especially active and ingenious in this field of research, and the name of their leading inventor, Carré, is now indissolubly connected with the successful application of the idea of evaporating a volatile fluid for the making of excellent and inexpensive ice. Among the new experiments made were those with ammonia, methylic ether, sulphurous acid, bisulphide of carbon, naphtha, and gasoline, or chimogene. Incidentally during the study of this subject some remarkable results were obtained. By the evaporation of sulphurous acid the temperature of 100° Fahrenheit below zero has been produced, and carbonic acid gas converted into a liquid, by the evaporation of which, in turn, the so-called permanent gases have been converted, under pressure, into liquids. Time and experiment have eliminated many of the substances above referred to from use; and the practical ice-machines of the present day employ only ammonia, ether, or sulphurous acid.

WHARF WITH ENDLESS CHAIN AND APPARATUS FOR TRANSFERRING ICE FROM SCHOONERS TO THE ICE-HOUSE.



There are now about forty different styles of ice-machines in operation in different parts of the world. Nearly a hundred have been patented at Washington. Not over half a dozen, however, are in this country considered of much practical value at the present time. The machines are all the same in principle, though various in construction. The principle is that a liquid in changing its form to a vapor abstracts heat from all surrounding substances; the more rapid the evaporation the more intense being the cold produced. The chief troubles the inventors have encountered have been the danger of explosion, to which the ether machine is especially liable; the leakage of the gases through the joints and pumps, which, by diminishing the pressure within, destroys the efficiency of the machine; the fact that an invention which will work successfully in a northern climate sometimes proves a failure in a warmer region, and the frequent great cost of operation. In order to carry on a successful business in artificial ice-making the product must be manufactured at a cost of not to exceed \$2 or \$3 a ton. The chief cause of the numerous disastrous failures so far has been that the product cost anywhere from \$20 to \$250 a ton. One American proprietor lost \$100,000 in experiments at New Orleans before success was achieved. It has been the aim of inventors in this country to make ice at from 75 cents to \$1 per ton. Many times during the last ten years the announcement has been made that the result has been accomplished. It is doubtful if, in practice, any ice-maker in America has yet been able to produce ice so cheaply; but the cost has, nevertheless, been reduced at length to a point where the making of ice is commercially practicable, and it is now carried on as a regular industry in a large number of southern cities in competition with the importation of natural ice from the north.

The process of ice-making is substantially the same in all machines, and a description of the way the thing is done by the Louisiana Ice Manufacturing Company of New Orleans will give a correct notion of it. The substance employed for evaporation is ammonia. In its uncombined form ammonia is a gas, having a remarkable affinity for water. A compound of water and ammonia is placed in an iron retort, or boiler, the fluid being deep enough to cover a coil of pipe in the bottom of the retort, occupying about one-third of its capacity. A current of steam is sent through this coil to heat the water to from 130° to 150°, and to volatilize the ammonia. The heat disengages the gas, which rises into the top of the retort, and is carried off into a series of pipes in a square box, called the "liquefactor." Cold water circulates in a constant current around the pipes of the liquefactor, and the gas condenses to a liquid under the influences of the refrigeration it receives and the pressure of the new gas which is continually coming. The liquid ammonia flows into a reservoir below called the "recipient" until a sufficient quantity has accumulated to begin the work of making ice. It is the return of this liquid to its gaseous form, or, in other words, its evaporation when pressure is removed, that generates the ice. A stopcock is opened which allows the ammonia to flow from the recipient into and through a network of pipes which fill the interior of a large tank called the "refrigerator." Finding room for expansion, the ammonia rushes into the pipes, vaporizes, absorbs heat in the process from the salt water surrounding the pipes, and rapidly reduces the temperature of the brine much below the freezing point. The brine, thus suddenly cooled, in turn absorbs heat from shallow pans of fresh water which are suspended in the refrigerator, and the fresh water is converted into blocks of solid ice. If this were the end of the process ice-making would be too expensive for commercial success. But so far only one-half of the business of the machine has been performed. The next step is to recover the gaseous ammonia for use a second time. When the ammonia was volatilized in the retort by heat a great pressure was generated. The water was forced back out of the bottom of the retort through a tube into an exchange or drum near by, and thence into a cooler, and still on into a "vase of absorption." Here the cooled water meets the gaseous ammonia, which has gone on through the refrigerator and has been conducted through tubes to the vase of absorption. The ammonia combines by affinity with the water again, forming a new saturated solution, and this is pumped back into the retort to undergo another operation. The gas is thus used over and over again. It is this part of the process which secures the economy of ice-making. This machine will make an average of 18 to 19 tons of ice a day, or about 5,500 tons a year.

Another variety of ammonia machine is used by the New Orleans Ice Manufacturing Company. It is the California invention of Mr. Beath. The principle is in all respects the same, but the ice is made not by freezing it in pans, but allowing it to form on the pipes of the refrigerating tank. The pipes are vertical, 32 feet high, placed in rows 4 feet apart one way, and 2 feet apart the other. When the liquid ammonia is allowed to enter them and evaporate into gas, water is showered upon the pipes and the ice forms on their surface, growing continually in thickness as long as evaporation continues. Water is thrown upon the pipes greatly in excess of the quantity that can be frozen. The result is that any solid substances contained in the water are washed down by the current, and thus the muddy water of the Mississippi river yields a pure and brilliant ice. The columns of ice around the pipes grow in diameter until they meet. They finally become transformed into perpendicular walls of solid ice, 32 feet high, and about 3 feet thick. Freezing is then stopped; gaseous ammonia is forced back into the pipes under pressure. Under compression heat is given out and the ice is melted away from immediate contact with the pipes. Horizontal and vertical grooves are then cut in the walls of ice and the blocks are split out and carried away for consumption. The house of the New Orleans company is large enough to hold 10,000 tons of ice. It is divided into four compartments, in which the vertical iron pipes are erected. In the winter of 1882-83, with only half its apparatus in use, the product was 50 tons a day.

Other machines have been tried in America, in which sulphurous acid and other liquids have been volatilized by creating a vacuum with a powerful pump, the liquid afterward being condensed under pressure. Two of the

Roach line of steamers to Brazil were supplied with refrigerating apparatus of this class. The work done did not yield satisfactory results, and the machines were taken out. Inventions of this class are being used, however, in various parts of the United States.

Within a few years a class of machines has been brought out, intended not for the manufacture of ice, but for the refrigeration of storage rooms by cooling the air. They are ammonia machines, as a rule, and in large establishments have been found to give satisfaction. They have been introduced to breweries in large numbers within the last five years. There are those who now predict their universal adoption by brewers within the next ten years, at least by all the large firms. It will be cheaper for the smaller firms to buy natural ice. A year of short supply and high prices tends to increase greatly the number of machines in the breweries of the large firms.

THE INDUSTRY IN THE SEVERAL STATES.

In the following notes no effort has been made to cover the whole industry throughout the United States. Only the general facts about the business in the principal regions of production have been collected. So far as these regions are concerned, inquiry has not been confined exclusively to the matter of the supply required for special cities, but a conscientious attempt has been made to give a fair picture of the whole production of each region. Some historical notes of each special locality have been added where possible.

MAINE.

The rivers of Maine are famous for the purity of their water. They rise in the depths of the forests, often flowing from crystal lakes, and their banks are free from large cities and manufacturing establishments to contaminate the current. Sawdust is about the only refuse of any account that finds its way into most of them. Their beds are deep. To add to their value as waters for the harvesting of ice, they nearly all flow with a strong current, which secures clearness and purity in the ice. The winters in Maine are severe, lasting long and freezing steadily, which is again an advantage. It is not necessary to harvest the annual crop with the feverish hurry of warmer states, and the ice itself is the denser and thicker for the long continuance of the cold weather. Of all the states, Maine is the most favored by nature for the ice business; and though the consumption of ice locally is small, owing to the coolness of her summers, yet Maine now stands first in the list of the ice-gathering states. Nine-tenths of the product is sent to other localities for consumption, chiefly to New York, Philadelphia, Baltimore, Washington, and the cities on the southern coast.

All the cities of Maine harvest their own local supply, but the principal cutting is done on the Kennebec and Cathance rivers, the Sheepscot river, and the Penobscot. Accessible to shipping, these streams export their ice. The first house on the Kennebec was built at Richmond in 1826, at a time when the operations of Mr. Tudor in Boston were attracting general attention. It was abandoned to natural decay about ten years afterward. The business made little progress in Maine until 1870, when a warm winter caused almost an entire failure of the crop on the Hudson and the Schuylkill. The ice dealers of those rivers became alarmed. They were obliged to buy ice in Maine for from \$7 to \$8 a ton, and in Massachusetts for \$10. They had had similar experiences before, and the failure of their crop in 1870 convinced the large companies that they would do well to locate at least a part of their plant in some northern locality, which could be depended on for a sure annual supply. There were then only 8 companies on the Kennebec and few anywhere else in Maine. But after 1870 there was a rapid increase in their number, and the ice business of the Kennebec and central Maine grew steadily year by year. One after another the following companies built houses on the Kennebec and its tributaries and on the neighboring Sheepscot river: the Knickerbocker Ice Company of Philadelphia, the pioneer; the Hancock Ice Company of Philadelphia; the Knickerbocker and the Consumers' ice companies, of New York; the Great Falls and the Independent ice companies, of Washington, D. C.; and W. H. Oler & Co., of Baltimore. A large number of new houses were also built by the Maine people themselves.

Maine ice was much admired in the markets to which it was sent, those markets being the coast cities from New York to New Orleans. It was forwarded in coasting vessels, of which a large fleet was annually required for the purpose. In 1878, the experiment was made of shipping to a distant market by railroad. Four freight trains of 20 cars each were loaded with ice at \$1.50 per ton and dispatched to Saint Louis, where they delivered in good condition 672 tons out of a total shipment of 1,275. The freight cost \$5.80 per gross ton, and the ice sold for \$10.50 per net ton. Owing to the waste of 50 per cent., the venture netted a large loss, and was not repeated.

The first great year on the Kennebec was that of 1879-'80. The harvest had been proceeding quietly through January and February, when word came from New York that the Hudson ice crop had failed, and that wholesale prices had risen in New York to \$4 and \$5 a ton. Ice was from 15 to 20 inches thick on the Kennebec, free from snow ice, smooth enough to cut without planing, firm, hard, and brilliant. It could be cut for 20 cents a ton; loaded on vessels for 50 cents; freighted to New York for 50 cents; and landed there at a cost of about \$1.50 per ton. The advices received were so favorable that all the ice-men of the Kennebec were thrown into a state of

great excitement. The companies all prepared to cut immediately as much as they could handle; and a number of new concerns promptly invested a good deal of money in tools and went into the business. Every idle workman along the river was employed and put to work. Shipyards and saw-mills were applied to for sawdust to pack the ice; the demand was so large and the supply so inadequate that the sites of old saw-mills were hunted up in order to dig out sawdust several years old. The price rose to \$3 per cord. Marsh hay, also used for packing, rose from \$5 per ton to \$10. Spruce and hemlock lumber for dunnage increased in price also. The river was a scene of remarkable animation. The dealers foresaw fortunes, and they pushed operations with the utmost energy. The portions of the river where cutting was done were covered with an army of 4,000 men and 350 horses, and work was prosecuted day and night. At Boothbay, a few miles from the Kennebec, and at other places, the houses were filled to the roof-plates, and thousands of tons were then stacked in the open air upon the ground for transfer to schooners for immediate dispatch to market. Similar scenes were enacted on the Penobscot, near Bangor and Brewer. When the harvest had ended, a total of about 1,300,000 tons of ice had been gathered in Maine. Of this, 950,000 had been cut on the Kennebec; 150,000 on the Penobscot; about 110,000 on the Sheepscot; and the rest at scattering points all along the coast. On the Penobscot, this was the first year in which ice had been cut in any large quantity. For fifteen years there had been no such business excitement in Maine.

