"De Sale Communi"

We are now able to present the continuation (chapters XXV-XXX) of the first English translation of Swedenborg's early work *On Common Salt,* which is being done by Michael V. David and J. Durban Odhner under the auspices of the Swedenborg Scientific Association.

¶XXV.

Boiling Salt from Spring Water at Halle

In Germany there are many salt-works, since in many places there are springs from which they boil salt, such as at Frankenheim in Thüringen, Allendorf in Hesse, Salzungen near Verre, Hallis in Schwaben, Ostern in Mansfeld, Salza in Aschersleben, Staffurt, Colberg in lower Pommern, Apolda in Weimar, Hallis in Salzburg, Kitzingen in Franken, and elsewhere. But of these the salt-works at Halle in Sachsen takes first place.

The springs are four in number, and called Teuschen, Gutgar, Metrits and Hackeborn. All are reinforced down to the bottom with oak beams. The first spring is 35 1/4 ells deep. The water there rises one ell every hour, so that the spring sometimes is filled up with water, which must then be let out. The spring Gutgar is 44¾ ells deep, and its flow is large and abundant. This spring's water is not so clean and clear as that of the first, but has an odor. The third spring is 38¾ ells deep, and the fourth 35 1/2.

They say that a pound of the salt water found in these springs contains seven or seven and a half to eight loths of salt; however, when the evaporation is finished, that amount is rarely obtained.

The water here is called *Sohle*[118] The first spring has 32 *Stuhle* or 128 *Quart,* as they are called, a *Quart* being twelve full evaporating pans; so there are 1536 pans. Each pan contains five *Zober*[119], and a *Zober* eight *amphorae* or *ambar*[120] or a weight of two and a half hundredweight. The second spring has 1008 full pans, but a pan and a half of this water is not considered more valuable than one pan of the first spring's water. The third has four *Stühle,* a *Stuhl* contains 20 *Quart,* a *Quart* two *Nbssel,* and a *Nossel* eight and a half pans. The

[118] Sohle or Sole is a Wendish word referring to salt water from springs (Zedier 38:521).

[119] Zober. A two-handled wooden container for liquids. A volume of eight Eimer (Zedier 63:48)

[120] Swedish for *buckets.* Equivalent of German *Eimer.*

fourth has two *Stühle,* one *Stuhl* sixteen *Nössel,* one *Nossel* six and one half pans, a pan containing 24 *Zöber*. Hence they drain *7680 Zöber* of water from the first spring, 3696 from the second, 800 from the third and 768 from the fourth for a total of 12,944 *Zöber.* All these belong to private citizens. 1928 from the first spring, 988 from the second, 538 from the third, 282 from the fourth, altogether 3736 each week are intended for the upkeep of the salt-works. The government possesses eight *Stühle* at the first spring, two at the second and third and a half *Stuhl* at the fourth, as well as twenty-five private shares or *Kothen,* but at present more than half of this operation has come into other hands. The rest belongs to the city government and the citizens, and there are shares belonging to the church at Magdeburg and other religious places. The law provides that no share may be sold or bequeathed to anyone who is not a citizen.

The water from the springs is run into wooden containers, one such container being in each building. The evaporating buildings or *Salt-Kothen* number 112. Fourteen belong to the government and to the king, 98 to private citizens. There are three sizes, 60 of the largest, 26 mid-sized and 26 smaller. It costs 900 Imperial thalers to build each building. Each is constructed of wood and roofed with reeds. There is a ceiling overhead which keeps heat in, as in a bath-house. The heat is conducted in through large channels so that the salt there will dry. The evaporating pans vary in size. The privately owned pans are 4 1/2 ells long, 4 ells wide and 7 inches *(digg.)* deep, holding 512 canthars (Halle measure). The ones belonging to the Prince differ in volume and size. The pan rests on the fireplace or, preferably, hangs from iron hooks and rings so as to fit closely on the wall. The pan consists of iron plates and its weight is usually about three hundredweight. It can be kept in the fire constantly for twenty weeks. Every three days the bottom of the pan must be cleaned, for if anything sticks to the bottom, it has to be wiped away, or the fire will eat through the pan.

They also did an experiment, using mined coal instead of wood. They observed that, when using such a coal fire, the salt, although somewhat rocky, still became quite white and bright. Hence such mined coal is used to great advantage in some evaporating houses.

The evaporation is accomplished in the following manner. They put wood or coal into the fireplace, but only a little. Water is carried into the pan, or piped in through some kind of channel, only enough at first to just cover the bottom, so they can find out whether the pan is sitting level, as is necessary. After that they pour in 21 or 22

