THE SALT MANUFACTURE OF MICHIGAN.

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HISTORICAL.

It was known from the earliest settlement in the country, that the Indians formerly supplied themselves with salt from springs existing in the peninsula, and numerous reservations of land supposed to contain the springs were made by the general government, and it is a matter of record that many years before Michigan was organized into a State government, attempts were made to manufacture the article.

By the act of admission of this State into the Union, in 1838, it will be recollected, the State authorities were permitted to select seventy-two sections of salt-spring lands.

A State geologist—the lamented Dr. Douglas Houghton—was appointed at the first meeting of the Legislature thereafter, who, in his report to the Legislature in January, 1838, says he regarded it important that the spring lands be selected for State purposes, at as early a day as possible, and most of his examinations the season previous were devoted to that end. Dr. Houghton's explorations resulted in finding many indications of saline springs, particularly on the Grand and Tittabawassee rivers, in Kent and Saginaw Counties, and also in St. Clair, Macomb, Wayne, and Jackson Counties. The Legislature passed an act for the improvement of the State springs in 1838, and by virtue of his appointment, Dr. Houghton was authorized to make examinations and to institute experiments, which he did on the Grand and Tittabawassee rivers with partial success.

Although public attention was at that time directed to our salt springs, and practical investigations relating to their development were for a time vigorously prosecuted, these experiments failed of complete success, and the subsequent death of Dr. Houghton, by depriving the State of one on

fastened to an ordinary "walking-beam" of wood, driven by an engine of small horse-power.

The beam rises and falls continually over the mouth of the well, the chain which suspends the tool passing over the end of the beam, being so arranged that it can be let out as the hole deepens, at the same time lifting the tool or drill and allowing it to drop with measured stroke on the rock, which is thus gradually drilled out. A workman sits at the mouth of the well, having the pole grasped by his hands, and after every stroke the poles are slightly turned so as to turn the drill which is working on the bottom, thus keeping the well true and circular in shape.

While the well is in process of boring, the tools are frequently removed and the sand pump introduced to remove the loose matter from the bottom of the well, which is done by means of a suction valve. The sand pump removes all the ground rock sand, and takes up at times stones an inch or more in size. In commencing the well, a strong wooden box 8 inches square, made from 2-inch plank, is driven down into the ground, say from 14 to 16 feet. Inside of this, an 8-inch iron tube or casing is put down as fast as the alluvial or drift material overlying the rock formation is broken up by the drill and taken out by the sand pump; this continues until the solid rock is reached.

At this point, considerable care should be taken that the opening into the rock is perfectly round and well finished by the drill; for the casing should be set so firmly in the rock as to prevent any sand or gravel from running in under the tube, and thus getting in on top of the drill and endangering its becoming fastened in the wall.

The rock-drilling now commences and continues to the depth to which it is proposed to sink the well. After drilling is done, the sides of the well are smoothed off with a tool called a reamer.

In most of the salt wells on the Saginaw river an offset is placed in the well at a short distance above the lower sand

instance has been known where parties have suffered much extra expense in not attending to this kind of leakage.

A manufacturer, in starting up his well pump, may also find that he has a short supply of brine, and the brine in the well tube runs down as soon as the pump is stopped. In this case he may have strong suspicions that his well tube is defective, or that the joints are not put together tightly, causing a leakage. To ascertain where this is, the tubing should be lifted out; the lower valve being allowed to remain in. As the tubing is being drawn, the pressure of the column of brine in the tube on the joints or imperfections will show where the leakage is. If the tubing is imperfect, it should be taken out and replaced by perfect tubing. When the leakage is at the joint, a new thread should be cut upon it, or the joint should be screwed together more tightly.

It is very important that the salt manufacturer should ever be on the lookout for these leakages, as they may and do often arise from a jarring of the tubing in running the pump faster than the supply of brine comes to the pumping chamber, causing a vacuum and producing the so-called pounding of a well. The capacity of a well has been very materially affected by such a leakage, increasing the expense of pumping from 50 to 100 per cent.

The supply capacity of a well is also very materially increased by the position of the pumping chamber in the well. In the early history of salt wells in Michigan, the pumping chamber was generally placed a short distance below the offset. More recent tests go to prove that the best location for the pumping chamber is at or very near the point where the largest supply of brine comes into the well, and that point is the lower portion of the sand rock, or within a short distance of the bottom of the well.

In pumping a well, it is also important that the weight of the pumping rods should be evenly counterbalanced by a weight on the other end of the walking-beam; this relieves

WORKS OF THE BUFFALO SALT COMPANY, EAST SAGINAW, MICH.

whom it had relied to give intelligent direction to these enterprises, discouraged in a measure their further prosecution.

Guided, however, by the information thus furnished, other investigators took up the matter, and on a thorough examination of the subject became so fully satisfied of the existence of rich saline waters in our State, that they at once determined to extend their experimental researches still further, and soon demonstrated in the most satisfactory manner the entire correctness of the theory advanced.