In marketing the large product of 1880 there was good success. To cut and house the ice cost from 14 to 22 cents a ton, according to locality, the thickness of the ice, and the amount of machinery used. To transfer it in the spring and summer to the holds of the schooners cost an average of 42 cents per ton, including dunnage. Freights were from 50 cents to \$1 25 to New York or to Philadelphia; from \$1 to \$1 75 to Baltimore, Savannah, and the West Indies; and a dollar more to New Orleans. There were a few cases early in the year when the supply of shipping was small, in which freights were \$3 and \$4 per ton. Large vessels were ordered by cable from Europe to load at \$3 per ton freight. But this state of affairs wrought its own curé by bringing to Maine an abundant offering of tonnage, so that during the most of the year the freight averaged not over \$1 per ton to the middle Atlantic ports. The whole harvest of 1879-'80 not required for home consumption was sold at not less than from \$1 to \$1 75 per ton. A portion of it was disposed of, late in the summer, at higher prices. A few concerns sold out at \$3 per ton; and several shipments were made at \$5 and \$6 per ton, delivered on board. It is safely estimated that the crop brought to Maine about \$1,500,000, of which sum \$600,000 was expended among the workmen who cut, stored, and transferred the ice to the shipping, working for from \$1 to \$1 25 per day. A further sum of more than \$1,000,000 was earned by the vessels carrying the ice to market. In all, close upon 2,000 cargoes were shipped, 1,735 from the Kennebec and locality, and 250 from the Penobscot and eastern coast. The shipments from the Kennebec region during the year of 1880 were, per statement prepared by John H. Raymond, deputy collector at Bath, as follows:

To what port.	Number of vessels.	Tons of ice.	To what port.	Number of vessels.	Tons of ice.
New York.....	581	257, 618	Bridgeport.....	1	400
Philadelphia.....	668	339, 444	Norfolk.....	2	707
Baltimore.....	177	111, 029	Wilmington, Delaware.....	2	770
Washington.....	97	63, 180	Port Jefferson.....	2	555
Newark.....	80	13, 762	New Bedford.....	1	420
Richmond, Virginia.....	32	14, 218	Galveston.....	2	917
New Orleans.....	14	18, 870	Jacksonville.....	6	2, 710
New Haven, Connecticut.....	20	12, 083	Portsmouth, Virginia.....	1	395
Wilmington, North Carolina.....	13	6, 420	Camden, New Jersey.....	1	390
Charleston, South Carolina.....	10	5, 284	Atlantic City.....	3	1, 198
Savannah.....	17	10, 030	Flushing.....	1	390
Providence.....	10	5, 078	Fredericksburg, Virginia.....	1	400
Georgetown, District of Columbia.....	10	5, 283	Petersburg, Virginia.....	4	1, 495
Greenport, New York.....	3	1, 335	Fall River.....	2	1, 086
Staten Island, New York.....	5	2, 726	Narraganset Pier.....	1	440
Annapolis.....	1	400	Gloucester.....	1	467
New Castle, Delaware.....	3	1, 613	Fernandina.....	1	450
Newport.....	7	2, 873	Unknown.....	5	2, 016
Brunswick, Georgia.....	1	422			
Mobile.....	3	1, 281	Total.....	1, 735	890, 364

The profits of the year gave a great stimulus both to the ice business of Maine and the ship-building industry. A number of new houses were built and many vessels were constructed to share in the freighting. The latter were center-board schooners, shoal vessels of light draught and large capacity, adapted for running up the rivers, commanding a somewhat higher rate of freight on that account. So much new capital came into the business, especially on the Kennebec, that there are now on that river alone 36 firms in the business, employing \$1,000,000 of capital, owning 53 houses of a total capacity of 1,050,000 tons. On the short stretch of river from Bath to Hallowell there is now more capital concentrated in the cutting and storage of ice than in any other locality of equal extent in the world.

It is to be remarked that shipments from the Kennebec begin, in different years, at dates varying from March 15 to April 15.

On the Penobscot scarce a thousand tons of ice had been cut for shipment before 1870-'80. The stretch of river from Bangor to Brewer froze over annually to the depth of from 15 to 25 inches, but no facilities were created for handling anything more than a local supply until the furore of the year in question. The Bangor men then resolved to enter into the industry. They cut and housed, or stacked in piles along the riverside for 4 miles, about 115,000 tons of ice, which they afterwards sold at paying prices. A good part of the crop was disposed of for \$3 a ton. There are now 26 firms in the ice business on the Penobscot, with houses having a capacity of close upon 210,000 tons, located at Bangor, Orrington, Hampden, Brewer, Rockport, Belfast, Saint George, and Rockland. The Penobscot and the Arctic Ice Companies at Hampden and Orrington have been the only ones on the river having steam engines and endless chains to hoist with.

Statistics as to the total cut in Maine during past years are imperfect. The capacity of the 109 houses at present in existence is 1,560,000 tons. There are 53 houses and 1,050,000 tons of capacity located on the Kennebec; 26 houses and 210,000 tons of capacity on the Penobscot; 12 houses with 39,000 tons of capacity on the Cathance river; and on the rest on the coast principally, at Booth Bay, Wiscasset, Damariscotta, and Portland, 28 houses having 281,000 tons of capacity. The actual harvest is believed never to have exceeded about 1,400,000 tons, of which from 900,000 to 1,000,000 tons were on the Kennebec. The harvest fluctuates with the state of the weather on the Hudson and Schuylkill. A good year on these latter rivers results in a smaller production in Maine and *vice versa*.

The companies report the waste of ice while in store in the houses as about 20 per cent. The waste during transportation by vessel to Atlantic and gulf coast markets is also about 20 per cent. The usual sizes of blocks stored for shipment are 22 by 44 inches, and 44 by 44.

MASSACHUSETTS.

The ice business of Massachusetts is concentrated chiefly in the city of Boston. The cities of Worcester and Fitchburg have companies which cut 80,000 tons a year in Worcester county, a part of it for shipment; and scattered throughout the state are many communities which harvest a local supply annually from their ponds and rivers. But Boston is the principal consumer and exporter of the state. There is usually an ample supply of ice on the ponds in the vicinity of Boston. Nevertheless the harvest is subject to great vicissitudes. The weather of the winter months is variable, and it often happens that not over one-half or one-third of a crop can be gathered, and that only too frequently of very poor quality. One of the most productive years ever known was 1855, when a second crop was harvested, a part of it 21 inches thick. Another good year was 1870; the winter was mild on the Hudson and further south, and ice was scarce; but the Boston companies were able to fill their houses with an excellent product; the wholesale price rose from \$2 a ton to \$10, and the crop was marketed with great profit. But there were other years when the crop was almost a complete failure about Boston. One of them was 1879-'80. As late as February ice had not formed thicker than from 6 to 9 inches, and not much even as thick as that. The dealers were forced to cut ice in New Hampshire and in Maine, and a portion of their supply was purchased from the Maine companies. The number of firms in the business in Boston is 14, of whom 5, with a capital of \$510,000, cut principally for the export trade; 8, with a capital of \$400,000, cut for local consumption; and one, with a capital of \$6,000, cuts for use in its own brewery. The Tudor Company, one of the five exporting firms, is now withdrawing from its foreign trade and building up a local business. In good years the Boston companies harvest, according to census returns, as follows:

Name of company.	Sources of supply.	Ice secured.
		<i>Tons.</i>
Boston Ice Company.....	Ponds in Wakefield, Wellesley, Woburn, Lynnfield, and North Chelmsford, Massachusetts..	180,000
Tudor Ice Company.....	Fresh pond in Cambridge, Massachusetts.....	110,000
T. S. Hittinger.....	Fresh pond in Cambridge, and Forge pond in Westford, Massachusetts.....	100,000
Addison, Gage & Co.....	Wenham lake and a pond in Arlington, Massachusetts.....	70,000
Jamaica Pond Ice Company.....	Jamaica, Hammond's, and Curtis's ponds.....	55,000
Drivers' Union Ice Company.....	Essex, Massachusetts, and Milton, New Hampshire.....	22,000
Wenham Lake Ice Company.....	Wenham lake, and in Beverly, Massachusetts.....	25,000
South Boston Ice Company.....	South Weymouth, Massachusetts.....	20,000
Charles Russell.....	Wellesley, Massachusetts.....	25,000
Locke & Downing.....	Chandler's pond in Brighton, and Strong's pond in Newton, Massachusetts.....	85,000
Morrell & Buckner.....	Concord, Massachusetts.....	10,000
Winkley & Maddox.....	Essex, Massachusetts, and Newton, New Hampshire.....	0,000
G. F. Burkhardt Union Ice Company.....	Wilmington, Massachusetts.....	11,000
Total.....		660,000

About 80,000 tons are harvested in the towns around Boston by local companies, making the annual harvest in good years about 750,000 tons. To ascertain the quantity actually consumed, a deduction of 20 per cent. must be made for meltage in the ice-houses, and a further deduction of from 20 to 33 $\frac{1}{4}$ per cent. for waste in handling during distribution. A safe estimate would put it at from 375,000 to 400,000 tons a year, and 175,000 tons of this amount would be the exportation to foreign and domestic ports. A total cut of close upon 900,000 tons is claimed for Boston and vicinity, but the returns of the ice companies to special agent R. T. Swan do not indicate an aggregate larger than above set forth.

The ice-houses of the Boston companies are usually of wood, costing 75 cents per ton of capacity. A few are of brick, costing \$2 per ton to erect. The usual size of block for storage is 44 inches square. For export the blocks are sold without dividing them, but for the local trade they are split up into 22 inches square. The ice is sent into town in railway-cars built for the especial purpose and carrying 5 or 6 tons each. Most of the retail companies load their distributing wagons at night for the next day's business, a practice which is said to result in a good deal of waste in spite of its convenience, for the wagons then stand all night in sheds. Wagons without springs were formerly used, but a change is now taking place in favor of springs. Drivers deliver on their routes from two to seven loads of about 3 tons each per day.

The prices of ice in Boston vary, as elsewhere, with the quantity cut the previous winter and the warmth of the summer. The wholesale price averages \$1.50 per ton, but in 1880 it was about \$6. To families and small consumers a fair average price is \$3 per ton in winter and \$8 per ton in summer.

NEW YORK.

The ice business took its rise in New York state shortly after its successful initiation in Boston. At the mouth of the Hudson river were the cities of New York and Brooklyn and the communities which are now united into Jersey City. Scattered along the river were what are now Newburgh, Poughkeepsie, Peekskill, Rondout, Hudson, Athens, Albany, Troy, and various other intermediate towns of smaller size. As these communities grew into importance the ice business kept pace with their demands, and the Hudson river has now been for forty years the principal center of the industry in the United States. New York city and suburbs require 1,500,000 tons of ice yearly, and they sell some ice to shipping and for export, while the cities along the river require about 500,000 for their own local consumption. There is no exact statistical account of the total quantity of ice annually cut on the river and adjacent lakes. The capacity of the storage-houses is known, however, and a rough calculation of the crop is made every spring for the benefit of the trade. From these data and the known consumption of the cities along the river an approximate and pretty safe estimate of the average crop can be made. It would appear that the river region now supplies from 2,000,000 to 2,750,000 tons of ice every fairly good winter. Even this quantity, however, is not sufficient for the market. A crop of 2,000,000 tons dwindles to 1,000,000 tons before it reaches the consumers by meltage in the houses, and by waste in forwarding to market and distribution through the cities. A part of the deficiency is now made up by the manufacture of ice in the breweries and by artificial refrigeration. The balance is supplied by the state of Maine and the lake Champlain region.

Great uncertainties attend the industry on the Hudson. The weather is variable, and in not more than two out of three years is the crop a fair one. The ice seldom forms to a greater thickness than 12 inches. The companies prepare for the harvest the moment they have 6 inches, and if the season is late they fill their houses with from 6- to 9-inch ice. A thaw with a rain storm often ruins the crop just as the companies are on the point of beginning operations. Should the crop be a small one, and the price of ice high the following summer, the large profits result in the immediate erection of a number of new houses, and every effort is made the succeeding winter to gather as much ice as possible. The result is that prices are apt to range so low for a year thereafter that there is no profit in the business. In such cases owners often carry their store of ice over until the following season as less likely to be productive of loss. Wholesale rates have been known to be \$1.50 and \$2 in one year, and from \$10 to \$12 a part of the next.

For the New York market ice-cutting is done on Rockland, Kensico, Tuckahoe, Croton, Mahopac, Greenwood, Highland, and Mealhagh lakes, all in the lower counties of the state, and on the Hudson river from Poughkeepsie to Troy. The ice-houses are more numerous as Albany is approached. The principal centers of operations are Rondout, Glasco, West Camp, Athens, New Baltimore, Coxsackie, Castleton, Albany, and Troy. In all there are 135 ice-houses between New York and Albany and about 25 more on the upper Hudson and lake Champlain, which are tributary to New York. There are also many small houses on the Hudson, of 3,000 to 5,000 tons, owned by local dealers. A very nearly perfect list of the houses between New York and Albany, a number of small local establishments being omitted, has been prepared by a well-informed man in New York for the *Ice Trade Journal*. It is as follows:

Locality.	Name of company or firm.	Dimensions.	Capacity.
		Feet.	Tons.
Lake Mahopac.....	Smith, Lynington & Co.....		25,000
Croton lake.....	National Ice Company.....		50,000
Greenwood lake.....	Cooper, Howitt & Co.....	250 by 200	45,000
Rockland lake.....	Knickerbocker Ice Company.....	302 by 168	45,000
Do.....	do.....	230 by 190	35,000
Lake Montagh.....	do.....		40,000
Highland lake.....	A. C. Cheney & Co.....	230 by 200	40,000
Marlborough.....	Knickerbocker Ice Company.....		25,000
Poughkeepsie.....	Carpenter & Co.....		3,000
Do.....	Myers & Co.....		5,000
West Park.....	J. Mulford.....	177 by 150	20,000
Do.....	Mutual Benefit Company.....	300 by 225	40,000
Staatsburg.....	do.....	{ 100 by 80 100 by 100 }	15,000
Do.....	Knickerbocker Ice Company.....	342 by 117	25,000
Esopus.....	do.....	{ 250 by 140 300 by 204 170 by 100 }	75,000
Do.....	Commonwealth Ice Company.....		20,000
Port Ewen.....	Knickerbocker Ice Company.....		40,000
Rondout creek.....	do.....	250 by 105	17,000
Do.....	do.....	200 by 80	8,000
Do.....	Brewers' Ice Company.....	{ 120 by 120 168 by 150 }	31,000
Do.....	J. Hoffman.....	75 by 40	10,000
Kingston point.....	Kingston City Ice Company.....		1,800
Rhinebeck.....	Knickerbocker Ice Company.....		18,000
Whistky point.....	do.....		40,000
Do.....	do.....		17,000
Do.....	Newark City Ice Company.....		10,000
Flatbush.....	do.....	200 by 200	28,000
Do.....	Knickerbocker Ice Company.....	312 by 200	48,000
Do.....	do.....	121 by 100	7,000
Do.....	do.....	200 by 111	15,000
Do.....	New Jersey Ice Company.....	205 by 154	16,000
Barrytown.....	Livingston & Co.....	257 by 150	30,000
Do.....	Mutual Benefit Ice Company.....	300 by 126	25,000
Turkey point.....	Knickerbocker Ice Company.....		300,000
Glasco.....	do.....	200 by 100	15,000
Do.....	G. O. Preston.....		8,000
Do.....	Oakes & Thompson.....	201 by 153	25,000
Do.....	Glasco Ice Company.....		30,000
Evesport.....	Knickerbocker Ice Company.....	200 by 118	18,000
Smith's landing.....	Sturges & Martin.....		17,000
West Camp.....	Knickerbocker Ice Company.....	200 by 150	21,000
Do.....	National Ice Company.....	300 by 200	40,000
Do.....	New Jersey Ice Company.....	250 by 200	35,000
Do.....	Consumers' Ice Company.....	400 by 200	01,000
Do.....	do.....		20,000
Germantown.....	Rockefeller & Co.....	250 by 83	11,000
New Paltz.....	Knickerbocker Ice Company.....		12,000
Catskill.....	do.....	{ 280 by 172 100 by 82 120 by 120 }	43,000
Do.....	H. Van Steenburgh.....	186 by 112	11,000
Do.....	do.....		6,000
Do.....	do.....	200 by 200	20,000
Rodger's island.....	Knickerbocker Ice Company.....	340 by 200	50,000
Hamburg.....	New York City Ice Company.....		25,000
Do.....	do.....		19,000
Do.....	Knickerbocker Ice Company.....	108 by 132	33,000
Athens.....	Arrow Ice Company.....	220 by 207	11,000
Do.....	Howland & Son.....	157 by 116	8,000
Do.....	Theodore Avery.....	102 by 84	30,000
Do.....	Hudson Ice Company.....		85,000
Do.....	Knickerbocker Ice Company.....	{ 357 by 202 304 by 90 }	55,000
Four-Mile point.....	Brewers' Ice Company.....		12,000
Do.....	H. Rogers.....		8,000
Do.....	James Saunders.....		11,000
Pino grove.....	F. A. Andrews.....		40,000
Do.....	Knickerbocker Ice Company.....		35,000
Stockport.....	Stockport Ice Company.....		85,000
Coxsackie.....	Knickerbocker Ice Company.....	{ 300 by 160 300 by 200 }	31,000
Do.....	do.....		10,000
Do.....	do.....		10,000

Locality.	Name of company or firm.	Dimensions.	Capacity.
		Feet.	Tons.
Coxsackie	Hudson Ice Company		17,000
Do.....	Rea Bros.....		9,500
Do.....	National Ice Company.....		5,000
Do.....	Green County Ice Company.....		37,000
Do.....	David Terry.....		12,000
Do.....	David Terry.....		1,500
Coxsackie island.....	Ridgewood Ice Company.....		35,000
Stuyvesant	New Jersey Ice Company.....	250 by 110	20,000
Do.....	Scott & Co.....	240 by 100	15,000
Do.....	Yonkers City Ice Company.....		40,000
New Baltimore	Shaddon & Co.....		10,000
Do.....	A. J. Vanderpool.....	105 by 105	8,000
Do.....	Horton & Co.....		20,000
Do.....	Knickerbocker Ice Company.....		25,000
Do.....	Vanderpool, Van Orden & Co.....		10,000
Do.....	Smith & McCabe.....	164 by 102	11,000
Do.....	G. B. Miller.....		12,000
Schodack channel	Scott & Co.....		15,000
Do.....	McCabe Bros.....		10,000
Do.....	Gardiner & Schermerhorn.....		20,000
Do.....	Knickerbocker Ice Company.....		50,000
Do.....	Downer & Herrick.....		6,000
Pook hook.....	Knickerbocker Ice Company.....		20,000
Ziegler's island.....	do.....		12,000
Barren island.....	do.....		35,000
Coyemans	J. A. Briggs.....		10,000
Do.....	Knickerbocker Ice Company.....	250 by 180	33,000
Do.....	Bean & Parker.....		8,000
Do.....	James A. Warren.....	163 by 154	18,000
Castleton	C. Warren & Son.....		15,000
Do.....	W. H. Phibbs.....		10,000
Do.....	H. Buckley.....		4,000
Do.....	F. E. Bean.....		8,000
Do.....	Miller & Ostrander.....	83 by 88	4,500
Do.....	Yonkers City Ice Company.....		30,000
Do.....	Ridgewood Ice Company.....		55,000
Do.....	Commonwealth Ice Company.....	107 by 100	10,000
Do.....	do.....		10,000
Do.....	Baker & Son.....		8,000
Campbell's island.....	R. English & Co.....	200 by 100	30,000
Cedar hill.....	do.....		35,000
Do.....	Allen & Co.....		5,000
Staats'.....	Freeman & Herrick.....		10,000
Van Wie's point.....	A. Dettlinger.....	{ 225 by 150 200 by 150 }	65,000
Jolly island.....	Houghtaling & Co.....	229 by 113	30,000
Dow's point.....	J. Patterson.....	110 by 76	6,000
Do.....	Gascolgne Bros.....	100 by 60	4,500
Greenbush	S. Vrooman & Co.....		15,000
Do.....	H. D. Moulds.....		25,000
Do.....	W. Smith.....		15,000
Do.....	C. Warren & Son.....	90 by 60	4,000
Albany.....	H. Houghtaling.....	144 by 144	13,000
Do.....	Knickerbocker Ice Company.....		20,000
Do.....	do.....		8,000
Do.....	Rose & Wilbur.....	{ 226 by 90 95 by 95 }	19,000
Do.....	Rouan & Sampson.....		25,000
Total capacity.....			2,860,800

To reach the full productive capacity of the Hudson river companies, half a million tons should be added to the figures above. That quantity of ice is sometimes cut and stacked on the banks of the river, and sold and shipped before the warm weather comes on.

These houses are almost universally supplied with endless-chain elevators driven by from 25 to 35 horse-power engines. The companies own large outfits of tools, and they employ every modern device for saving labor and expediting the harvest. Speed is of the utmost importance. When there is good ice the houses are filled severally in from ten to twenty days after cutting begins. In good years the industry employs close upon 20,000 men and 1,000 horses. The men are recruited largely from the brick-yards of the river, which are idle in the winter time.

The wages paid vary from \$1 to \$1.50 per day. The cost of cutting and housing is from 25 to 50 cents per ton. A harvest of 2,500,000 tons is therefore the means of disbursing about \$900,000 in ready cash to the inhabitants of the river towns.

There have been many open winters on the Hudson. A notable one was that of 1869-70, when the crop was so small that ice sold for from \$16 to \$25, a little at \$30, per ton the following summer. The dealers also had small success, in 1879-80. The river did not close until the middle of January. A month later there had been only a scanty harvest of 4- to 8-inch ice at scattered points. The dealers then realized the danger of the winter passing without a harvest, and there was a rush with men, horses, tools, and building material to the upper Hudson, above Albany, and to lake Champlain. The Knickerbocker and the Consumers ice companies made arrangements for a part of their supply in Maine. In that winter there were not over 600,000 tons of old and new ice on the river and neighboring lakes; and much of the new crop was soft and spongy. Agents from Canada visited New York to sell ice, and arrangements were made for purchasing a few cargoes in Norway. Maine was the chief reliance for good ice that summer. The only thing that prevented a repetition of the famine prices of 1870 was the fact that about 400,000 tons of old ice had been carried in the Hudson river houses from 1878-79. Prices rose sufficiently high, however, as soon as spring had arrived and dealers realized that the supply was scant. In January the wholesale price had been \$1.50 to \$2 per ton. The rates then rose as follows: in February to \$3 per ton; March, \$5; April and May, \$7; June and July, to \$8 and \$10; August, \$10 and \$12; September, \$8 and \$9; October, \$8; and November, \$6 and \$7. These were the rates for large consumers, brewers, packers, butter dealers, hotels, and saloons. At retail, to families, the rates in the hot months rose to 60 and 75 cents per 100 pounds, and finally for a short time to \$1, equal to \$20 per ton. The houses on the Hudson river were virtually emptied during the summer. From the Kennebec, in Maine, 257,000 were imported, and many cargoes from other parts of the State; from Canada, by rail and canal, 15,000 tons; and from Norway, 8 cargoes amounting to 18,000 tons. The latter ice was good, pure, and hard, in cakes of 24 inches; it sold at the wharf at \$7.50 wholesale; very little money was made on its importation.

The winter of 1880-81 was a severe one. A large crop was harvested, and prices dropped back again to almost unremunerative rates. The wholesale price ranged from \$1.50 to \$2 through the summer; the retail price to small consumers from \$4 to \$8; the dealers and drivers paid \$2 per ton, and considering that the waste in delivery is from 25 to 33 per cent, and the expense of distribution about \$1.50 per ton, the retail price during most of the summer was too low for profit. Such are the vicissitudes of the ice business. The only advantage to the companies of the low prices was that it increased the consumption of ice permanently; and in 1882 the market took a larger supply than ever at fairly-paying rates. In years of excessive production new uses for ice are discovered, which give rise to new and important sources of demand.

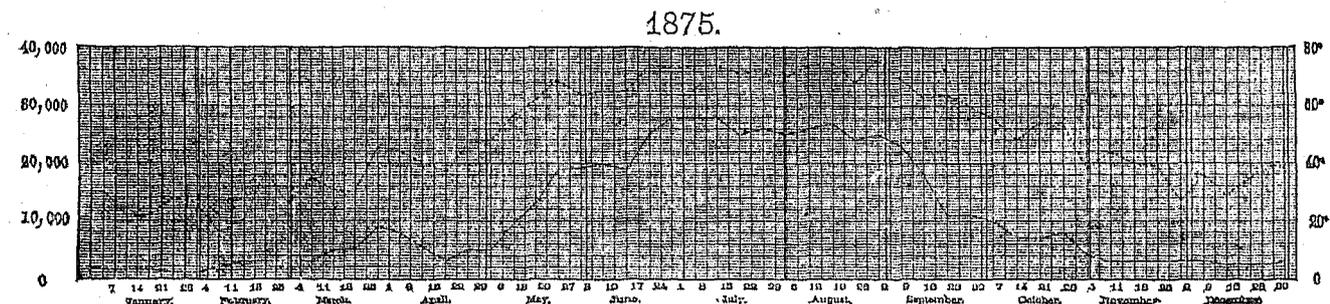
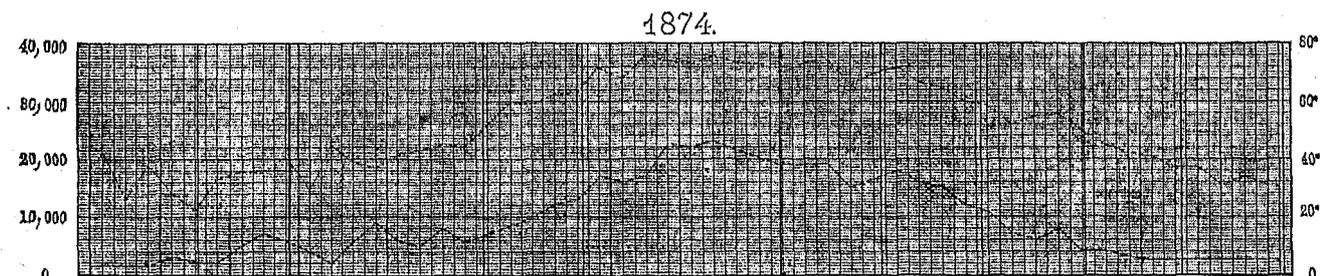
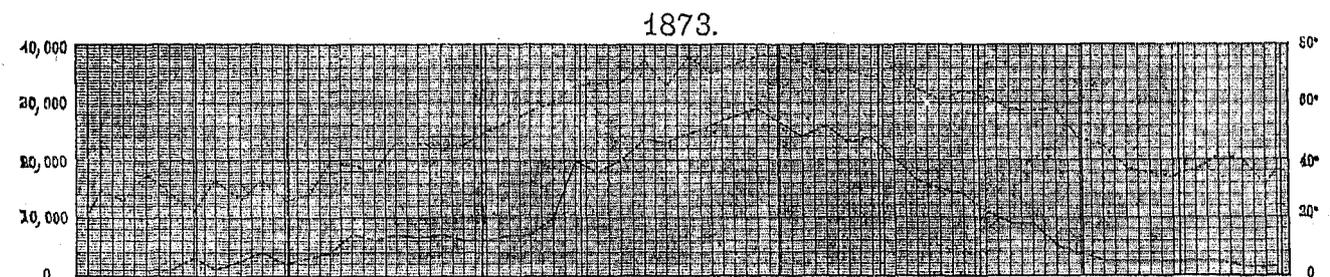
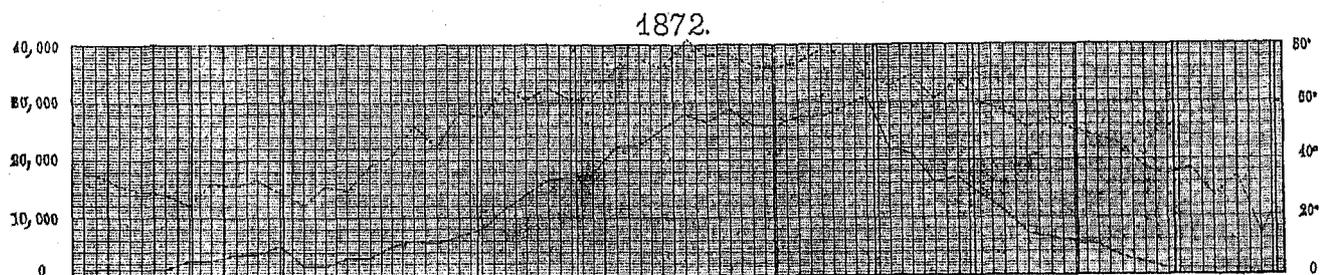
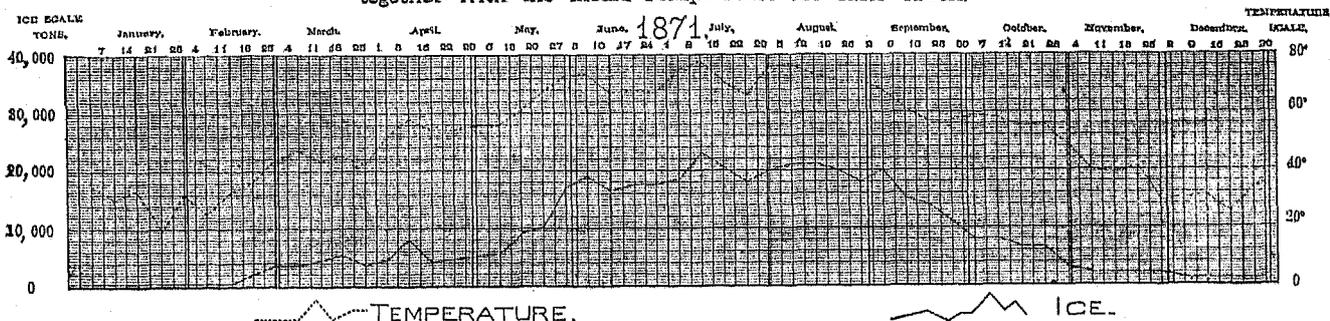
The ice-houses on the Hudson are located chiefly on the western bank of the river. They are all of wood, with double walls from 20 to 36 inches thick, the inner space packed with sawdust. A few are not boarded up on the outside of the frame, but all the new houses have the double walls. The lofts are high and spacious. The houses set almost invariably broadside to the river. In connection with the largest of them there are usually outbuildings—barns, workshops, tool-houses, and boarding-houses. In Ulster county the Knickerbocker Ice Company has a large farm for the raising of grain and hay. Much land elsewhere along the river is cultivated by ice companies for a similar purpose. At Rockland lake a railroad and inclined plane run over the summit of the mountain to the Hudson river for the transfer of ice to barges. When the harvest is over each winter the army of cutters is disbanded, and a smaller force is employed to cover the ice with hay, close the rooms, house the tools, make necessary repairs, and clean up the debris of the winter's work. In the summer a fresh force is employed in opening the houses, taking out the ice, loading it on cars and boats, and, in case of the boats, navigating them to New York, Brooklyn, Jersey City, and Newark.