amphorae or *ämbar,* and only then light the fire. Before it comes to a boil, they pour in one cup *(cornu)* of cow's blood, called "color" *(Farbe),* so that the resulting fermentation may separate impurities from the water. Finally they fill the pan up with water, with four and a half *Zöber,* or 36 *ämbar* or *amphorae,* and increase the temperature. Meanwhile the boiling is kept up for a quarter of an hour and the impurities come to the surface in the foam, which is scooped off with a wooden blade, making the water clear. Then a plank is put on it to prevent the smoke from getting in. The fire is intensified for an hour, and then called a "great fire." When rather clear bubbles appear, it is a sign that the salt is granulating or crystallizing. At that point they pour in a spoonful of a certain kind of beer, called *Schwenkenbier*[121], to help it coagulate and crystallize. The plank-covering is then replaced on the vessel or pan and on it two baskets of woven sticks, into which the salt is lifted, until they are filled to capacity; from these the water drips out and flows back into the pan. The amount of water is regulated so that two such baskets are refilled again and again, with a large accumulation of salt. When the baskets are filled, they again pour out some of the beer, and keep the boiling going for a quarter of an hour, so that the salt will go to the bottom. From the bottom of the pan the salt is raised up into the baskets, which are filled with this salt. Again they pour in beer and boil for a while, and when this process is finished, they take the salt out and throw it on top of the previous salt, until the pile of salt in the baskets reaches the baskets' height. But they must take care lest towards the end the heat increase too much so that all the moisture evaporates and the water at the bottom dries up, leaving salt sticking anywhere on the bottom. If this happens, the pan can easily be eaten away and broken, which sometimes happens with a loud noise. They avoid this problem by constant stirring. There is usually one and a quarter hundredweight of salt in each basket, but since it is still wet, it weighs two hundredweight. When there is no water left, except such a little bit that it only covers the bottom, the pan is refilled to boil a new batch, which is done in the same way as described above. Each boiling takes four hours, sometimes less. It is to be noted that if boiling continues in one pan for a couple of days, a crust sticks to the bottom, which has to be completely removed; but this cannot be done without taking the pan off. When the boiling is finally finished, they fill the pan with ordinary water until the new

[121] Schwenkenbier, or Schwenkebier according to Zedler, is a kind of beer used at Halle to promote the granulation of salt (Zedler 36:385).

boiling begins, so that the stuff on the bottom thoroughly dissolves and separates from the sides.

If there is any grease in the pan, the water cannot be brought to the point of granulation until the bottom has been cleaned.

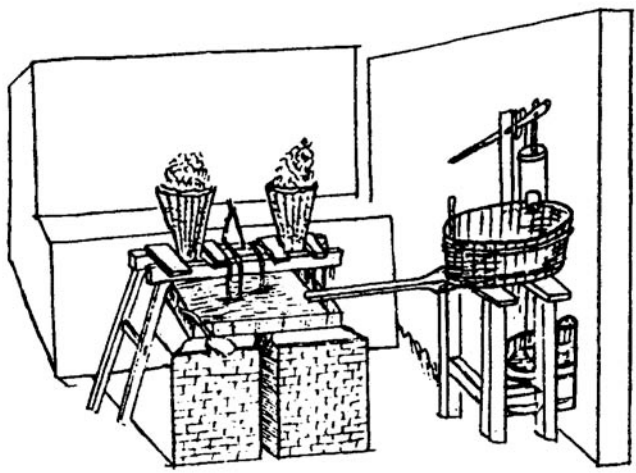
Once the boiling is finished they carry the baskets to the upper part of the building, which gets hot like a bath-house. There they arrange them and leave them until all the salt has fully dried out.

Each week, or period of 144 hours, they get 36 *""Werck,"* as they term them, or 72 baskets, and they use up 160 *Zöber* of water, and fourteen or fifteen canthars of the beer called *"Schwenkenbier,"* and two to two and a half canthars of cow's blood. Each basket can be used twelve to fourteen times, and it is best to wash them between loads.

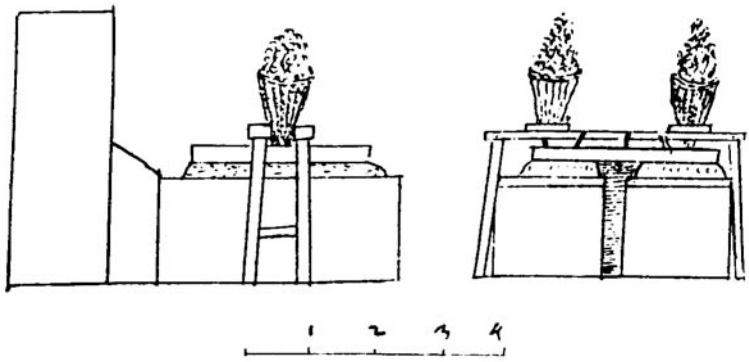
First salt water is brought from the wells into containers, half of which stand inside the building and half outside. From there it is drained into another vessel holding five *såar*[122] of water, and then through channels into the evaporating pan (see fig. 1 below).