Saginaw Valley has the honor of having practically proved the wisdom of our first State geologist, in regard to the saline resources of the State, and demonstrated in a few short years, to an extent hardly to be credited, their unlimited supply, as well as their profitable and beneficial nature. Encouraged by the information furnished by the geological surveys, borings in several localities have been extended to other groups of rocks, much older and lower than the preceding, viz., Onondaga salt group—the representation in this State of the group so called in the State of New York—and though their productiveness is not yet perhaps satisfactorily established, sufficient encouragement has been received to afford reasonable hopes that these rocks may yet yield a supply of salt sufficient to render them a source of profit, thus adding immensely to the saline wealth of the State.

WELL-BORING MACHINERY.

The proper location having been selected for the salt well, a drill house, 16 by 30 feet, with a tower, is erected. This is large enough for a boiler, small portable engine, and a forge for repairing tools and keeping the drill sharp.

The tower or derrick has a height of 50 feet, or is high enough to draw out the drilling poles. The tool with which the boring or drilling is done is a drill, 3 feet long, shaped at one end like a chisel, and made of the best quality of steel.

The drill is screwed into the sinker, which is a round iron bar 40 feet long and 3 inches in diameter and weighing about 2000 pounds.

Attached to the sinkers by strong screws are the "jars," these are about 7 feet long and made of good iron. The "jars" are two slotted links, moving up and down within each other, and are intended to increase the force of the blow of the drill upon the rock by allowing it to fall with a sudden jerk.

The jars are attached by a screw to the drill pole, which is, in turn, connected by a swivel to a chain. The chain is

rock. Below the offset the size of the well is lessened half an inch in diameter.

On this offset is made the so-called rock-packing, the hole being drilled bevelling so as to receive a tightly-fitting iron collar or funnel-shaped piece of metal. A tube corresponding to the size of the upper part of the well is made to rest on this rock-packing as the offset and runs to the top of the well; in this way, all the weak brine from the upper rock and any fresh water that may come into the well above the offset are shut off. Below the offset, the tube continues in reduced size to the locality of the lower sand rock, at which point the pumping chamber containing the pumping valves are placed.

In the early history of the salt-well boring in Michigan, the pressure of the brine in the well tube forced it within 100 feet of the surface. More recently, owing no doubt to the great demand for brine, it does not rise so high. It only requires a small amount of power, after the pumping rods are properly balanced, to lift the brine out of the well into the settling tanks.

PUMPING BRINE.

Often, in starting a new salt well, the brine is weak—that is, shows a small percentage of salt by the salinometer. This arises from the fact that a large quantity of fresh water or weak brine from the upper formations has passed down into the well during the time the well was opened or being tubed. To test this point, and to bring the brine up to the usual strength of salt brines, the pump is put in operation and run for some time. If the brine continues to show an increase of strength on being tested by the salinometer, the pumping is continued until the strength of brine remains permanent at such a percentage as wells of equal depth in the same locality have shown.

If, however, the brine does not increase in strength, there are strong probabilities that there is a leakage of fresh water or weak brine into the well at the offset. This should be remedied at once—the more so if the well is a deep one, such as most of those in the Saginaw Valley are; for in this case the offset in the well is below the so-called gypsum formation, and you are drawing in and mixing with your strong brine a weak brine from these formations, which has a higher percentage of gypsum.

This mixing of the two brines in the well and tubing causes a precipitation or separation of the gypsum upon the pumping rods and in the pumping chamber. If this is not stopped, it will eventually close up the valves, and prevent them from being drawn out of the chamber. More than one

the engine, the only weight to be lifted being the brine.

The stroke of the piston in the pumping chamber should be made as long as possible, and the motion of the engine should not be over 32 revolutions to the minute. In this way, about the entire supply of brine in the well is obtained, without forming a vacuum, thus preventing the pounding of the well and the danger of parting the pumping rods or jarring the tubing loose at the joints, causing leakage.

The capacity of salt wells varies in different localities, from 12 to 20 gallons per minute—the size of the well and the quantity and porosity of the sand rock having much to do in increasing the amount. A good well will fill a cistern 20 x 30 x 6 feet in about 20 hours. A salt well in Saginaw City, owned by Pierson, Wright & Co., produced enough brine during a manufacturing season of eight months to make over 26,000 barrels of salt. At East Tawas, the wells, 3½ inches in diameter, fill a cistern of the above size in about twelve hours. At Port Austin, the well fills a cistern in seventeen hours.

RECEPTION AND SETTLING OF BRINE.

The salt manufacturer having satisfied himself in regard to the quantity and quality of the brine supply, must now be prepared with cisterns to store his brine during the process of settling.

These cisterns or outside settlers were formerly built in size 20 by 30 feet and 6 feet deep, having a capacity of 25,000 gallons. More recently the size of these has been increased to suit the wants of the manufacturer. They are built of sound 2 to 3 inch plank, well and properly keyed together by strong girders, and are also calked to prevent leakage. These cisterns are elevated on piling or framed timbers, high enough to allow the settled brine to flow through pipes to the blocks.

The connections from the cisterns into the pipes are 6 inches above the bottom, the flow of the brine being controlled by gates. The supply pipes from the cisterns are usually made of wooden pump logs having a 3-inch bore.

The brine, as shown by the analyses, contains a small percentage of carbonate of protoxide of iron, held in solution by an excess of carbonic acid.