The size of block popular on the Hudson is 32 by 22 inches. It is a convenient size to handle. If the blocks were thicker than they generally are a smaller size would be preferred.

The distribution of ice in New York city is carried on partly by the regular companies and partly by independent dealers and drivers of ice-wagons. There are thirteen depots in the city (mostly on the Hudson river front) at which the ice is unloaded and transferred to the wagons; and it is then distributed by wagons having regular routes. In the statistical returns no account is taken of the number of independent dealers, so that there may not be a duplication of returns of consumption. It is estimated that 700 wagons and teams of horses are employed in distribution in New York city.

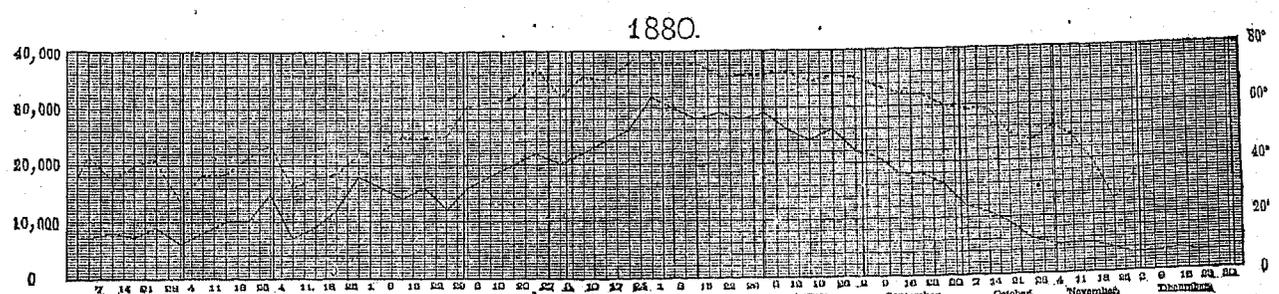
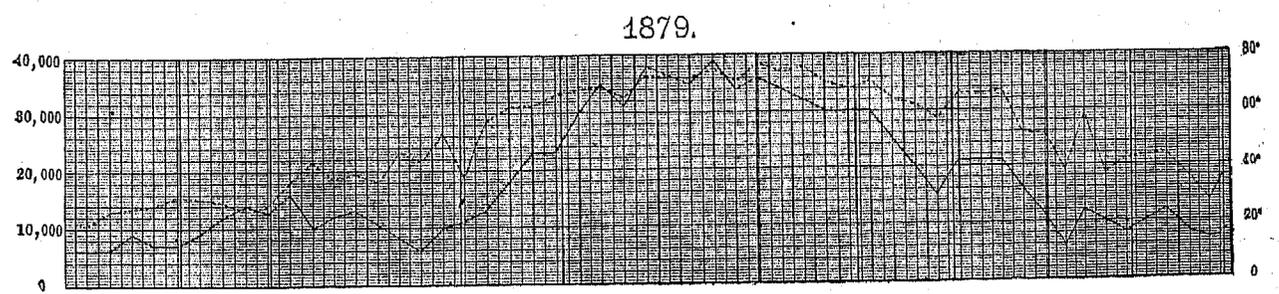
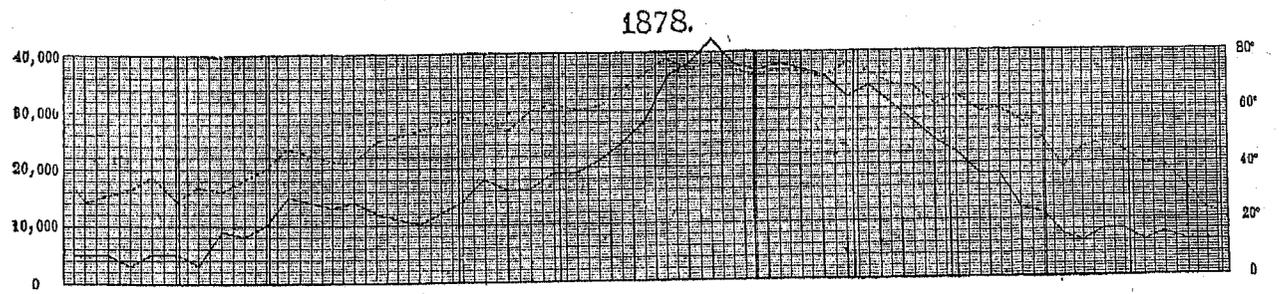
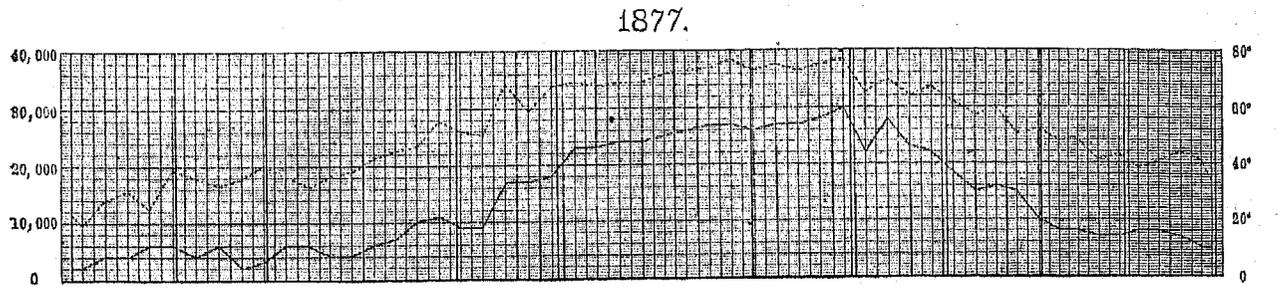
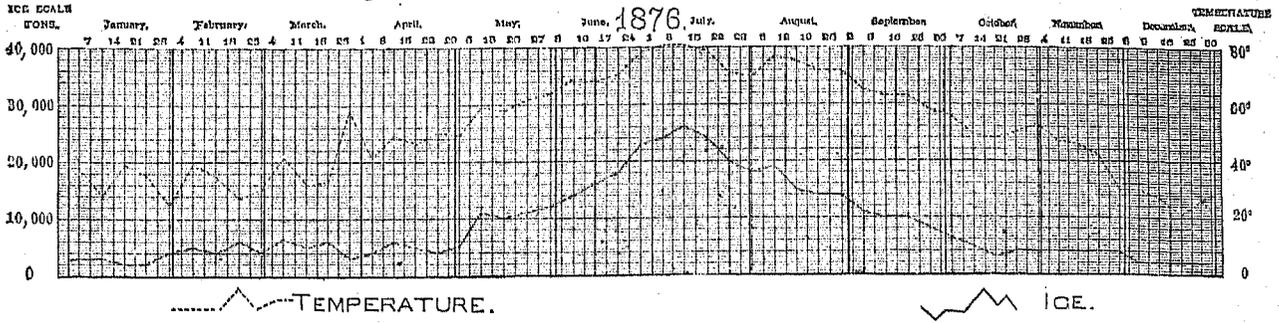
At the request of Mr. Charles E. Hill, chief special agent of the census for New York city, a chart was prepared by Mr. Ballentine, of the Knickerbocker Ice Company, for this report, which is presented herewith. It shows, by the profile, the weekly consumption of the ice in New York and Brooklyn, in tons, and the weekly average of the thermometer readings for the corresponding weeks, extending over a period of ten years, from 1871 to 1880. The chart is the result of much patient care and labor, and is a valuable indication of the general fluctuations of the consumption of ice in the two cities.

CHART showing weekly Sales of Ice in Tons for NEW YORK and BROOKLYN, from 1871 to 1875 inclusive, together with the Mean Temperature for each Week.



Compiled from Chart furnished the Census Office by KNICKERBOCKER ICE CO., New York

CHART showing weekly Sales of Ice in Tons for NEW YORK and BROOKLYN,
 from 1876 to 1880 inclusive,
 together with the Mean Temperature for each Week.



Compiled from Chart furnished the Census Office by KNICKERBOCKER ICE CO., New York.

In Brooklyn the ice supply arrives almost entirely by boat from the Hudson river. Perhaps 10,000 tons are cut in good seasons at ponds on Long Island for the use of brewers and packers, but the main dependence of the city is the Hudson river. The Knickerbocker and the Ridgewood companies supply nearly the whole of the quantity consumed in the city. About one-third of the crop harvested by the Knickerbocker Company is required by its Brooklyn trade. There are a number of small concerns and independent drivers in the city, but of these no account is taken in the statistical returns in order to avoid duplication.

PENNSYLVANIA.

Pennsylvania is third in the list of ice-producing States. Streams and ponds abound, from which good pure ice of sufficient thickness can be taken in average years. Statistics of the annual harvest and consumption were gathered, however, only with relation to the city of Philadelphia. With the data at command, it is difficult to estimate the precise extent of the ice production of the state. Philadelphia alone ordinarily consumes close upon 500,000 tons, which means a harvest of about 900,000 tons. The rest of the state probably consumes as much more. All of the many industrious communities of the state have each from 1 to 12 ice firms which harvest for local consumption, some of them occasionally sending ice by rail to Philadelphia and to Pittsburgh; and the known product of a majority of these firms makes the estimate above a safe one.