The fireplace is made of brick, three and a half ells square and one and a half ells high. The pan, whose measurements I gave above, is placed on top. The pan costs seven and a half Imperial thalers and lasts for a year. 113 pans are made of lead, fourteen of which belong to the Prince, and 99 are made of iron. The water filling one pan

[fig. 1]



[122] Swedish *så* = cowl, tub, barrel



Scale of ells

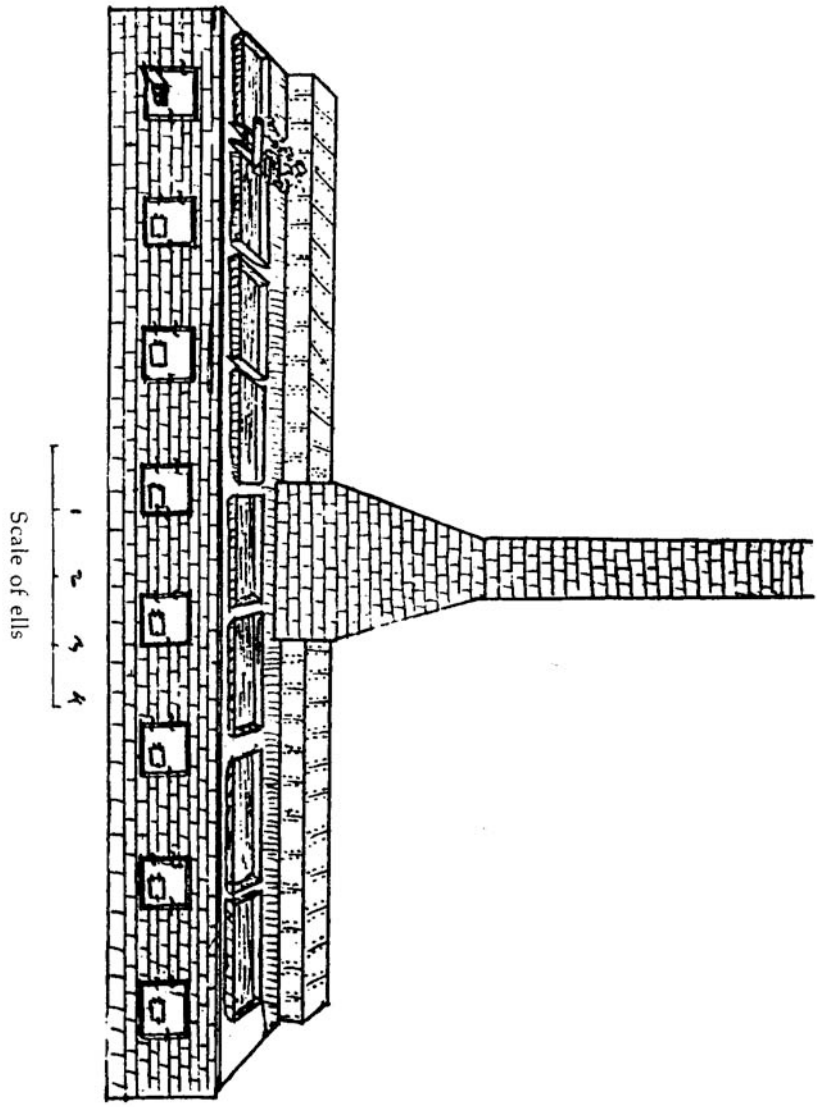
weighs nine or ten hundredweight. They get two baskets full of salt from each pan, and three of them measure one ton. In any four-hour period they get two of these baskets, twelve in twenty-four hours, and seventy-two in a week. They use up one foot-and-a-half measure *(mensura sesquipedalis)* of wood, which is three and a half to four feet long.

But the pans that belong to the Prince or Elector are constructed on a single fireplace or wall, as in the drawing opposite, fig. 2. In one fireplace there are sometimes six, seven, eight or up to fourteen lead evaporating pans. Here coal is used instead of wood. A lead vessel is two ells square and one palm deep, weighing four hundredweight. It lasts for a quarter of a year, and must then be re-formed. Every week, from eight such pans, they get 50 to 60 tons of salt. But neither beer nor blood is used when boiling in lead pans. All told, this saltworks operation produces around 111,200 tons of salt annually.

In these lead pans the boiling goes on long enough to drive out all the moisture. The salt that is made in these pans is removed immediately and placed on a pavement covered with heavy linen cloths. They pour new water into the pan while it is still heating.

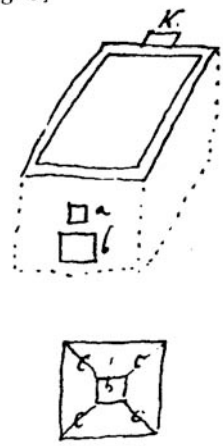
As for this description, one should be aware that those notes about the Halle method of boiling salt were taken down twenty or thirty years ago. If things are different now, they should be revised. The fireplace itself is constructed as shown in fig. 3 below[123], rising four feet from the hearth itself, closed in front with an iron door,

[123] Acton misread *appositae* as *opposilae*.



[fig. 2]

[fig. 3]



over which an opening has been constructed through which they throw logs into the hearth, (a) is that opening; (b) is the door; (k) is the chimney through which the smoke escapes. The inner walls of the fireplace angle inward toward the hearth, or bottom, which may be seen in (cccc), so that the hearth is only three feet from each side, but the upper edges four feet from that point (b). In a hearth made this way, the flame hits the base of the pan evenly. Smoke is let out through the chimney (k) and then conducted through iron ducts across the other part of the house where salt is being dried. The authors have also noted that there is the same degree of saltiness in the spring whether the prevailing weather is rainy or dry, so that there is no intermixture with rain or flood water. A salty lake of Leeburg lying two miles from Halle, is half a mile long, extends up to 200 ells in width and is very deep in places. Water flows into this lake from numerous fresh water springs and from a neighboring fresh lake. It flows out again in streams that eventually converge into the river called Salza, which flows into the sea[124]. A measure of water taken from this lake contained three drams of salt, and it is amazing that the level of salt in it does not increase or diminish, even though in several years numerous floods have inundated the area. It is still more notable that in places where mildly salty springs come up a unique plant with a salty flavor grows, locally known as *"Kaly."* This plant is reduced to ashes and alkaline salt is extracted from them.