If the brine was boiled down or evaporated with this iron in, it would give the salt a red color and very materially affect its commercial value.

As soon as the cistern is filled with brine, preparation should be made to settle it. A tight box large enough to hold a barrel or more of water is placed on the top of the

cistern. In this a proper quantity of fresh burnt lime is slacked with fresh water, enough being afterward added to fill the box, so as to make a whitewash or milk of lime. The mixture being a caustic lime, is freely sprinkled over the brine. The brine is then thoroughly "plunged"—that is, it is stirred up until the lime is well mixed with the brine. The caustic mixture of lime having a strong affinity for the carbonic acid extracts the same from the brine, thus releasing the iron which is precipitated with the lime to the bottom of the cistern as an insoluble peroxide of iron. The brine is then allowed to rest for 48 hours, when it is quite clear and ready for the boiling house or block. This process is called "settling," and on the care with which it is conducted depends much of the success in making good salt.

EVAPORATION OF BRINE.

Having made a stock of settled brine, the next process in the manufacture of salt is the evaporation of the brine; and this is effected by three different methods:

- 1st. By the direct application of fire-heat to kettles and pans.
- 2d. By the use of steam, either exhaust steam from saw-mills, or steam generated by flue boilers built expressly for the purpose.
- 3d. By solar evaporation.

EVAPORATION OF BRINE IN KETTLE BLOCKS.

A kettle block for evaporation of brine consists of a wooden building, 140 feet long by 45 to 50 feet wide, with an elevation of 18 feet, so framed as to admit of the steam passing out at the ventilators. In this building are set from fifty to sixty kettles, having each a capacity of 100 to 120 gallons. The kettles are set in two rows over arches running from the mouth or furnace to the chimney. These are called "arches." These arches run close together, with a dividing wall between them; the kettles are set close together in a row, resting on the dividing wall on the one side and on the inside wall on the other.

The fire arch or furnace at the front is 3 feet from the bottom of the kettles; from here the bottom of the arch gradually rises so that under the back kettles the space is only 10 or 12 inches. Here the flue passes into the chimney, which is about 40 to 50 feet high.

Between the arches and the salt bins, which are under the same building, is the sidewalk. On this sidewalk the salt boiler operates in drawing the salt from the kettles into the draining baskets, which, when it is sufficiently drained, are wheeled off to the salt bins on this sidewalk or platform. The bins, which run the entire length of the block, are divided off in sections, and are made with open floors for the proper drainage of the salt.

Through the centre of the block, just on top of the middle wall, two sets of pump logs or pipes are laid—one for fresh water, and one for the settled brine, each of them being supplied with faucets for each kettle.

The kettles, after being well cleansed, are filled with brine, and boiling soon commences after the fire is under good headway. A scum rises to the surface, which is taken off with a skimmer.

Of late years, owing to the dry and light material used for fuel (being the refuse slabs from saw-mills), the first ten or fifteen kettles in the arch are protected from the excessive heat by patent arches, which are built over the fire flue, and directly under the bottom of the kettle. By this arrangement and a narrowing of the flue, the heat is distributed more evenly through the entire arch, and the kettles boil more regularly.

Soon after the brine commences to boil, the crystals of salt commence to form on the top, and then fall to the bottom. When the brine is boiled down to about one-third, the salt is dipped out with a ladle and thrown into a basket, which is placed over one side of the kettle. The salt is allowed to remain in the basket for two or three hours, the bitter water containing the earthy chlorides being thus drained off. Thorough drainage is considered an important point in this mode of manufacture. The balance of the brine or bitter water remaining in the kettle is now bailed out into the drainage trough. The kettle is then rinsed out with fresh water, and again filled up with brine.

The difference of the time in which the front and the back kettles boil down varies from four hours in the front to twelve hours in the back. The kettle blocks are generally run day and night by four men, two boilers and two firemen, taking tours of twelve hours each. The average product of a good kettle block is seventy-five barrels of salt per day of twenty-four hours.

EVAPORATION OF BRINE IN PAN BLOCKS.

Pan blocks are buildings of various dimensions, built to accommodate the size of the pan, settlers, and salt bins.

The pans are made of quarter-inch boiler-plate iron. They vary from 90 to 120 feet in length, being divided into sections of 30 or 40 feet, are 12 to 15 feet wide, and from 10 to 12 inches deep. With some the sides are straight, the salt being raked to the side, lifted out with a shovel, and thrown on the draining boards. In others, the sides are flanged, and the salt is raked directly on to the draining boards.

Pans of the above size rest on three walls as in kettle blocks, the arches running directly under the pan to the chimney at the end. As the firing of these blocks is done mostly with slabs and light fuel, the first 30 or 40 feet are also protected by patent arches thrown across the flues, thus dividing the heat more generally throughout the block.

The brine boils very rapidly in these blocks, and as the salt makes fast, it requires much care and attention on the part of the workmen to keep the salt from baking on the bottom of the pan; this is prevented by raking out the salt almost as fast as it makes.

Improvements in heating pan blocks have been made of late years in those localities where the price of fuel is a consideration. A pan block of an improved plan for boiling the brine has been erected by Messrs. Ayres & Co., of Port Austin, Huron County.