For the Philadelphia market ice was originally cut wholly on the Schuylkill, above Fairmont dam, and afterwards above the dam, at Manayunk, and finally as far up the stream as Norristown. In winters of ordinary severity an abundance of good ice, 10 to 12 inches thick, forms on the river, and there is good railway communication between the houses and the city. Of late years a part of the ice-cutting has been done on the Delaware, 20 miles above the city, where occasionally the ice is 18 inches thick; on the Lehigh river, Perkiomin creek, and various ponds in the northeastern part of the State. The cheapness of transportation by water from the upper Delaware has been the inducement to the companies to operate in that region. The city now regularly depends for a part of its supply on the state of Maine. The Knickerbocker Ice Company of Philadelphia was the first one in the Middle States to operate in Maine. Its ponds, ice-houses, facilities for loading vessels, and other plant at Booth Bay, are extensive and of the finest description. The cheapness of ice in Maine, its great thickness and density, and the low cost of its transportation to market by coasting schooners, have led to the Knickerbocker company's harvesting at Booth Bay about one-half of the 400,000 tons it requires every year. The other dealers also obtain large quantities of ice from Maine, their trade being with the Kennebec region; and the certainty with which an adequate supply can be secured from that part of the country makes the practice a growing one. For the last three years the streams in the vicinity of Philadelphia have yielded only a small quantity of not very good ice. Either the winters have been open ones or the ice, when formed, has been damaged by bad weather. At present about one-half of the whole supply of the city is drawn from the state of Maine.

The Knickerbocker company ranks, with its namesake in New York, as one of the largest ice concerns in the United States. It employs in distribution \$300,000 of capital, 800 men, and a large number of wagons, and pays out in the city about \$250,000 annually in wages and incidental expenses. Its annual sales approximate 200,000 tons, of which 30,000 are for export. The company was formed in 1869 by the consolidation of the old Knickerbocker company with seven others. In 1873 Mr. Thomas E. Cayhill, its president, proposed the establishment of a depot for the manufacture and sale of the tools, elevators, and machinery used in the trade. A shop which they were employing for the construction of wagons was enlarged and fitted up, and the factory has since been doing an extensive business with all parts of the country. One of the original ideas of the company has been the application of the endless-chain elevator to the handling of ice on the pier at which the vessels from Maine unload. A brick ice-house has been built on the pier, with a platform running out along the water's edge the whole length of the pier. The ice from the ship is unloaded upon this platform, and is either transferred to the wagons ranged along the other side of it, or is carried by the endless-chain elevator to the store-house. The part of the platform adjacent to the house can be raised or lowered by windlass-power to suit the height of the ice within. By reversing the machinery the endless chain serves the purpose of taking a supply from the house and distributing it to the wagons backed up against the platform. An illustration of this arrangement on another page of this report, will more fully explain its convenience and ingenuity.

The average wholesale price of ice in Philadelphia in 1880 was \$3 75 per ton, but \$5 75 and \$6 were the rates a portion of the summer. The price to small consumers per 100 pounds was 20 cents down to the 1st of May, and 40 cents thereafter. In 1879 the wholesale price was about \$2 50 per ton. In 1870, a year of short supply, it was as high as \$15.

Pittsburgh, Meadville, Oil City, and other towns in western Pennsylvania harvest some ice in their respective localities, but they depend on Chautauqua lake in New York for a large part of their supply.

OHIO.

In winters of ordinary severity good ice forms in every part of the State of Ohio. It is naturally most abundant in the northern counties; thinner but in sufficient supply in the southern. The demand for ice is large in the state, owing to the density of the population and the extent to which the various towns carry on the brewing of beer and packing of meats. Every community has its ice-houses, and local harvests are always gathered when the weather permits. When the crop fails in the inland counties, as it does in part in about every third winter, extraordinary efforts are made to secure a supply of ice from any point at which it can be obtained, either within or beyond the State. Indiana is a favorite resort of the Ohio ice men. The usual practice is to buy in Cleveland, Sandusky, and Toledo, on the shores of the lake. It is sometimes necessary to go to the lakes in Michigan and Wisconsin, and in the early spring of 1880 the Cincinnati men even bought largely from Lachine and Montreal, Canada.

The most important center of the trade is Cincinnati, on account of the large number of its brewing and packing establishments. The business is controlled by three large companies, who cut their ice on natural and artificial ponds located from 5 to 100 miles from the city in Ohio and Indiana, from the Little Miami river, Mill creek, and the Miami canal. There are 60 houses belonging to the companies and to various private owners in adjoining towns. The storage capacity is 450,000 tons. This is more than Cincinnati actually requires in any one season, but bitter experience has taught the dealers to house enough ice in a sharp winter to last two years if necessary. There have been several ice famines during the last twenty years, during which \$40 a ton has been paid by those who did not have contracts with the regular and responsible dealers. A large amount of ice is now carried over every year to provide against emergencies, and so that the dealers may reap the benefit of any scarcity the following winter. Two-thirds of the ice cut is brought into town by the Miami and Erie canal, the balance by railroads. Besides the regular companies there are a number of farmers and small operators in the ice business. They cut in the townships around the city and deliver to sundry private individuals for their own consumption. Of late years the brewers and packers have practiced employing these small dealers and others to cut for them in the winter time from 500 to 6,000 tons of ice to store in their own houses. They have adopted this plan to save the profits of speculators. Their factories are largely adjacent to Mill creek and the Miami canal, and the ice is generally cut there. Some of the largest brewers have also introduced ice-machines into their factories of late. As industries, the brewing and packing of Cincinnati are now nearly independent of the regular dealers, and this has considerably affected the trade of those concerns. In 1880 the brewers and packers cut 46,000 out of the 87,000 tons of natural ice consumed by them.

The actual consumption of Cincinnati ranges from 200,000 to 225,000 tons yearly. To meet the demand there is a harvest amounting (with the old ice carried over) to about 350,000 tons. The actual harvest varies from 150,000 to 400,000 tons. The vast bulk of all the cutting is done by the regular companies, who own 240,000 tons out of the total storage capacity above referred to. The winter generally allows field work to begin the latter part of December or in January. It is dangerous to wait until February before storing ice, but sometimes the companies must thus wait. The ice at Cincinnati is from 6 to 12 inches thick. In years of scarcity the dealers have to act with great energy. They prospect in the north, along lake Erie, and up into Michigan and Wisconsin, until they find good ice which can be bought to advantage, and they purchase and forward as much as possible of their supply while the cool season lasts. Northern firms often establish agencies in Cincinnati in such years, and sell direct from the cars to consumers and dealers at lower prices than the regular companies. These agencies are always of a temporary character. They are closed on the approach of the following winter. The wastage of ice between the source of supply and point of distribution is reported in Cincinnati about 33 per cent. Brewers and packers who get in their own ice report no waste. They haul and store their ice as soon as it is cut, and do not remove it from the store-house.

There is very little danger of an ice famine or of fancy prices in the future. The annual product is now too large. Prices vary in Cincinnati with the quantity in store and the quality of the stock. The cost of cutting and storing at the river side, or at the pond, appears to be from 50 cents to \$1 per ton. Before it can be sold for distribution a further charge must be made for freighting profits and interest. This charge necessarily varies with different firms. Some houses are located so advantageously that the cost of transportation is nominal, whereas those at a distance from the city are at heavy expense when forwarding their store to market. The brewers report that it costs them from 50 cents to \$1.50 per ton to house a supply of ice from their locality. When they buy of the regular dealers in the summer months they must pay from \$3 to \$6 per ton, according to the quality of the ice and the season. For the general trade the wholesale prices by canal-boat load of 60 tons should be from \$4 to \$6 per ton; in abundant years it falls to \$2 and \$2.50, whereas in years of short local crop it goes to \$10. The rate for families and small consumers varies every year. In 1880 hotels, markets, and saloons paid from \$14 to \$16 per ton, buying by the 100 pounds, and families paid \$20. The fair average price to families in abundant years is \$6 or \$7 per ton in winter, and \$10 or \$12 in summer. Cincinnati does not have as large a river trade in this commodity as would be fair to expect, in view of her large tonnage of steamboats and barges and the active business her merchants drive with all points in the south. Occasionally a little ice is shipped to points in Georgia, Kentucky, and

Tennessee by rail; but, as a rule, the city does not export, unless the 7,000 to 10,000 tons sold to steamboats for consumption on board and to railways for refrigeration on railway cars be considered as exports. The fact is the city seldom has a ton more than she needs herself, taking the bad seasons with the good.

Chief Special Agent Henry Cole estimates that the capital employed by the Cincinnati companies in harvesting and transporting ice to the localities of distribution is \$685,000; that the average number of hands employed is 2,500, and the aggregate amount of wages paid to the same is \$49,000. In the city \$248,000 of capital and 260 hands are regularly employed in distribution. Returns show a total of 967 people employed in distribution a part of the year.

The part of Ohio in which the ice business is carried on to the best advantage is the section bordering on the shore of Lake Erie. These northern counties are subjected to severe weather in winter, and they are never so destitute of ice that they do not have all they want for local consumption, and an abundance to spare for the interior towns. The business is carried on principally at Cleveland, Sandusky, and Toledo; and if at one of these cities they cannot harvest a full crop, the others are pretty certain to have a surplus. It is rare that there is even a partial failure of the crop along the whole shore. Cleveland is the main consumer. Toledo and Sandusky operate chiefly for the interior trade.

Cleveland consumes the most ice by virtue of her industries. The city has many breweries, packing-houses, and fish-markets, to all of which an abundance of ice is as the breath of life. The family and retail trade of the city does not take more than a quarter of the whole quantity of ice consumed. The waters upon which the companies operate are the Cuyahoga river, Rocky river, a number of ponds in and around the city, and Lake Erie. In good winters ice forms far in excess of the needs of the city, and of a thickness of from 12 to 20 inches, being hard, clean, and pure. The weather is, however, somewhat variable, and safety requires cutting to begin when from 8 to 11 inches are attained. The brewers generally cut for themselves from small artificial ponds, sometimes from the river and the lake. Many of them have introduced refrigerating machines; but natural ice is cheaper than the manufactured, and it pays to allow the machines to rest and to fill the houses from the ponds, when that can be done. They report the cost of so doing at from 25 to 50 cents per ton for cutting and storing. From \$1 to \$2 per ton is paid when they have to buy from regular dealers. The total storage capacity of the dealers and manufacturing establishments combined is about 260,000 tons. The average crop stored is 210,000 tons. The average consumption is from 125,000 to 135,000 tons. Brewers report that the waste in hauling and in the house does not exceed 10 or 15 per cent., but the regular dealers encounter a loss of from 25 to 40 per cent. when their houses are near the city, and from 50 to 60 per cent. in all when the houses are at a distance. Inquiries made by M. M. Hobart, chief special agent for Cleveland, indicate the employment of \$540,000 and 1,900 men in harvesting and storing. The wages paid to the men is about \$60,000 in average years, or about 30 cents per ton. One of the companies, which has a large investment on Rocky river, employs barges of about 150 tons capacity to bring the ice to the city. The blocks from that stream are valued for their purity and thickness. Cleveland is fortunate in her almost complete freedom from the dangers of an ice famine and in the low prices which prevail. The wholesale rate for ice seldom goes to \$6 per ton, and it is more likely to be about \$2 and \$2 50, sometimes \$1 00.

Sandusky has a storage capacity equal to 150,000 tons. A large part of it was created in the excitement of the winter of 1879-'80, when the crop failed in so many other parts of the country. Large houses were built in February and March with a capacity of 60,000 tons, and the companies went further and prepared apparatus for stacking considerable quantities of ice for shipment to the interior. The local consumption of Sandusky does not exceed from 16,000 to 20,000 tons, so that when the houses are filled, as they generally are every winter, there is an immense surplus for shipment to interior towns. Sandusky ice is in great demand. It is generally from 14 to 20 inches thick and as clear as plate-glass. Columbus, Springfield, and Cincinnati buy a great deal of their supply at this point. The freighting of from 100,000 to 130,000 tons of ice yearly to these and other towns is a source of great profit to the railroads.

Toledo can store about 160,000 tons. Her dealers operate both in the vicinity and on the lakes and rivers of Michigan. They have an abundance of ice of good quality, generally from 12 to 20 inches thick. The city ships by rail to numerous interior markets.

ILLINOIS.

The ice business of the southern part of the state is tributary to the Saint Louis market, as noticed elsewhere. It remains to speak of the business of Chicago, in the northern part of the state. It is the principal center of consumption in Illinois, and the operations of its numerous companies dwarf the industry in the rest of the state by comparison.

The history of the trade in Chicago dates back to 1847. A house holding 2,000 tons was put up by two men named Frisbie and Burroughs, who filled it with ice taken from the North Branch. In 1848 a house was put up by a competitor in the business. For many years there was little except the family and the ice-cream trade in the city, and a few thousand tons of ice was an ample supply. As the city grew in population, however, and industries sprang up, and especially after the port became a point for packing and shipping meats, the demand for ice increased. In 1860 James P. Smith & Co., now next to the largest concern in the city trade, began operations. One company

after another was started, as the opportunities for making money became known. In 1883 there are 22 regular companies in Chicago, together with a number of small concerns, with an aggregate trade not exceeded in any part of the United States except in New York city. There are \$950,000 invested in ice-houses and tools. There is a storage capacity of 1,300,000 tons. From 2,600 to 3,500 men are employed a part of the winter in cutting and storing, earning from \$140,000 to \$180,000 in wages. A crop of from 700,000 to 1,100,000 tons is annually harvested at the various points at which the companies operate; and within the city \$303,000 of capital and 835 men, earning \$200,000 in wages, were employed in distributing the ice to consumers in 1880, which was a short-crop year. The actual consumption of the city is from 575,000 to 900,000 tons, varying with the dearthness of the commodity.