The oldest spring is the one called Gutgar or Vandalicus. It is forty-five ells deep, and extends into an ever-narrowing space, surrounded with brush on the upper part as well as the middle. It is boarded all around and equipped with a gridiron at the very bottom, through which one can stir with a stick and find black and muddy silt. More than all the others this spring has the characteristic that the water comes out of the spring muddier, emitting a stronger smell, and pours out foam more forcefully than is usual—which those who are familiar with its action can only attribute to the

[124] *Ms.* has *salum,* misread by Acton as *Sala.*

vicissitudes of the weather and sky. The second spring is called *"den Teuschen,"* is located in a lower place, and extends up to thirty-six cubits toward the bottom. Its vein, coming in from the northeast, generously pours out pure and clear brine, so that only if the spring is completely drained can its source be seen; and when it is emptied, the liquid it contains increases so much in a period of twenty-four days that on account of its low location, it rises above the hedge round about and overflows.

Scarcely six paces away from this lies the third spring, which they call by the peculiar name *"Metritz."* Its depth reaches thirty-nine ells, where from a narrow vein a dirty and murky stream emerges. The fourth is called *"Hackeborn,"* set in a more prominent place, in a rocky cavern. It is dug out like mines at the bottom, and its depth is forty ells. This spring gives a quite saturated brine, in lesser quantity than the others, which requires a stronger fire, but yields a good solid salt. In addition to the four springs that have been noted, they have been trying to get a fifth going. It has reached the great depth of 136 ells, but the vein is narrow and not so rich in salt.

In a year they drain off 750,000 basins *(capedines)* or jars *(situlae)* of water, from which they get 333,332 lumps *(glebae)* of salt. It takes thirty-two lumps to make twelve tons or one last [so each year they get 11,000 lasts] or 330,000 hundredweight.

A pound of water from the first spring, *Teuschen,* contains three ounces and three drams of salt; from the second, *Gutgar,* three ounces, two drams; from the third, three ounces, one dram and thirty-six grains; from the fourth, *Hackeborn,* three ounces and two drams. The salt water of Schower in Hungary, in the district of Eperies which comes as far as the Bavarian district of Reichenhalle, abounds with four and a half ounces, two drams of salt. Lüneburg water contains four ounces of salt, Stasfurd water three ounces and a dram, etc.

The kettle is six and a half ells long, four and a half wide and half an ell deep. If they cook salt in it for a whole week it is thrice purified. They lift it up, set it down outside and, propping it up at a side with a stick, set straw afire under it. Next they set it upright again and with hammers break away the stony deposit sticking to the bottom. Finally they smear it with ashes and beef blood and put it back in its original place.

To produce the amount of salt which they call *ein Wenk* or two lumps *(zwey Stücke* or *baskets),* they need four and a half brine basins *(capedines)* or thirty-six *amphorae* (buckets). The salt-worker, having

poured a large amount of this liquid into the kettle, puts a hot fire under it and pours in half a bucket *(calathus)* of beef blood, which further purges the salt. As soon as the brine begins to boil, it foams up strongly, just like meats that busily foam up. Then, with the unwanted matter purged out, it takes on such a clear and transparent appearance that the bottom is visible. This takes an hour. At the same time it begins to coagulate and put forth small lumps of salt. They cut down the flame a little and place three boards over the kettle, lest a chilly breeze or wind should rush in. In three hours they pour in several buckets of beer *(zythi),* which makes it turn out grainy. When this is done they leave it alone for just long enough, and add coal to get complete coagulation *(zum Söcken).* They continually remove the top matter and, laying on two boards, put in more, which they call "pouring full." Working in this way, they build up the pile to a height of several spans, until all the salt has been extracted. The whole task can be accomplished in four hours, and therefore the saltworkers normally make twelve lumps of salt in a day and night.

On the beams overlying the fire-pan, stalactites form from the dripping brine. These, along with the salt (called *Kot*[125]) that falls in drops into the pan and hardens there, are left to the use of animals.

If they use brush or straw as fuel, the resulting salt is not of such good repute.

They recognize the best salt by the following signs: it is slightly spongy, white and light, has a little larger grains in it, and is dry. But low-quality salt comes out heavy, in a very packed mass, ashen-colored and damp.

The beef blood should not have too much fat in it, but should have a penetrating, spreading odor; because anything greasy impedes the coagulation of the salt and makes it soft and floury. It is different, however, if it throws off a lot of dark, yellow and fine foam. Then a very bright salt comes out. Sometimes the brine is muddy, and then the foam must be blended with beef blood or even egg white, to remove along with it the contaminating dirt.

To obtain better granulation, they use a milder fire, for it has been proved by daily experience, that when the flame has been increased too much, especially near the end of the process, they do not obtain so much, or such a light and grainy salt as when the boiling goes more gently.