The block is 120 feet long, 43 wide, outside post 10 feet high, the centre post 18 feet high—almost too high to carry off the steam in winter. The length was also calculated for four pans. Three pans only were put on, being each 30 feet long and 16 feet wide on bottom, sides flanging and bolted to the draining boards.

The pans rest on seven walls, which are so arranged that they make two fire flues in the centre and two return flues on the sides.

The centre and outside walls run the entire length and width of the pan. All the walls are a foot wide at the top. The two fire flues which are under the middle of the pan on both sides of the centre wall are 2½ feet wide. Height of grate to pan, 3½ feet. The return flues are next to the outside walls, under the sides of the pan, and are 2 feet wide. This gives a heating surface of 180 feet in length on both

sides of the middle wall. The outside flues run into the chimney, which is placed at one side of the front of the block—the space under the pan being reduced to one foot.

The advantage of this arrangement of the flues is that, as the brine boils freely over the fire flues, the salt, as it makes, is thrown to the cool side of the pan, and therefore it is not so liable to bake to the bottom of the pan before it is raked out. Another advantage is in the economy of the heating surface, the entire amount being well used up before it gets to the chimney. This is shown in the amount of salt made—Ayres and Co. reporting the making of 140 barrels of salt with 13 cords of hemlock wood in a day of 24 hours.

The brine for pan blocks is settled cold in the outside cisterns, and in most instances is brought to saturation by the inside steam settlers. The salt, as it makes in the pan, is drawn out by rakes upon the draining boards, where it remains for a time, when it is shovelled into barrows and taken to the store bins for further drainage.

It is very desirable that the draining boards should be so arranged in pan blocks that the workmen should not be compelled to walk over them in the operation of drawing or wheeling off the salt.

EVAPORATION OF BRINE BY STEAM.

The evaporation of salt brine by the steam process is now producing the largest portion of salt made in Michigan.

In describing the arrangements of a steam salt block and the accompanying process, we have selected the steam salt block, drill house, cisterns, and saw mills of the Buffalo Salt Company, managed by Sears & Holland, of East Saginaw, and represented in the accompanying view.

This steam salt block is 140 feet long, 122 feet wide, and has an elevation of 52 feet to the top of the ventilator. Height of ventilator, 16 feet. Included, therefore, in the above space are the inside settlers, grainers, salt bins, and packing room.

The inside steam settlers are 136 feet long, 9 feet wide, and 6 feet deep, made of 4-in. plank, well keyed together, and tightly calked.

This block is supplied with seven grainers, 136 feet long, 7½ feet wide, and 16 inches deep.

Over each drainer are the draining boards running the entire length. Passing through each settler and grainer, and near the bottom, are 4-in. galvanized tubing, four or five in number, depending on the size of the grainer, through which exhaust or live steam is forced.

In the steam as in the kettle process, the brine is first pumped into the outside settlers, where it is partially settled. It is then drawn into the inside steam settlers, where it is heated up by the steam pipes and brought to saturation—that is, a point just preceding the formation of salt crystals. It is allowed to remain until all sediment of iron has fallen to the bottom, by which time it becomes as clear as crystal.

The brine is now ready to be drawn into the grainers, which are filled to about two thirds of their capacity, or nearly full. As the settled brine comes into the grainers quite warm and full saturated, it soon commences to make salt, which forms on the surface of the brine, and then falls to the bottom of the grainers, when a new lot of crystals are formed, to fall in the same way. The brine is also occasionally stirred so as to make the crystals fine. Thus the evaporation continues for twenty-four hours, the temperature being kept at 170° to 175° of Fahrenheit. The brine being sufficiently evaporated by the time, the workmen commence the "lifting." This is done by first washing the salt in the brine that is left in the grainers, and then taking it out with shovels and throwing it on the draining boards, where it remains a number of hours for drainage.

A large "lift" or "draw" fills the boards with salt, and it is a beautiful sight to see the salt as it comes white and sparkling from the brine. The salt should remain on the draining boards to drain thoroughly, twenty-four hours, if possible, before going to the bins. It lies in the bins two weeks to complete the drainage, when it is ready for inspection and barrelling for shipment.

SOLAR EVAPORATION OF BRINE.

The first preparation for solar evaporation is to have a series of covers or wooden vats. The covers are rectangular in shape, being 16 by 18 feet and from 6 to 8 inches deep. They are raised on wooden supports, 2 to 3 feet from the ground, and are arranged in sets or strings. Each cover has a movable roof, which can be run on or off to protect or expose the brine, according to the weather. At the end of the string of graining covers, somewhat higher and deeper, are the "strings" of settling covers into which the brine is led from the store reservoirs or cisterns. No lime is used in settling the brine in this process; for in these deep rooms, the brine absorbs a portion of oxygen from the air, by which means the carbonate of iron, which is dissolved in the recent brine, is converted into an insoluble peroxide of iron. In Syracuse, a second series of covers are used to get rid of the gypsum, which separates or is deposited in the form of a crystal. As the quantity of gypsum is very small in the Saginaw brines, these rooms are now dispensed with.

As soon as there is a show of salt crystals, the first stage of the process is accomplished, and the saturated brine known as salt pickle is ready for the last stage. It is then drawn into the salt room or graining vats, in which the salt soon commences to crystallize on the bottom of the covers.