The largest concern is the Washington Ice Company. They have store-houses located as follows:

Whence obtained.	Where stored.	Method of transportation.	Amount.
			Tons.
Calumet river.....	Riverdale, Illinois.....	Chicago and Saint Louis and Pittsburgh Railroad.....	24,000
Do.....	Calumet, Illinois.....	do.....	35,000
Do.....	Clarke, Indiana.....	Pittsburgh, Fort Wayne and Chicago Railroad.....	27,000
Do.....	South Chicago, Illinois.....	do.....	23,000
Do.....	Wildwood, Illinois.....	Illinois Central Railroad.....	13,000
Do.....	Thornton, Illinois.....	Michigan Central Railroad.....	20,000
Stone lake.....	La Porte, Indiana.....	Lake Shore and Michigan Southern Railroad.....	84,000
Clear lake.....	do.....	do.....	11,000
Fox river.....	Cary, Illinois.....	Chicago and Northwestern Railroad.....	24,000
Do.....	Elgin, Illinois.....	do.....	19,000
Do.....	West Elgin, Illinois.....	Chicago, Milwaukee and Saint Paul Railroad.....	11,000
Geneva lake.....	Wisconsin.....	Chicago and Northwestern Railroad.....	13,000
Sturgeon bay.....	do.....	Water transportation via Lake Michigan.....	27,000
	City store-houses.....		3,000
Whole capacity.....			651,000

The company has ice-cutting privileges without store-houses at lake Winnebago, Oshkosh, Wisconsin; Rock river, Watertown, Wisconsin; and Fox river, at Clintonville, and at Aurora, Illinois. They harvest an average of 250,000 tons. The best ice is cut at Elgin and at Laporte, and is reserved for special trades. The Wisconsin ice is, however, remarkably fine and of great thickness and density. When the Illinois streams and ponds do not freeze more than 8 or 10 inches thick, the bays of Wisconsin freeze two feet thick.

Among the other ice firms are James P. Smith & Co., who rank second only in the magnitude of their operations. They have houses in several states and at a large number of places, chiefly at Chicago, Riverside, Aurora, and Batavia, and on the Calumet lake and river, Illinois, and at Fond du Lac, Wisconsin. They do a large business in the city. Their storage capacity is equal to 90,000 tons, and they cut on the average about 60,000. A. S. Pifer & Co. cut on the Desplaines river, Illinois, on Fox river, and at Sturgeon bay, Wisconsin; storage capacity, 100,000 tons. E. A. Shedd & Co. have large houses at Wolf lake, Indiana, and in Calumet and McHenry counties, Illinois; storage room, 80,000 tons. These comprise the largest four concerns. There are three others, the O. & W. Guthrie ice company, Maginnis & Boyle, and J. H. Dale & Co., which report from 40,000 to 60,000 tons of capacity at various points in four adjoining states. The rest of the dealers handle quantities varying from 15,000 down to and below 1,000 tons. These small concerns operate mainly on the Chicago river, and in the close vicinity of the city.

With access by rail and water to so many points where pure, thick ice can be obtained, Chicago is virtually safe from an ice famine, and the industries dependent on refrigeration for running to their full capacity are seldom troubled either with short supply or excessive prices. It is of some importance to all consumers, however, whether any particular winter is, or is not, a severe one in the vicinity of the city, because the cost of transportation is a considerable element in the rates of the following year; and, if the crop must be brought from distant points, the rates run high. Occasionally the waters of the state yield an insufficient supply. This occurred in 1877-78 and in 1879-80. In the winter last named from 8 to 10 inches of ice formed about Christmas time, but an untimely thaw destroyed the fields; and, as the succeeding fortnight passed without the prospect of another freeze, the companies fled northwards at once and harvested an adequate supply at Green Bay, Sturgeon Bay, Fond du Lac, and Oshkosh. In years like these high prices naturally prevail during the following summer. But there is never an ice famine now, for the companies always carry along more or less old ice from one season to another. The high rates are not due to speculation in a commodity which ranks with the necessaries of life, so much as to the greater cost of meeting the requirements of the city from distant sources of supply. With every year of good prices, moreover, the old companies put a large part of their profits into new houses and general increase of their plant, and many new companies are organized, so that the community gains the benefit of greater supply the next winter and, consequently, moderate prices. In this way the business grows steadily, and is kept commensurate with the expansion of the city and its industries. The winter of 1880-81 was a great crop year at Chicago. One estimate of the amount cut puts it at 1,200,000 tons. It is believed that 1,000,000 tons would be nearer the truth.

At the lower estimate, however, the business nearly reached the magnitude of the product of the Hudson river in New York. There were four months of continuous cold weather. The bulk of the crop was harvested at home. Some waters were cut from three times, 12-inch ice being taken out each time. A good deal of 26-inch ice was cut that winter, all free from snow, and clear as crystal. The city derived great benefit from the large product. Prices ruled low, and ice was used with liberality by individuals who, previous to that, had been able to purchase only a limited quantity. In general, Chicago prices are lower than those in any other part of the country, except the east. In bountiful years they range from \$1.50 to \$2 per ton in car lots free on board; \$2 to \$3 per ton by the wagon load; and from \$4 to \$6 per ton by the 100 pounds to families. In 1878 wholesale lots sold for from \$4 to \$7 per ton; a few as high as \$10. In 1880, which was a year of good prices, though not of scant supply, they were from \$3 to \$5 per ton. During the summer families and small consumers, buying by the 100 pounds, paid from \$8, which was the average, to \$15 per ton. In 1881 families paid \$5 and \$6 per ton. At retail the price in summer is always a little more than double the one which rules in the winter.

The large packing houses at the Union stock yards are the largest consumers of ice in Chicago. The brewers, however, use large quantities. The proprietors of both classes of establishments put in their own ice as far as possible. Of the about 350,000 tons which they require, 100,000 tons on an average are harvested under their own direction, at a cost of from \$1 to \$2.50 per ton, delivered in the house. They employ men who are little more than day laborers, having idle teams, to cut in the outskirts of the city and haul it directly to the houses. Sometimes the cost exceeds little more than the wages paid the men. In such cases it falls below \$1 per ton. One large firm reports getting ice at a cost of 16 cents per ton.

MISSOURI.

Missouri is almost on the southern edge of the ice belt. No natural ice forms in the states southward of her, and the whole region to the gulf depends upon Missouri and the upper Mississippi for its supply. The only exception is the city of New Orleans, which purchases ice from Maine. The trade of the upper Mississippi naturally centers at Saint Louis. The city is, in the first place, the largest consumer of this region. She requires about 250,000 tons yearly for her own use, and various large companies have been formed among her merchants to gather and supply her with this large quantity of ice. In the next place, the city is the center of a network of railroads extending to every part of the northwest, and she also has extended water communication, by which means if the crop fails at Saint Louis ice can be drawn from a hundred other localities where it is sure to freeze from 15 to 20 inches thick. And, finally, the city is the best point for shipping ice to the southern markets; there is always a sufficient depth of water from Saint Louis southward to float the largest boats employed in the trade, even in the driest months of the summer. The tonnage of Saint Louis is also immense. She also has railroads to Texas. All these advantages tend to make the city the ice market of the Upper Mississippi.

To supply the wants of Saint Louis and the southern trade a crop of 550,000 tons is annually required. About 270,000 tons are consumed in the city, and 280,000 are sent south to Helena, Arkansas City, Greenville, Memphis, Vicksburg, Natchez, New Orleans and other points on the lower rivers. Of late years it has not been possible to obtain a full supply in the immediate vicinity of Saint Louis in more than one year out of two. In severe winters, with steady weather, the river near the city and the ponds and stone quarries will yield an abundance of ice about a foot thick. But if a good crop is harvested in one winter it is more than likely that no ice of any amount will form the following winter, or the crop will be spoiled by a thaw and a rise in the river. There have been many years of great scarcity, and the prices of ice have fluctuated in a surprising manner. An average wholesale price, in which there is a profit, is \$5 per ton, the ordinary range being from \$3.25 to \$6. But in 1863 ice sold in Saint Louis for \$30 and \$40 a ton. In 1876 it sold by the car load, early in the season, for \$7.50 per ton, and during the summer rose to \$15 and \$16; the retail price to families was \$20. In years of scarcity the greatest sufferers are the breweries and meat-packers of the city. They take half the quantity consumed by the city, and the wholesale price for the year is of immediate importance to them. The uncertainty of the local harvest has led to an extension of the operations of all the Saint Louis ice-cutters over the whole northwest. They have established houses at De Pue, Kingston, Peru, Peoria, LaSalle, Quincy, Alton, and other points in Illinois, as also at many places in Iowa and Minnesota, and their operations are now supplemented by local enterprises, both in the cities named and in Keokuk, Cedar Rapids, Des Moines, Burlington, and other towns having good routes of transportation to the city; occasionally the dealers resort to Toledo and Canada. The necessity of a sure supply has also led about 25 brewers and a number of meat-packers to act independently of the regular companies and lay in a supply of their own every year. They either harvest near the city or buy wherever the ice is good, filling their houses at a cost varying from 75 cents to \$1.50 per ton for the ice, and \$1 to \$2 per ton for railroad freight. Ice is even brought from Minnesota frequently at a cost for freight of \$3 per ton. One brewery firm has established storage houses at De Pue, Illinois, with a capacity of 20,000 tons, and employs a tow-boat and eight barges of its own to bring down the ice when required. The brewers and packers have a storage capacity of 175,000 tons, and they are

well satisfied, when the crop fails in the neighborhood of Saint Louis, to fill their houses at a cost of \$3 to \$3 50 per ton. They have to pay from \$5 to \$8 when they buy from regular dealers during the summer. It is estimated that about half of the ice required for Saint Louis and the southern markets is now harvested on the Illinois river.

The ice-houses of the upper Mississippi are as a rule smaller than those in the east. They are, however, constructed on the same principle. Within four or five years they have been supplied quite generally with endless-chain elevators and all the modern appliances for saving labor and expediting the harvest. One feature of western work is the mooring of a large number of model barges near the ice-houses before the ice forms, and the loading them with ice after the houses are full. These barges are often old steamboat hulls, from which the machinery has been removed. The others are regular freighting barges. They have cargo-houses on deck, and they carry from 400 to 900 tons of ice each; a few of large size carry from 1,200 to 1,500 tons each. About 100 are employed in the ice business of Saint Louis. It is not unusual to load from 60 to 75 of these boats with about 60,000 tons of ice in all in the course of the winter. This is especially a popular practice on the Illinois river. When the rivers open, either through some unexpected thaw or in the spring time, the barges are towed to the city and their cargoes are discharged. The shipments to the lower river are always by this class of boats.

The thickness of the ice varies with the locality and the season. Around Saint Louis the usual thickness is from 8 to 10 inches. On the rivers in Illinois ice of a thickness of from 10 to 15 inches is obtained. In Minnesota and Wisconsin a supply of hard clear ice can be obtained from 16 to 24 inches thick.

One of the growing points in the Saint Louis district is Quincy, Illinois. This city has long supplied the market with a good deal of excellent ice cut from a bay three miles long and a quarter mile wide. Her nearness to market and comparative security against the disastrous floods which destroy the ice-houses at other points from time to time are advantages which have had great influence on her trade. She has now a storage capacity of 160,000 tons, and her dealers sell to the lower market direct without the intervention of the Saint Louis companies. They ship by barge and railway-car to the most distant points. Some of her trade is by rail with Texas. The ice is sent in refrigerator cars carrying 12 tons each. It is from 5 to 7 days en route. Upon its arrival it is unloaded into 100-ton ice-houses, the walls open at the top, and it is then covered with sawdust. Two other points of great activity are Hannibal, Missouri, where about 75,000 tons are cut yearly, whence shipments are made to Texas direct, as well as to other southern states; and Cedar Rapids, Iowa, where as much as 100,000 tons is sometimes cut. The other western towns tributary to the river market cut from 10,000 to 45,000 tons each.

In Minnesota and Wisconsin a hard clear article is harvested, ranging from 16 to 24 inches.

The returns of the dealers indicate an average waste of 20 per cent. in shipping ice to southern markets. There is from 5 to 10 per cent. waste in bringing ice to the city for local consumption, and 20 per cent. in distribution.

Experiments have been made both by brewers and by regular dealers in Saint Louis during the last 10 years in the manufacture of artificial ice. On the whole, results have not been satisfactory. Natural ice is still preferred as cheaper and better.

THE GULF STATES.

The memoranda in the first part of this report on the birth of the ice business in the United States show that a large part of the trade of Frederic Tudor, of Boston, was with the southern states. In 1817, he sent a vessel to Savannah; in 1818, one to Charleston; and in 1820, a first shipment was made to New Orleans. From that beginning, a trade of from 75,000 to 100,000 tons of ice yearly has grown up from Boston, the Kennebec river, and other localities in Maine, and from New York and Philadelphia. The principal destinations of cargoes from the north have been Savannah and New Orleans. Both cities are large consumers, and in addition thereto, Savannah has been the gateway through which ice has been sent by water to Augusta, and by rail to Macon, Atlanta, and other interior towns. Other ports to which northern shipments have been made are Wilmington, North Carolina, Charleston, South Carolina, Jacksonville, Appalachicola, and Pensacola, Florida, Mobile, Alabama, and Galveston, Texas. A waste of from 25 to 30 per cent. has attended these shipments. The cost of freight has been from \$1 50 to \$2 50 per ton. After the landing of the cargo, a further waste of not less than 25 per cent., and often as much as 40 per cent., has been met with in distribution. The wholesale price of northern ice has, as a consequence, been not less than \$10 per ton in the coast cities, and has often risen to \$30 per ton. The regular charge to consumers has been \$20 per ton; but in epidemic years on the coast, and in inland towns, often as much as \$60 and \$75. The high prices made ice, for fifty years, a luxury to be indulged in only by the prosperous. The masses in the cities were unable to afford the costly pleasure of its consumption. Ice does not form naturally in the south; and the entire lack of a local supply has at times been felt severely, especially in the years of the prevalence of yellow fever, when quarantine regulations cut her cities off from communication with the rest of the country.