It also promotes coagulation if while boiling they mix in, not beer

[125] *Kot,* German monosyllable meaning excrement. Misread by Acton as *pot.*

but *zythus*[126] *(Breyhahn*[127]) or Löbejün[128] beer, which is less acid. Better still is wine, and it is said that even brandy contributes much to crystallization.

The salt that hardens while boiling should be removed cautiously with a spade, lest it be stirred up too much and the forming crystals be broken apart. Hence in *Acta Soc. Reg. Angliae,* p. 885, describing the preparation of Nantwich[129] salt, they report that salt made in small kettles in a couple of hours lasts much longer in the air than salt made in deeper ones and constantly extracted from the brine, although the latter salt is more pleasant to the taste, grainier and lighter.

It is interesting that the salt which is first made in a kettle that has just been cleansed of its stony deposit is not as good, light or bright as what is made afterwards, nor is it of the same weight; however, that stony material should still not be allowed to grow to an excessive bulk and thickness.

Halle salt initially absorbs moisture from the air, and eventually settles and sinks down. It is not hard to remove the water from it provided the salty liquid that drains from the lumps and also the liquid remaining at the end of the boiling process are not mixed back into the brine in the vessel. It is added that although this salt takes up some moisture from the air, still, if one leaves it out for a while in a larger and more spacious vessel, it will dry out as time passes, and come out compact and hard, so that it will endure in the air.

It is also interesting that from the salty liquid that drips from the lumps they can, by boiling, prepare a salt tasting like marjoram, which, when exposed to the air for twenty-four hours, grows wet and liquefies.

It is no less noteworthy that in the springs Teuschen and Hackeborn, at the bottom near the mouth of the spring, solid and rather hard salt rocks form, appearing to consist in layers. They prove to have the same origin as the stony matter that sticks to the walls of the kettle and in three days can grow to weigh twelve pounds. But on this subject, refer to Chapter 44.

It should not be overlooked that if one puts brine from one spring, not mixed with any others, on the fire, each spring separately yields

[126] A malt beer. For Zythus, Zedier says "see Beer."
[127] Breyhahn is Weissbier (wheat beer).
[128] Town about 9 km north of Halle.
[129] *See* Acton, footnote 1, p. 64.

salt of a somewhat different quality. The salt prepared from the spring called "Gutgar" certainly excels over the others in whiteness and mild taste; the one from "Teuschen" produces smaller granules and is solid; that from "Hackeborn" is grainy, bright and white; finally, what the spring "Metritz" yields is not as white in color as the rest. Furthermore, the brine from the springs "Gutgar" and "Metritz" boils much quicker and harder than that of the rest, because they carry smooth and soft water that has passed only through rich mud; while the former springs push forth along a rougher, rocky stream bending its course through chalky and gypsiferous land. The ancients wisely established and ordained things, so that from the confused brine of springs, salt might be made.

These later things are from Hoffmanns *Opuscula Physico-Medica.*

¶XXVI.

Boiling Salt from Spring Water at Lüneburg

The salt springs of Germany are many, but the foremost and most valuable are the celebrated springs of Halle and Lüneburg. At the others, the method of boiling out salt is the same as at Halle and Lüneburg, so it is not worthwhile to describe more than three or four more important ones.

The salt springs of Lüneburg have been known for seven centuries, as far back as the metal mines of Rammelsberg and Goslar, certainly to the year 968. Henry Auceps[130], father of Otto the Great, is said to have started it; and when, in 1369, a new and generous vein burst forth in the middle of the city, and proved to be of high salinity, these salines became still more eminent and thus attained special renown. They have been boiling salt in lead pans for six hundred years, since the water is more abundant and rich in salt than that of Halle. It does not need to boil all day, but soon solidifies, nor does much grit settle out of it.

The spring is quite deep, and the water is emptied out of it by men. It then flows through channels into the evaporating buildings, and is collected in quite large containers. In each house there are four pans, one next to another. Each weighs three hundredweight. A pan is approximately square, four feet long and wide, and half a foot deep. The fireplaces that they lie on are low. There are fifty-four evaporat-

[130] Henricus Auceps or *Heinrich der Vogler,* born 876, Duke of Sachsen 912, German king 919, died 936.

ing buildings of this kind. A ton of water almost fills such a pan. All of the water is thrown off by boiling, until almost dry salt remains, which is cooked with a rather hot fire for three hours. When the salt begins to crystallize, they decrease the heat, then take the salt out and carry it off in baskets, and finally dry it in the usual manner in a warm place. It is said that they get six tons of salt in twenty-four hours from each evaporating building. The salt water contains four ounces of salt per pound—some say five ounces. The work goes on day and night, and the fire is never put out unless something has to be repaired. Sixteen pans belong to the Prince, and the rest are privately owned. Each year they make about 98,000 tons of salt.

They believe here that the true flavor of their salt is lost if it is boiled in kettles of iron rather than lead, or at least that the operation is accomplished better here in lead ones than in iron.

¶XXVII.