"One of the conditions required for the production of a good, large-grained solar salt, which is most esteemed in the market, is that the bottom in the covers in the salt room should be as smooth as possible, rough surfaces favoring the deposition of numerous small crystals. It is also necessary to have the salt covers supplied with a sufficient supply of good pickle, so that the salt already deposited may always be covered. An exposure of the salt uncovered to the air favors the formation of new small crystals, and the addition of an unfinished or not sufficiently concentrated pickle produces the same effect. It is also important that the waste or exhausted pickle from which the greater part of the salt has crystallized should be discharged from time to time, as its presence not only impairs the quality, but diminishes the quantity of the salt deposited."

The time required for the evaporation of sufficient pickle to make a crop of salt depends largely upon the weather, dry and clear weather, of course, being most favorable; six weeks to two months is the usual time. Three crops of salt a season are gathered: the first about the middle of July, the second in the early part of September, and the third at the end of October. The second crop is generally the best, as it is coarser than the others.

The crop of solar salt is first gathered by loosening it from the bottom of the "covers" with a rake or spud. It is then washed in the pickle that is still left in the cover, and "gathered" to the street gunwale. Here it is shoveled into drain-

ing tubs, to remain a short time before being emptied into the salt carts, for removal to the salt bins for further drainage.

TREATMENT OF CRUDE PRODUCT.

The legal time, fourteen days, required for drainage having passed, the bins are opened and the salt is packed in barrels holding five bushels, or 280 lbs.—each barrel being branded with the name of the firm or person manufacturing the same.

GRADES AND QUALITY OF MICHIGAN SALT.

The salt product has been divided by the State Inspector into the following grades;

Fine.—In barrels, 280 lbs., suitable for general use for all family purposes.

Packers.—In barrels, 280 lbs., suitable for packing and bulking meat and fish. One of the best and purest grades of salt, and branded, when coarse, C Packers C.

Solar.—In barrels, 280 lbs.; when screened, branded C Solar C for coarse, and F Solar F for finer grades. Solar salt suitable for bulking meats.

Second Quality.—All salt intended for No. 1 of any of the above grades, when for any cause it is condemned by the Inspector, is branded Second Quality and sold as such. This salt is good for salting stock, hay, hides, etc.

ANALYSIS OF SALT.

Experience proves that the best quality of salt can be made from Michigan brines, and that a great preponderance of the salt sold in the market has been found as pure and as efficient an antiseptic as any mined or manufactured elsewhere, either in our own or foreign countries.

The following are analyses of various grades of Michigan salt:

Kettle Salt made by the East Saginaw Salt Company, East Saginaw, Michigan. Analyzed by Dr. C. A. Goesmann.

Sulphate of lime.....	0.3165
Calcium.....	0.3564
Chloride of magnesium.....	0.1408
Moisture.....	3.3441
Chloride of sodium (salt).....	95.8422
	100.0000

Pan Salt made by Taylor & Co, Zilwaukee. Analyzed by Dr. H. C. Hahn:

Sulphate of lime.....	0.088
Chloride of calcium.....	0.737
" magnesium.....	0.445
" sodium (salt).....	98.730
	100.000

Steam Salt made by New York and Michigan Salt Company, at Zilwaukee. Analyzed by Dr. H. C. Hahn:

Sulphate of lime.....	0.363
Chloride of calcium.....	0.699
" magnesium.....	0.313
Moisture.....	3.308
Chloride of sodium (salt).....	95.327
	100.000

Solar Salt made by New York and Michigan Salt Company, at Zilwaukee. Analyzed by Dr. H. C. Hahn:

Sulphate of lime.....	0.173
Chloride of calcium.....	0.743
" magnesium.....	0.417
Moisture.....	2.197
Chloride of sodium (salt).....	96.470
	100.000

Average analysis of common salt, made by Dr. C. A. Goesmann, of Syracuse salt.

Sulphate of lime.....	1.2550
Chloride of calcium.....	0.1550
" magnesium.....	0.1869
Moisture.....	3.0000
Chloride of sodium (salt).....	95.4531
	100.0000

The amount of salt made in Michigan by the different processes for the year 1875, was as follows:

Kettle salt.....	117,000 bbls.
Pan ".....	199,100 "
Steam ".....	741,439 "
Solar ".....	24,336 "

Total..... 1,081,865 bbls.

FUEL.

The fuel used in kettle blocks is cord wood, mixed soft and hard, refuse slabs, and sawdust from sawmills. Mixed wood now costs \$1.25 per cord, delivered at block. Slabs cost 45 to 50 cents per cord at the mills.

A kettle block will consume 10 cords of mixed wood in 24 hours, or 16 cords of slabs in the same time.

Pan blocks on the Saginaw River are run almost entirely with slabs and sawdust from the sawmills. On the lake shore, mixed cord wood is the fuel used. A pan block 90 feet long and 60 feet wide, as above described, will use 13 cords of mixed wood in 24 hours, making 140 barrels of fine salt.