For fifteen years efforts have been made to reduce the cost of ice in the south and render her, in a measure, independent of outside sources of supply. Tennessee and Georgia have imported extensively from the Ohio River region by rail. The lower Mississippi has bought in the Saint Louis region; and Texas has imported by rail. Enterprise has, however, been chiefly in the direction of the manufacture of artificial ice. The inventors of ice-

machines have found the south their most profitable field of operations. In order to introduce their patents they have followed the practice of selecting some inland town of considerable population, in which their product would not come into too direct competition with northern ice. They have set up their machines, retaining a part interest in them, and begun the process of manufacture, supplying, so far as possible, the local demand, and, in many cases, selling their surplus to other communities easily accessible by rail or by water. In other places the business has been undertaken by local capital. There is scarcely a large town in the south in which the experiment of manufacture has not been tried with more or less success. In Atlanta six machines, producing about 50 tons of ice a day in the aggregate, have now been in operation for several years. In Augusta there have been three, producing about 20 tons a day. Austin has had two companies, which have been making, jointly, 10 tons a day, in blocks of from 25 to 60 pounds each, the larger blocks being for the trade with surrounding towns and villages. Ice-machines are especially numerous in Texas. New Orleans now has three factories for making artificial ice. The cost of production has been reduced to about \$5 per ton in most places, which is a trifle below the rate at which ice can be delivered in Tennessee and Georgia by rail from the Ohio river, and considerably below the cost of the article from Maine, delivered in inland southern towns. With this advantage in its favor, the business of manufacture is steadily growing at all points at a distance from the sea-coast. The prospect is fair that they will soon be independent of outside sources of supply, although it will be many years before the cost to small consumers will fall anywhere nearly as low as in the north. On the sea-coast northern ice still has the preference. It can be landed more cheaply than the local article can be made; and by purchasing in Maine or Massachusetts the dealers avoid the heavy risks of experimenting with expensive plant and imperfect methods of manufacture. The solitary exception is the city of New Orleans, which, though still buying northern ice, is nevertheless manufacturing on an extensive scale.

The principal drawbacks to the making of artificial ice in the south have been the imperfection of the machines, resulting in a contamination of their product by the escape of the ammonia, ether, or other refrigerating fluid; the difficulty of securing in a hot climate the efficiency manifested by the machines in a cooler region; and the heavy expense of operation. The failures have been as numerous as the successes. The genius and energy of the inventors have triumphed, however, at last. Leakages have been stopped, expenses have been reduced, and practical results have been obtained. The machines most preferred at present are the ones using ammonia as the means of refrigeration.

In New Orleans, according to the report of Chief Special Agent E. A. Deslonde, the quantity of ice actually consumed in 1880 was about 32,000 tons, requiring a supply amounting to 55,000 tons. The consumption has at times been as high as 50,000 tons, requiring a supply of 91,000 tons. These figures were arrived at both by a study of the returns of the ice companies and by a careful inquiry among 210 consumers (families, hotels, saloons, fishermen, etc.). The business has grown since 1880, and may be considered at the present time as large as the highest figures above given. The artificial product is made by two corporations, the Louisiana Ice Manufacturing company and the New Orleans Ice Manufacturing company, both having large capital, with extensive establishments, machinery, and appliances. The full capacity of production of these concerns has not yet been fully demonstrated. The Louisiana company was formed in 1868 and was the pioneer in the business. At the outset of its career, after lavish expenditure on costly, but imperfect machinery and appliances, its managers found the result of their operations far from satisfactory. Their losses were disastrous. It has only been within the past few years, and after the adoption of new methods and many mechanical improvements, that they have succeeded in making blocks of 100 pounds, in quality and appearance equal to the best river ice secured in the north. Their earlier product was in 20-pound blocks, and was often damaged by an ammoniacal taste and many impurities. Their final success dissipated the prejudice against the use of artificial ice and enabled them to enlarge their plant by the construction of a second factory. The company now has 10 Carré machines, 6 in one factory and 4 in the other, with a total capacity of 45,000 tons a year. The New Orleans company was started in 1880. It employs the California invention of J. M. Beath, which was first put into operation in Los Angeles and San Francisco and afterwards in Atlanta, Chattanooga, and Nashville. The machine uses liquid anhydrous ammonia as the refrigerating fluid, and differs from the Carré machine by making ice not in blocks in pans, but by freezing it into solid walls on the surface of a network of iron pipes, the water descending upon the pipes in a shower. The product of the factory in 1880 did not exceed 1,800 tons, but with the completion of its plant a capacity of 30 tons per day has been attained. The operations of these two companies have materially reduced the price of ice to consumers in the city. The wholesale price has often ranged as high as \$30 a ton; it has been lowered to \$10 by the competition between the manufacturers and the importers. To small consumers the price has always been extravagantly high. The distribution has been made by small drivers and dealers who have not practiced weighing the ice, but who have been accustomed to saw or split off pieces by guessing, and call them of such and such a weight. From information obtained through many sources, it appears that it has not been unusual to charge customers 2 cents a pound, or \$40 a ton, and in epidemic years or periods of ice famine, from 3 to 5 cents a pound, or from \$60 to \$100 per ton. Local production has reduced these retail rates to an average of 1 cent per pound, or \$20 per ton. Lowering of cost to the consumer has had the effect, as might be expected, of increasing the consumption of ice since 1880. Families, hotels, and saloons are buying in large quantity; and the traffic in fish,

oysters, fresh meats, and vegetables during the summer months has been greatly promoted. It is confidently anticipated by both the manufacturers and the importers that the business will hereafter expand rapidly, year by year. With prices as low as in the north the consumption of New Orleans would probably exceed 250,000 tons yearly.

Distribution in New Orleans is not yet systematically done. Sales are generally for cash. Few accounts are kept. The ice is sold to wagon-peddlers and hucksters, of whom there are about 100 owning carts and horses of an average value of \$158 each, and these peddlers sell from the wagon with a crude method, which usually, but not always, leaves them a little more money at the end of the day than they had at the beginning.

ON THE PACIFIC COAST.

The coolness of the summers along the Pacific coast obviate the necessity for much ice cutting. The preservation of fish and meats calls for only a small amount of ice. The hotels and barrooms, and the more luxurious families are the principal consumers. San Francisco is the principal market, but the consumption does not exceed from 20,000 to 40,000 tons a year at present. The first ice was brought from Sitka, in Alaska, by trading vessels. A company was formed to deal in the commodity while that region was still under Russian control. The government made a concession to the company, and small amounts of ice were brought to the market and sold there at retail for 5 and 6 cents a pound, that is to say, from \$100 to \$120 per ton. The Pacific railroad opened up new and nearer sources of supply in the Sierra Nevada mountains, and the price was cut down to about \$40 per ton at retail. Good ice, from 10 to 24 inches in thickness, is obtained in the mountains in abundance. At Nevada City it forms 4 feet thick. The high freights retarded the business, however, they being about \$100 per car load of 10 or 12 tons. A reduction of this rate to \$70 per car resulted in the abandonment of the Alaska trade. The high prices led to the introduction of ice machines in all the principal cities of California, especially in San Francisco, Sacramento, and Los Angeles, and for a number of years a lively war was carried on between the mountain companies and the machine companies. A compromise was finally effected, by which the former were to load ice on the cars in the mountains at \$3 per ton, \$7 per ton being added for freight, and the machine firms were to sell at the wholesale price of \$10 per ton. A new competition sprang up, however, with new and rival companies of both classes, and the retail prices of ice have been cut down, within two or three years, to \$10 and \$15 per ton. Machines are being constantly introduced in every part of the state subject to warm summers. Low prices seem hereafter assured. Farther up the coast, in Oregon and in Washington, the need of ice is seldom felt. There is plenty of the commodity on the higher lands, and when needed it can be harvested in abundance.

Statistics of consumption of ice in twenty principal cities of the United States, from October 1, 1879, to September 30, 1880.

Distribution, etc.	Amount.	Remarks.	Distribution, etc.	Amount.	Remarks.
BOSTON, MASSACHUSETTS.			NEW YORK, NEW YORK.		
Harvested	<i>Tons.</i> 660,000	There are 14 companies, with a capital of \$100,000, employing 308 men. Wages paid during the year, \$265,000. Value of ice sold and consumed, \$1,025,000. Of the amount shipped to other places 100,000 tons is not included in distribution by month, having been shipped at irregular intervals. Wholesale prices during 1880, from \$2 to \$8 per ton; retail, by the 100 pounds, 15 and 25 cents in the winter and spring; 40 and 60 cents in the summer.	Harvested	<i>Tons.</i> 1,885,000	There are 11 companies, with a capital of \$633,000, employing 2,502 men. Wages paid during the year, \$1,183,480. Value of ice sold and consumed, \$3,190,000. Sales for shipment were mainly for refrigeration of meats, etc., on steam-vessels. Wholesale prices in 1880, from \$3 to \$7, and up to \$10 per ton; in small lots, during June and July, prices ran up to \$20 in some cases; retail prices, 20 to 30 cents per 100 pounds until the end of February, then up to 50, 60, and 75 cents in June, July, and August; one company charged as high as \$1 per 100 pounds.
Sold to customers	381,588		Sold to customers	950,559	
To brewers	13,317		To brewers	185,247	
To butchers and meat-packers	45,702		To butchers and meat-packers	110,030	
To butter dealers	4,375		To butter dealers	31,275	
To ships and shipped to other places	173,575		To ships and shipped to other places	38,350	
To private families	127,471		To private families	425,887	
To miscellaneous consumers	17,148		To miscellaneous consumers	190,704	
Consumed during—			Consumed during—		
October	10,653		October	78,159	
November	9,522	November	36,300		
December	5,212	December	28,403		
January	4,020	January	31,077		
February	4,030	February	38,620		
March	6,004	March	54,043		
April	8,365	April	70,532		
May	23,075	May	92,313		
June	24,085	June	122,500		
July	40,508	July	107,500		
August	37,422	August	124,530		
September	20,470	September	100,321		
PROVIDENCE, RHODE ISLAND.			JERSEY CITY, NEW JERSEY.		
Harvested	40,070	There are 0 companies, with a capital of \$31,500, employing 100 men. Wages paid during the year, \$41,700. Value of ice sold and consumed, \$320,000. In 1880, wholesale prices ranged from \$5 50 to \$10 per ton; retail prices, 25 cents to the end of February, 50 cents in March and April, 60 cents in the summer.	Harvested	51,580	There are 4 companies, with a capital of \$40,000, employing 100 men. Wages paid during the year, \$31,500. Value of ice sold and consumed, \$270,000. To dealers and large consumers, wholesale prices from \$8 to \$8 in the summer; butchers, hotels, and families were supplied at from 50 to 75 cents per 100 pounds.
Sold to customers	32,800		Sold to customers	33,552	
To brewers	300		To brewers	2,009	
To butchers and meat-packers	8,100		To butchers and meat-packers	3,811	
To butter dealers	5,850		To butter dealers	300	
To ships and shipped to other places	150		To ships and shipped to other places	4,472	
To private families	10,200		To private families	14,091	
To miscellaneous consumers	2,200		To miscellaneous consumers	7,075	
Consumed during—			Consumed during—		
October	2,082		October	4,079	
November	2,230	November	1,301		
December	1,480	December	1,505		
January	1,400	January	762		
February	1,491	February	402		
March	1,400	March	770		
April	1,402	April	1,672		
May	2,240	May	3,060		
June	2,082	June	4,840		
July	5,062	July	5,315		
August	5,064	August	4,386		
September	2,082	September	4,841		
BROOKLYN, NEW YORK.			NEWARK, NEW JERSEY.		
Harvested	528,000	There are 4 companies, with a capital of \$100,000, employing 661 men. Wages paid during the year, \$320,210. Value of ice sold and consumed, \$1,000,000. Wholesale prices to wagons at the ice depots and to large consumers, from \$3 to \$9; average retail price in summer, 55 cents for 100 pounds.	Harvested	80,300	There are 5 companies, with a capital of \$74,040, employing 85 men. Wages paid during the year, \$43,975. Value of ice sold and consumed, \$360,000. Wholesale prices in 1880, from \$3 50 to \$8; retail price to families from 50 to 70 cents per 100 pounds.
Sold to customers	334,536		Sold to customers	52,010	
To brewers	67,510		To brewers	18,200	
To butchers and meat-packers	17,040		To butchers and meat-packers	4,737	
To butter dealers			To butter dealers		
To ships and shipped to other places	7,230		To ships and shipped to other places		
To private families	168,760		To private families	10,003	
To miscellaneous consumers	73,000		To miscellaneous consumers	12,500	
Consumed during—			Consumed during—		
October	24,021		October	2,700	
November	10,061	November	1,072		
December	8,403	December	1,424		
January	10,038	January	1,757		
February	12,531	February	3,001		
March	17,358	March	3,507		
April	20,053	April	2,247		
May	34,091	May	4,448		
June	43,001	June	6,329		
July	61,030	July	8,136		
August	44,103	August	9,167		
September	30,070	September	8,102		

Statistics of consumption of ice in twenty principal cities of the United States, etc.—Continued.