Boiling Salt from Spring Water at Hesse

In Hesse the Allendorf saltworks, which seem to be very ancient, are well-known. The well is sunk down quite deep in the marshy soil, and gushes forth a liquid that is indeed generous, but not very rich in salt. Because of this they have to remove the excess moisture from the brine by various devices in the salt-making houses. The salt is extracted using bituminous coal and even wood. It is sold throughout the adjoining regions of Hesse, Pfalz and the Rhineland. About this, see Hoffmann, *Opuscula Physico-Medica.*

Elsewhere in Hesse, there is a spring not far from Almerode near the river Werra.[131] It bursts forth there beneath a mountain of chalky stone. Its flavor is astringent, indicating the presence of some amount of alum. At a depth of about fifteen ells, a large rock blocks the way, around which the veins of the spring bubble out. It is emptied out with the help of horses and machines, and conducted from there into the evaporating house where there are about thirty kettles made of iron. These are five ells long and four ells wide, and towards the bottom they narrow to three by two and a quarter ells. Part of the brine is poured into such a kettle and partly evaporated. When this has been done, it is removed and exposed to cooler air, to

[131] Reading *Almerode* for Acton's *Almerade.* Apparently refers to Großalmerode, a town about 20 km ESE of Kassel, and 10 km from the river Werra *(Verra).*

find out whether or not the salt is separating from its water; then it is evaporated again, until the salt begins to solidify around the poles and hooks from which the kettle hangs. The timing must be watched carefully, that is, when the evaporation process must be stopped, lest too much brine evaporate, for otherwise the salt comes out too hard and heavy, or of a quality which is considered inferior. If it is not evaporated enough, the salt does not separate from its water in sufficient quantity. If the boiling is carried out with a wood fire, then towards the end the boiling must be coaxed along by the burning coals, not by a flame; but if bituminous coal is put under the kettle, they think there is less need for that precaution. When the brine seems to be boiled enough, the coals that lie under the kettle are pulled together under the middle of the vessel, and broken up, so they will fall into ash more easily. The ash is also collected and sold.

If a crack appears on the side or at the seam of a pan, they close it right away with a kind of putty made from ashes and blood. When the boiling is finished, they cover the vessel, then remove and dry the salt. It is reported that in eighteen hours, eight to nine hundred-weight of salt can be obtained from 120 tons of brine.

The fireplace is repaired every year, and a kettle lasts for five years when wood is burned, but when a coal fire is used, its lifetime is much shorter, because the sulphurous fumes from coal smoke slowly eat away iron. For each kettle they use twelve or thirteen baskets of coal, which is bought from the Prince.

Some have observed (if this is true) that in the summertime, especially in the rainy season, the brine is richer than in the winter. At other times a pound of this water contains three to three and a half ounces of salt.

¶XXVIII.

Boiling Salt from Spring Water at Lutz and Elsewhere, Where They Use Water-Powered Mechanisms, Commonly Called *Leck-* or *Gradier-Werke*[132]

In some places in Germany they use a mechanism for separating salt, commonly called a *leek- or gra deer-werk* (seepage or concentrating-

[132] Zedier describes a *Saltz-Gradir Haus,* 11:489. *Gradieren* can mean to concentrate: "eine Salzlösung gradieren *durch Verdunsten konzentrieren;" (Wahrig Deutsches Wörterbuch,* Mosaik Verlag, 1982).

works). This mechanism renders less salty water richer in salt, by throwing off much of the moisture with the help of the air. This is customary in various places, such as Auleben, Allendorf, Nauenheim, Nidda, Salzung, Lützen, Aschen, Lutz[133] not far from Leipzig, and elsewhere. In places where there is water abounding in salt, these operations are not necessary.

They construct a building roofed with stubble or reeds from the fields, sixteen feet long and eight feet high. Inside the building a container is made, as long as the building itself, to receive the water. This container is filled with the rather weak brine that occurs there. Between the roof of this building and the container heaps of reeds have been placed, onto which they pour the salt water from both sides. When the water has been poured through the heaps several times, part of the fresh water evaporates, rendering stronger the water that remains in the container. They report that water with a salt-level of five loths per hundredweight can be so enriched by four cycles of this process that it ends up containing twenty eight loths per hundredweight, providing the weather is suitable.

Heavy rains frequently disrupt this process, and rainwater or dew gets into the liquid, rendering the whole task more difficult. But if it is a dry year, and the north or east wind is blowing during spring or summer (but not winter), then it is usually successful. Also, the construction cost of these buildings is no small expense, for in one, hardly enough brine can be prepared to fill two kettles. In addition, the bundles of straw that are put down rot every year, and the bundles of twigs that are put in their place impart a bitter flavor to the salt.

Boiling is done in kettles here, in the same way as at Halle and Lüneburg, so it is not worthwhile to recount the same method again.

Rössler in his *[Most highly Polished] Mirror of Metallurgy* says that by such means water with one and a half loths of salt [per pound] can be concentrated to seven loths, if these buildings are so constructed that they stand exposed to the sun and wind—especially if the long axis of the building runs north and south. At the foundation the width should be twelve ells, and the length 126. It can be built smaller or larger according to the quantity of brine available. The

[133] *Lucena* is the Latin name for *Lützen,* a town about 20 km. WSW of Leipzig (Zedier 18:676). There does not seem to be a *Lutz* in that vicinity. Perhaps this is a double reference to the same place.