Steam blocks are mostly heated during the day with the exhaust from the sawmills. This is the steam that has been made in the mill boilers. Having performed the work of running the mill engines, it is then exhausted into the pipes connected with the salt block, which carry it through the settlers and graining pipes, and causes the evaporation of the brine. If the mill does not run at night, the boilers are connected directly with the steam pipes in the salt block, and live steam is used, the fuel being the sawdust left from running the mill in the daytime.

BARRELS, MATERIAL, AND COST.

The salt barrels of Michigan are now mostly made of pine staves and heading. In some localities elm staves and ash heading are used. Most of the pine staves are made of the refuse lumber from the sawmills. The elm stave is mostly made from stave bolts cut for that purpose.

There were manufactured into salt barrels, on the Saginaw River, last year, staves, heading, and hoops as follows:

Staves.....	16,195,480
Heading.....	6,138,000
Hoops.....	9,872,000

The barrels are mostly made by hand in cooper shops connected with the salt blocks. The average cost of salt barrels is from 28 to 30 cents each. The Rules and Regulations on Cooperage are as follows:

COOPERAGE

(Regulations in Regard to Barrels.)

All staves must be of such length that when the barrel is finished it shall not be less than 30½ inches, or more than 31½ inches long. Soft-wood staves, whether rove or cut, to be ½ an inch thick. Hard-wood staves ⅞ of an inch thick after seasoning. Staves not more than 4 inches wide, of sound timber, and properly jointed.

Heading must be ¾ of an inch thick, of good, sound lumber, free from holes or unsound knots, smooth for branding. No basswood will be allowed for either staves or heading.

Hoops to be 1 inch wide and ½ of an inch thick, 10 to each barrel, shaved and well set.

Barrels for fine salt must have heads 17½ inches in diameter. Chime to be 1 inch from point of croze. Bilge from 21 to 21½ inches in diameter outside.

Solar salt may be packed in barrels not less than 30 inches in length with a head 16½ inches. Barrels charred on the inside must be rejected.

Gould's steam salt block at Carrollton, Saginaw County, Mich.:

Size of block, 177 feet long, 84 feet wide, with an elevation of 26 feet. It has two inside settlers and 5 graining vats.

Size of settlers, 126 feet long, 7½ feet wide, and 6 feet deep.

Size of grainers, 126 feet long, 7 feet 9 inches wide, and 15 inches deep.

Outside settlers, 20 x 30 feet, 6 feet deep, 4 in number.

Bin room for storing 3,000 barrels of salt, unpacked. Shed room for 3,500 barrels of packed salt.

Capacity of block, 126 barrels a day, and has 2 salt wells.

Engine and boilers for two wells.....	\$2,800 00
Drilling salt wells.....	2,200 00
Poles for wells.....	250 00
Tubing ".....	1,400 00
Pump chamber and valves.....	250 00
Salt block, cisterns, settlers, and grainers...	9,600 00
Tubing and connection to salt block.....	3,500 00

Total..... \$20,000 00

COMPANIES, CAPITAL, AMOUNT OF SALT MADE, NUMBER OF KETTLES, GRAINERS, PANS AND COVERS, DEPTH OF WELLS, ETC.