Distribution, etc.	Amount.	Remarks.	Distribution, etc.	Amount.	Remarks.
TROY, NEW YORK.			CLEVELAND, OHIO.		
Harvested	Tons. 52,000	There are 13 companies, with a capital of \$32,900, employing 50 men. Wages paid during the year, \$20,683. Value of ice sold and consumed, \$235,000. About 25,000 tons sold from the houses direct, for shipment and other purposes, at about \$3 50 per ton. Retail prices to families, 10 cents per 100 pounds in winter, and 40 to 50 cents in the summer.	Harvested	Tons. 140,480	There are 28 companies, with a capital of \$167,100, employing 1,014 men. Wages paid during the year, \$70,818. Value of ice sold and consumed, \$320,000. 10 firms of brewers and packers cut and themselves consumed 100,710 tons of ice, valued at \$65,000, which are incorporated above. Wholesale prices, from \$2 to \$9 per ton; retail prices in the summer, from 50 to 60 cents per 100 pounds.
Sold to customers	43,560		Sold to customers	129,785	
To brewers	2,585		To brewers	21,842	
To butchers and meat-packers	2,000		To butchers and meat-packers	87,350	
To butter dealers	45		To butter dealers	150	
To ships and shipped to other places	10,000		To ships and shipped to other places	910	
To private families	18,350		To private families	18,715	
To miscellaneous consumers	80		To miscellaneous consumers	788	
Consumed during—			Consumed during—		
October	1,640		October	5,220	
November	1,453		November	3,793	
December	1,001	December	2,221		
January	850	January	2,220		
February	850	February	2,099		
March	898	March	3,952		
April	1,300	April	7,544		
May	2,045	May	15,323		
June	7,025	June	17,698		
July	8,875	July	24,093		
August	9,020	August	23,089		
September	7,543	September	21,718		
ALBANY, NEW YORK.			CINCINNATI, OHIO.		
Harvested	121,500	There are 14 companies, with a capital of \$18,200, employing 117 men. Wages paid during the year, \$29,420. Value of ice sold and consumed, \$190,000. About 22,000 tons sold for shipment to New York for \$3 to \$9 per ton; wholesale rate to the public, the same; retail prices to families, etc., 10 cents to April, and then 40 and 50 cents per 100 pounds.	Harvested	283,000	There are 41 companies, with a capital of \$248,000, employing 907 men. Wages paid during the year, \$65,241. Value of ice sold and consumed, \$1,200,000. 38 firms of brewers and packers cut 45,642 tons of ice for their own consumption, valued at \$68,000, which are incorporated above. Wholesale prices varied from \$2 in the winter to \$9 and \$10 in the summer; retail prices in the winter, 25 to 35 cents per 100 pounds; 50 to 60 cents in the summer.
Sold to customers	90,550		Sold to customers	206,885	
To brewers	12,500		To brewers	47,100	
To butchers and meat-packers	11,250		To butchers and meat-packers	46,040	
To butter dealers	20		To butter dealers	1,025	
To ships and shipped to other places	22,000		To ships and shipped to other places	6,800	
To private families	44,080		To private families	77,429	
To miscellaneous consumers			To miscellaneous consumers	34,500	
Consumed during—			Consumed during—		
October	4,120		October	11,004	
November	2,530		November	9,287	
December	1,470	December	6,132		
January	6,200	January	6,732		
February	2,235	February	7,832		
March	2,000	March	11,087		
April	4,475	April	10,400		
May	5,045	May	20,023		
June	12,050	June	25,494		
July	15,700	July	28,028		
August	18,000	August	33,090		
September	12,005	September	29,301		
BUFFALO, NEW YORK.			CHICAGO, ILLINOIS.		
Harvested	100,000	There are 45 companies, with a capital of \$135,000, employing 208 men. Wages paid during the year, \$76,250. Value of ice sold and consumed, \$925,000. 22 brewers and 14 butchers and meat-packers in Buffalo cut their own ice to the amount of 57,250 tons, at a cost of about \$1 per ton, and this quantity is incorporated in the above statistics at the valuation of \$1 per ton. Wholesale prices, \$2 to \$6 per ton; retail prices, 40, 60, and 60 cents per 100 pounds in the summer months.	Harvested	710,000	There are 53 companies, with a capital of \$303,500, employing 885 men. Wages paid during the year, \$259,815. Value of ice sold and consumed, \$2,400,000. 31 firms of brewers, packers, and brick-makers and others having an independent business of their own cut 103,643 tons of ice either for their own consumption or for the general trade, valued at \$150,000. Wholesale prices varied exceedingly, each firm having its own; they ran from \$1 25 to \$5 per ton, a few sales going higher. Retail prices, 20 cents per 100 pounds in the winter, and from 35 to 50 cents in the summer. One company reported retail sales at 75 cents per 100 pounds.
Sold to customers	95,750		Sold to customers	576,087	
To brewers	47,005		To brewers	73,238	
To butchers and meat-packers	22,045		To butchers and meat-packers	273,770	
To butter dealers			To butter dealers	4,110	
To ships and shipped to other places	800		To ships and shipped to other places	17,521	
To private families	23,200		To private families	188,219	
To miscellaneous consumers	1,500		To miscellaneous consumers	19,820	
Consumed during—			Consumed during—		
October	8,377		October	53,100	
November	5,509		November	23,045	
December	2,980	December	29,534		
January	2,527	January	31,408		
February	2,528	February	18,002		
March	3,493	March	18,128		
April	6,007	April	32,014		
May	8,420	May	51,023		
June	12,402	June	67,551		
July	10,334	July	93,079		
August	14,843	August	88,035		
September	12,270	September	70,451		

Statistics of consumption of ice in twenty principal cities of the United States, etc.—Continued.

Distribution, etc.	Amount.	Remarks.	Distribution, etc.	Amount.	Remarks.
DETROIT, MICHIGAN.			SAINT LOUIS, MISSOURI.		
Harvested	<i>Tons.</i> 165,850	There are 21 companies, with a capital of \$50,050, employing 228 men. Wages paid during the year, \$32,075. Value of ice sold and consumed, \$995,000. 15 firms of brewers and packers consumed 32,050 tons of ice, which was cut for them by contract at an average price of \$1.50 per ton stored in the house. Prices to large consumers, \$8 and \$10 per ton the season through; to families, about 60 cents per 100 pounds.	Harvested	<i>Tons.</i> 270,000	There are 33 companies, with a capital of \$650,400, employing 535 men. Wages paid during the year, \$153,007. Value of ice sold and consumed, \$1,460,000. Brewers purchased largely of regular dealers at \$5 and \$6 per ton. Wholesale prices were \$3.50 and \$4 in the winter, rising to \$8 and \$9 in June, and declining to \$7 and \$8 for the rest of the summer; retail prices, 40 cents per 100 pounds in the winter, and from 50 to 75 cents in summer.
Sold to customers	138,450		Sold to customers	205,041	
To brewers	29,550		To brewers	92,774	
To butchers and meat-packers	13,500		To butchers and meat-packers	6,210	
To butter dealers .....	.....		To butter dealers	500
To ships and shipped to other places	5,000		To ships and shipped to other places	6,577	
To private families	90,400		To private families	90,074	
To miscellaneous consumers .....	.....		To miscellaneous consumers	500
Consumed during—	.....		Consumed during—	.....
October	3,635		October	5,020	
November	2,100		November	3,069	
December	1,135	December	2,010		
January	310	January	9,054		
February	675	February	21,133		
March	880	March	26,370		
April	1,880	April	23,665		
May	4,470	May	17,800		
June	20,050	June	23,272		
July	44,540	July	28,841		
August	42,500	August	27,070		
September	10,815	September	18,370		
INDIANAPOLIS, INDIANA.			PHILADELPHIA, PENNSYLVANIA.		
Harvested	70,500	There are 11 companies, with a capital of \$13,100, employing 148 men. Wages paid during the year, \$22,864. Value of ice sold and consumed, \$625,000. Retail prices, 50, 60, and 70 cents per 100 pounds.	Harvested	700,000	There are 81 companies, with a capital of \$330,220, employing 1,278 men. Wages paid during the year, \$304,148. Value of ice sold and consumed, \$1,950,000. Seventy firms of brewers, packers, and provision dealers cut their own ice, amounting to 56,270 tons, worth \$62,000. Wholesale prices rose from \$2.25 per ton in the winter to \$5 and \$6 in the summer; retail prices, 20 cents per 100 pounds in the early part of the year, 40 cents in summer.
Sold to customers	61,246		Sold to customers	370,890	
To brewers	12,740		To brewers	92,371	
To butchers and meat-packers	36,650		To butchers and meat-packers	30,537	
To butter dealers	600		To butter dealers	6,813	
To ships and shipped to other places	1,150		To ships and shipped to other places	40,783	
To private families	8,900		To private families	195,855	
To miscellaneous consumers	1,200		To miscellaneous consumers	21,311	
Consumed during—	.....		Consumed during—	.....
October	4,208		October	28,627	
November	1,820		November	13,740	
December	814	December	9,013		
January	770	January	8,536		
February	1,433	February	13,747		
March	1,152	March	19,512		
April	3,124	April	13,960		
May	5,348	May	31,075		
June	9,159	June	43,207		
July	12,480	July	76,068		
August	19,055	August	65,400		
September	7,865	September	62,770		
LOUISVILLE, KENTUCKY.			BALTIMORE, MARYLAND.		
Harvested	43,000	There are 15 companies, with a capital of \$38,000, employing 103 men. Wages paid during the year, \$28,837. Value of ice sold and consumed, \$330,000. Ice at Louisville is about wholly imported from the north and sells high. Brewers pay \$5 and \$6 at wholesale. Retail prices in 1880, 30 to 75 cents per 100 pounds in the winter, and from 75 cents to \$1.50 in the summer months. Six of the above concerns are brewers and packers who contract for their supply.	Harvested	105,000	There are 7 companies, with a capital of \$104,000, employing 354 men. Wages paid during the year, \$102,000. Value of ice sold and consumed, \$1,200,000. Retail prices, 20 cents per 100 pounds until April, then a gradual rise to 50 cents in the hot months; 75 cents in some cases in August and September. Wholesale price, about \$8.
Sold to customers	35,100		Sold to customers	124,000	
To brewers	20,844		To brewers	20,103	
To butchers and meat-packers	2,500		To butchers and meat-packers	17,579	
To butter dealers	220		To butter dealers	647	
To ships and shipped to other places	470		To ships and shipped to other places	4,863	
To private families	10,040		To private families	61,274	
To miscellaneous consumers	1,020		To miscellaneous consumers	10,030	
Consumed during—	.....		Consumed during—	.....
October	3,164		October	12,980	
November	1,147		November	4,533	
December	752	December	3,368		
January	1,401	January	3,302		
February	1,142	February	3,845		
March	1,044	March	8,839		
April	2,857	April	9,473		
May	3,475	May	11,511		
June	4,087	June	15,376		
July	5,097	July	21,036		
August	4,850	August	17,225		
September	3,024	September	12,581		

Statistics of consumption of ice in twenty principal cities of the United States, etc.—Continued.

Distribution, etc.	Amount.	Remarks.	Distribution, etc.	Amount.	Remarks.
WASHINGTON, DISTRICT OF COLUMBIA.			NEW ORLEANS, LOUISIANA.		
	<i>Tons.</i>			<i>Tons.</i>	
Harvested	75,000	There are 3 companies, with a capital of \$42,300, employing 134 men. Wages paid during the year, \$65,780. Value of ice sold and consumed, \$600,000. Prices, in winter, 75 cents to \$1 per 100 pounds; from April to October, \$1 to \$1 50 per 100 pounds.	Harvested	55,000	There are 4 companies, with a capital of \$587,000, employing 172 men. Wages paid during the year, \$52,000. Value of ice sold and consumed, \$315,000.
Sold to customers.....	53,410		Sold to customers.....	31,530	
To brewers	13,600		To brewers		
To butchers and meat-packers.....	7,700		To butchers and meat-packers.....	8,520	
To butter dealers			To butter dealers		
To ships and shipped to other places.....			To ships and shipped to other places.....	1,118	
To private families	32,185		To private families	21,880	
To miscellaneous consumers.....			To miscellaneous consumers.....		
Consumed during—			Consumed during—		
October	3,400		October.....	2,000	
November	2,435	November	2,000		
December.....	1,732	December.....	2,000		
January	1,200	January	2,000		
February	1,000	February	2,000		
March	2,550	March	2,000		
April	3,465	April	2,030		
May	5,308	May	2,300		
June	0,050	June.....	3,200		
July	8,010	July	4,500		
August.....	0,400	August	4,300		
September.....	7,060	September.....	3,200		

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