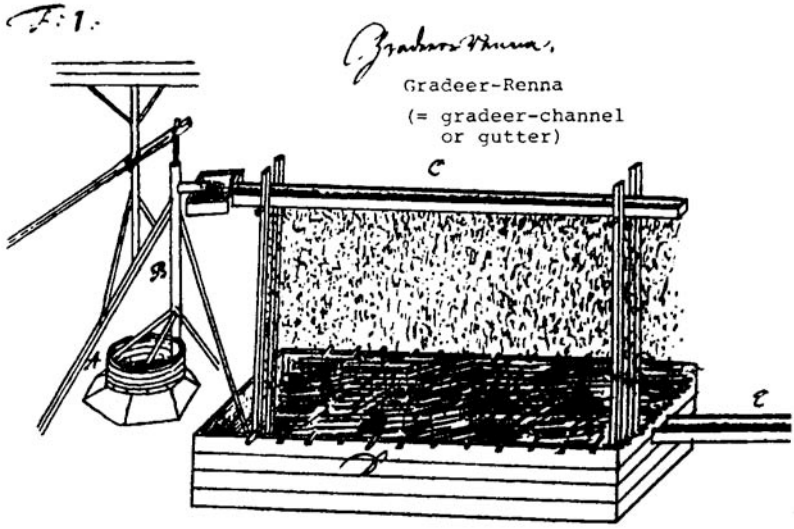
beams are raised nine ells high, etc. In the middle of this building, a container should be placed equal in length to the building itself and nine ells wide. On either side there is a gap of one and a half ells, into which rain falls. This rather long container is divided lengthwise into three channels. One and a quarter ells above these containers three similar channels of the same length are to be placed. On either side of this type of channel, pairs of little channels two ells long should be installed, and bundles of straw placed in them one eighth of an ell apart. Thus when the brine flows into these little channels, it separates and is carried off immediately, for it flows down through the bundles of straw into the big container. If the floor beneath is sloping, each separate trickle of brine flows down into a container placed below it. The brine that has flowed down is raised back up through a siphon and poured onto the bundles again in the same manner, and in passing through them is diffused in such a way that the sun and wind can best dissipate the water. This is the method by which water with one and a half loths of salt per pound is said to be enriched to contain seven loths per pound.

Some have observed that it is possible to enrich water with two, three or four loths per pound until it contains eight, ten, twelve or fourteen loths. But these kinds of buildings cost a lot, since they must be very long and high, and four or five must be built if five or six thousand *Sfucke* are to be evaporated. They are also exposed to storms, since they must be open and are thus not protected against damage from the weather. During the rainy season this work cannot be continued, nor during cloudy periods. If the wind is more than just right, a great part of the salt will also be carried off. Nor can the work continue in the winter. These are difficulties which no one can avoid.

Others have also thought up machines for both separating and dissipating into the air part of the fresher water until a residue richer in salt is left; but since there has not yet been any actual experience with them, no one can vouch for their usefulness. But I wish to present the machines themselves, since they are a kind of *seepage* or *concentrating-works.*

In fig. 1, A is the well or spring from which water is conducted into the upper channel C. This channel has small holes all over its bottom, so that the water can fall down like rain[134]. D is a wooden container, covered with leaves, branches or swamp-reeds. Thus the

[134] ms. *imbris:* Acton *ignis.*



water, falling like rain, is spread and scattered around by hitting the leaves beneath. As a result, it is dissipated in the air, the fresh part of the water is driven off, and the salty remains—all the more when it is exposed to air and wind so that the wind brushes against the falling drops of water.

Whole bundles and handfuls of reeds can also be hung between the perforated channel and the container below, to scatter the falling water still more. If you wish, it is also possible to enlarge such a machine.

Fig 2. In this machine, the water is sprayed out at a height by means of a pump *(sipho),* and so the fresh part is driven off as vapor. E is the pump or hydraulic machine, by which the water is carried up the vertical pipe KK. The water, expelled through the upper opening of the pipe, hits H, from there falls back into the container G, and from there into F. Meanwhile it is being dissipated as vapor, and the lighter or fresh component gradually diminishes. They think that water can be reduced to strong brine if the process is repeated several times. If you wish to use the customary hydraulic machines, it comes down to the same thing: such as if the water winds through a leather channel and is forced through leaves, stubble or other porous bodies; or if it is driven up into the air itself, but in such a way that it falls back onto a sloping wooden floor where it flows down into a container placed below it.