SALT WORKS AND LOCATION.	Salt made in 1875.	Capital Invested.	No. of Blocks.	No. of Grainers.	No. of Kettles.	No. of Pans.	No. of Covers.	No. of Wells.	Depth of Wells.	Mode of Manufacture.
BAY COUNTY.	bbls.								feet.	
John McGraw & Co., Portsmouth...	43,837	\$25,000	1	10					1000	Steam.
M. Watrous & Son, " " " " " "	8,471	20,000	1	4					1000	"
A. Miller, " " " " " "	48,812	60,000	1	1					1050	"
S. McLean & Son, Bay City...	25,135	30,000	1	3					1050	"
S. H. Webster, " " " " " "	25,981	20,000	1	5					1040	"
A. Rust & Co., " " " " " "	27,134	20,000	1	1					1000	Steam and Pan.
Hay, Butman & Co., " " " " " "	New	20,000	1	1					1036	Steam.
N. B. Bradley & Co., " " " " " "	29,264	30,000	1	1					1000	"
William Peter, " " " " " "	17,981	20,000	1	1					1047	"
Eddy, Avery & Co., Bay City...	35,292	35,000	1	3					1050	Steam and Pan.
H. M. Bradley & Co., " " " " " "	21,243	20,000	1	5					1000	Steam.
Pitts & Cranage, " " " " " "	23,292	25,000	1	5					960	"
N. W. Gas and Water Pipe Co., Bay City...	11,660	20,000	1	1					740	Steam and Pan.
Folsom & Arnold, Bay City...	10,135	25,000	1	5					954	Steam.
Chapin & Barber, " " " " " "	31,000	20,000	1	2					938	Steam & Kettles.
Dolson, Chapin & Co., " " " " " "	26,796	25,000	1	5					950	"
John McEwan, " " " " " "	24,529	20,000	1	4					935	Steam.
Atlantic Salt Co., " " " " " "	2,563	58,000	1	1					800	Kettles and Solar.
J. P. Hall, " " " " " "	New	20,000	1	4					823	Steam.
Carner & Co., " " " " " "	15,329	20,000	1	4					735	"
Moore & Smith, Banks, " " " " " "	8,791	20,000	1	3					830	"
Long & Bradford, " " " " " "	5,351	23,000	1	1					800	Pan.
Taylor & Mouthrop, " " " " " "	4,783	25,000	1	1					840	Steam and Pan.
Keystone L. & Salt Co., Banks, " " " " " "	6,196	20,000	1	3					980	Steam.
H. W. Sage & Co., Winona, " " " " " "	11,089	49,000	1	10					1020	"
W. H. Malone, " " " " " "	New	20,000	1	4					1023	"
Ladach Bros., Salzburg, " " " " " "	5,066	20,000	1	1					1000	Kettles.
L. L. Hotchkiss & Co., Salzburg, " " " " " "	8,728	20,000	1	5					1013	Steam.
SAGINAW CO.										
East Sag. Salt Mf. Co., East Saginaw...	30,208	110,000	3	120					806	Kettles and Solar.
A. P. Brewer, " " " " " "	18,960	25,000	1	5					800	Steam.
C. & E. Ten Eyck, " " " " " "	5,705	15,000	1	1					750	Steam and Pan.
Warner & Eastman, " " " " " "	New	20,000	1	1					750	Steam.
Sears & Holland, " " " " " "	22,956	25,000	1	7					762	"
Thompson & Camp, " " " " " "	15,240	20,000	1	4					820	"
Burnham & Still, " " " " " "	8,329	25,000	1	3					820	"
Gebhart & Estabrook, " " " " " "	New	20,000	1	3					825	Kettles.
George Rust & Co., " " " " " "	21,943	20,000	1	6					820	"
Eaton, Potter & Co., " " " " " "	4,515	50,000	1	1					828	Pans.
Bundy & Youmans, " " " " " "	12,575	25,000	1	60					830	Steam & Kettles.
H. Beschke, " " " " " "	New	10,000	1	1					830	"
Sturtevant & Green, Saginaw City...	21,907	80,000	2	5					830	Steam and Pan.
Swift & Lockwood, " " " " " "	15,848	20,000	2	4					802	Kettles.
Barnard & Binder, " " " " " "	26,367	50,000	2	4					800	Pans.
Conrad Kull, " " " " " "	24,031	20,000	1	1					770	Steam.
Geo. F. Williams & Bro., " " " " " "	26,168	20,000	1	1					741	"
C. T. Brenner, " " " " " "	5,319	20,000	1	1					800	Kettles.
Pierson, Wright & Co., " " " " " "	24,752	25,000	1	1					800	Pans.
Chicago Salt Co., Florence, " " " " " "	5,300	50,000	1	120					800	"
Shaw & Williams, " " " " " "	25,609	25,000	1	1					800	Steam.
H. B. Allen, Carrollton, " " " " " "	5,621	20,000	1	1					746	Pans.
E. F. Gould, " " " " " "	11,350	20,000	1	5					743	Kettles.
T. Jerome & Co., " " " " " "	19,350	25,000	1	1					763	"
E. Litchfield, " " " " " "	Not run.	75,000	3	180					780	"
H. Ballentine & Co., Carrollton, " " " " " "	30,000	30,000	1	60					835	Kettles and Solar.
Saginaw Valley Salt Co., " " " " " "	5,000	20,000	2	120					840	Steam and Pans.
H. P. Lyon & Co., " " " " " "	11,941	20,000	2	60					800	Kettles and Pans.
A. J. Bliss & Bro., Zilwaukee, " " " " " "	17,431	20,000	2	5					800	Steam.
John F. Driggs & Co., " " " " " "	5,153	25,000	1	1					860	Steam and Solar.
Rust, Eaton & Co., Zilwaukee, " " " " " "	23,432	25,000	1	4					950	Steam and Pan.
New York and Mich. Solar Salt Co., Zilwaukee, " " " " " "	23,877	270,000	1	4					1760	"
W. R. Burt & Co., Melbourne, " " " " " "	49,417	75,000	1	8					1198	Pans.
LAKE SHORE.										
Frank Crawford, Caseville, Huron Co.	29,063	30,000	2	3					785	"
Pigeon River Furnace Co., Caseville, " " " " " "	5,206	30,000	1	6					702	"
Ayres & Co., Port Austin, " " " " " "	73,994	20,000	1	1					565	Steam.
New River Salt Co., New River, " " " " " "	6,954	25,000	1	1					835	"
Port Hope Salt Co., Port Hope, " " " " " "	14,883	20,000	1	1					1103	"
Jenks & Co., Sand Beach, " " " " " "	New	20,000	1	1					1070	"
Thomson & Bro., White Rock, " " " " " "	82,474	20,000	1	4						
Grant & Son, East Tawas, Isosco Co.	Not run	20,000	1	1						
Weeks Bros., " " " " " "	8,895	25,000	1	4						
Loud, Gay & Co., Oscoda, " " " " " "	New	50,000	1	8						
Smith, Kelly & Dwight, Oscoda, " " " " " "	New	25,000	1	4						
Totals.	1,081,865	2,216,000	95	240	1310	55	4092	119		

LABOR.

The work connected with a kettle block can be accomplished by 7 men and 1 two-horse team, divided as follows: 2 boilers, 2 firemen, 1 engineer, 1 salt-packer, and 1 teamster.

The capacity of pan blocks being greater than that of kettle blocks, more labor is required, and is divided as follows: 4 boilers, 3 firemen, 2 engineers, 2 salt-packers, and 2 or 3 teamsters.

Steam blocks being run with exhaust steam, the same firemen who run the mill during the day are employed. At night an extra man is put on. The number of boilers varies with the capacity of the block, being from 4 to 6 men, engineers 2. In many of the steam salt blocks the boilers also pack the salt, after they have finished lifting the same.

In the early history of the salt manufacture the supply of good labor hands was not equal to the demand. Of late years the supply has been largely in excess.

The average price of labor in 1864 was \$2 a day. In the present year the average per day for salt laborers is \$1.25.

FIXED OUTLAY IN DETAIL.

The following figures give the fixed outlay of E. F.

The cost of the Buffalo Salt Company's block was \$4,000 for tubing and \$6,000 for block, cisterns, settlers, and grainers.

PRINTING ON WOOD.

THE Williamsport, Pa., *Gazette & Bulletin* has the following description of the practical working out of a unique idea: A planing mill is a strange place to find a steam power cylinder printing press at work, and yet stranger to find it printing on wood. In the box factory of T. U. Thompson, on Hepburn street, this sight may be witnessed almost any day. The press is similar in principle to the ordinary newspaper cylinder press, and is used for printing the business card of the customer on the boxes—as they are made. It will print a card of about 8x15 inches as clear and distinct on wood as on paper, and is generally used on the ends of small boxes. The rapidity with which it works is not equalled by any ordinary newspaper press. When run at an ordinary speed it is capable of turning out 4,200 impressions per hour, and faster than one man can carry them away. The boards are piled two feet high on the bed and require no feeding. By an ingenious piece of mechanism

the lower board is caught by an automatic feeder and forced through the rolls, leaving the pile to settle as it disappears. The type is composed of metal cast into a sheet and moulded to fit the cylinder. It creates a slight indentation in the wood.

NOVEL PATTERNS FOR SLEIGHS.

We have had a long and pleasant correspondence recently with Mr. George Meitinger, the well-known carriage-builder of Munich, Bavaria, who for a number of years edited the *Wagenbau Zeitung*, the only organ of the carriage trade pub-

FIG. I.

FIG. II.

FIG. III.

lished in the German language. Mr. Meitinger has kindly sent us the following original designs for sleighs, which from their novelty of general design and unusual grace of outlines, they should prove suggestive to all sleigh-builders, even if these particular patterns are not followed.—*The Hub*.

An ice machine in Dallas, Texas, just finished, produces ice cakes thirty feet long and six feet wide, weighing from 10,000 to 12,000 pounds each. They are formed by freezing fine rain or spray. When the freezing is done, the bottom and sides of the cake are thawed loose from the inclined plane, and the cake slides out upon a platform where it is cut into pieces six feet square. Four cakes a day are frozen. The works cost \$30,000.

REPORTING SPEED.

In the *Reporter's Guide*, by Thomas Allen Reed, London, we find the following: "No reporter should be content with less than the ability to take a verbatim note of a moderately slow speaker. If he acquires this, and can write with ease and certainty at the rate, say, of 120 words per minute, he will rarely be at a loss with a much more rapid speaker, for if he is unable to secure a strictly verbatim note, he will very nearly attain that result, and by the omission of the less important portions of the speech, will miss very little that the public cares to read, or that the speaker himself would desire to see reproduced."

Mr. Isaac Pitman, in one of his circulars, states that Mr. Reed is the best reporter in the world, and as illustrating the speed of his system, says that Mr. Reed, and one of the Pitmans—Fred, we think—have, on several occasions, written 200 words per minute.

It is reported that the *New York Tribune* sent their best reporter to report Mr. Moody—that he took 2,200 words in 10 minutes, and then had to give it up, as Mr. Moody exceeded this speed.

Mr. George Waring, Jr., of Tyrone, Penn., the editor of *The Phonetic Magazine*, and a first-class reporter withal, replies to this by saying that "the reporters of England all write Pitman's system, and did not find any fault with Mr. Moody's speed."

Is it not probable that one of the above quotations explains this? But Mr. Reed, in another part of the same book, says this:—180 or 200 words in a minute, is no uncommon speed in certain styles of speech, such as the conversational. It may be continued for only a few moments, but the reporter who would reach the highest excellence should be able to seize the most rapid passages, which are sometimes the most effective, and therefore the most worthy of recording.

These two quotations from Mr. Reed's work may not seem very consistent with each other, but as the latter is probably the most worthy of observation, it would be unfair to quote only the one.

Inasmuch as we believe a speed of 120 to be only about half way to 160, and 160 not over half way to 200, and as there has been so much said upon the subject and so little arrived at that is definite, we think perhaps a few words upon the subject may be of some use to beginners, who are laboring under the delusion that when they can write 160 words in a minute, they will be accomplished reporters.

In court work, it is seldom we have anything under 140 to 160, and there is seldom a day but we could use a speed of 200 or over to good advantage.

A prominent reporter of this State (Iowa) once said that a reporter who could not sit down and write 200 words in one minute in any average matter, was not a reporter but