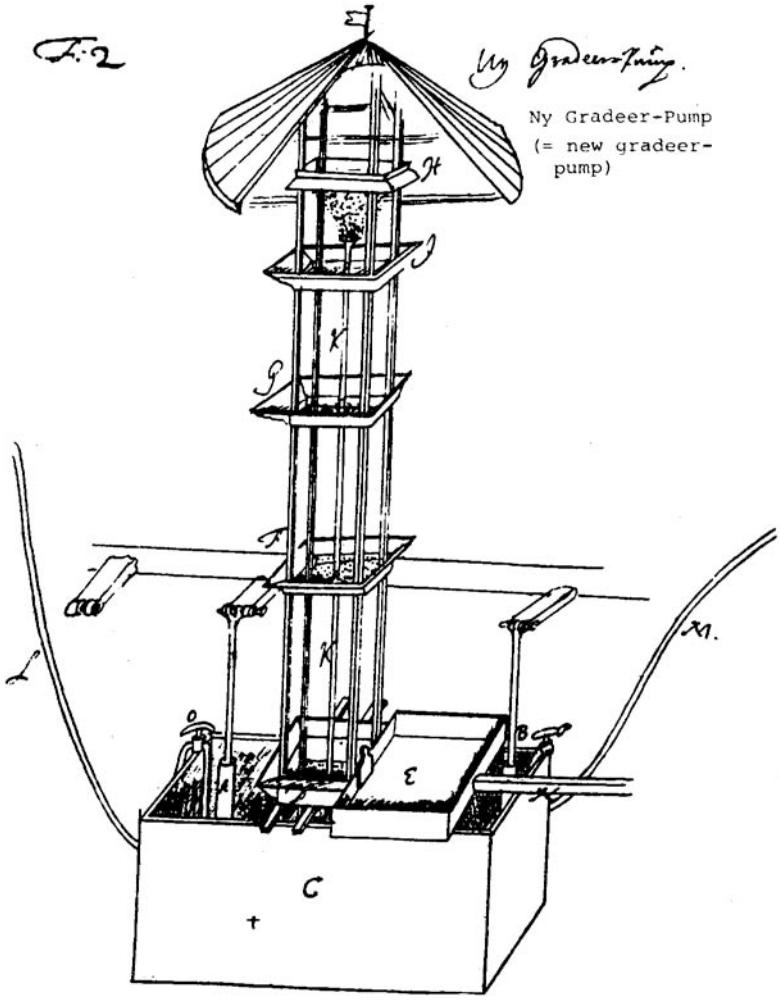


Fig. 3 is a machine by which it seems that the water can be violently dissipated and separated. A is a container full of salt water. E is a handle attached to a cylinder covered with many little rods and sticks hollowed out on one side. When the cylinder is turned, each of these holds some salt water in its hollow and throws it out, onto the covering [C], also made of small rods. From there, the heavier part of the water falls back onto the sloping floor [D], and thence back into the container A.

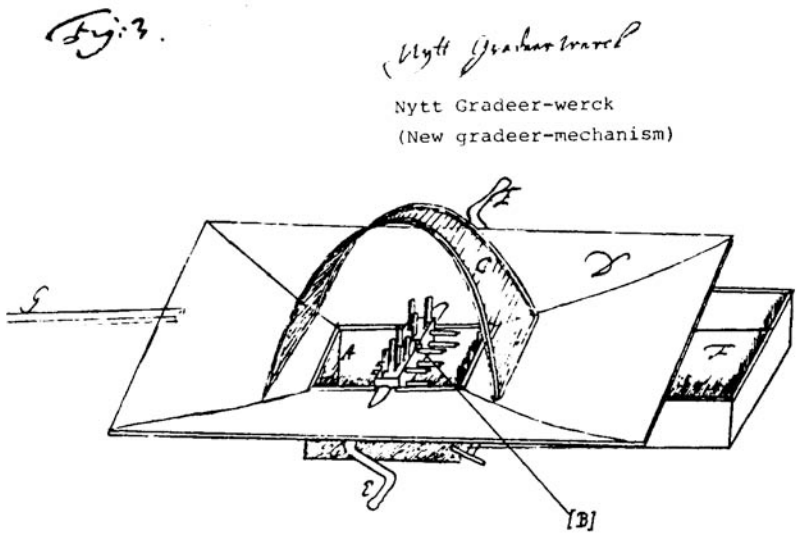
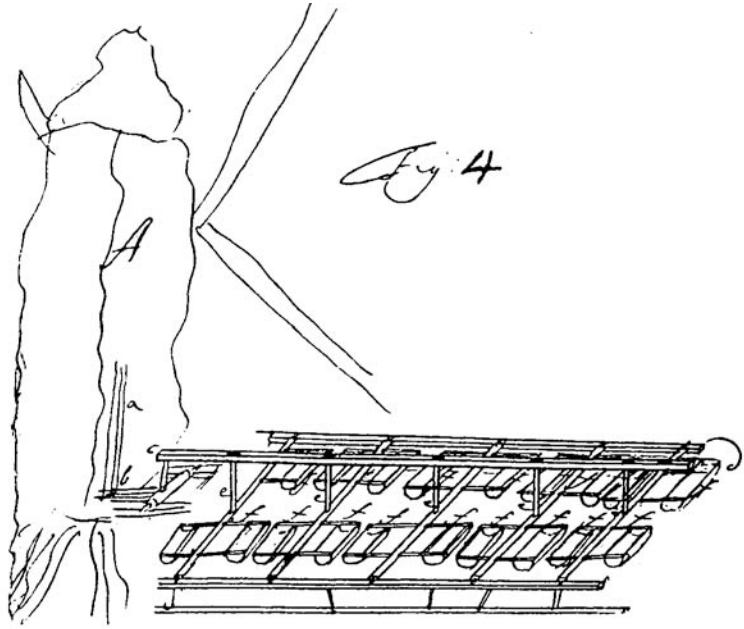


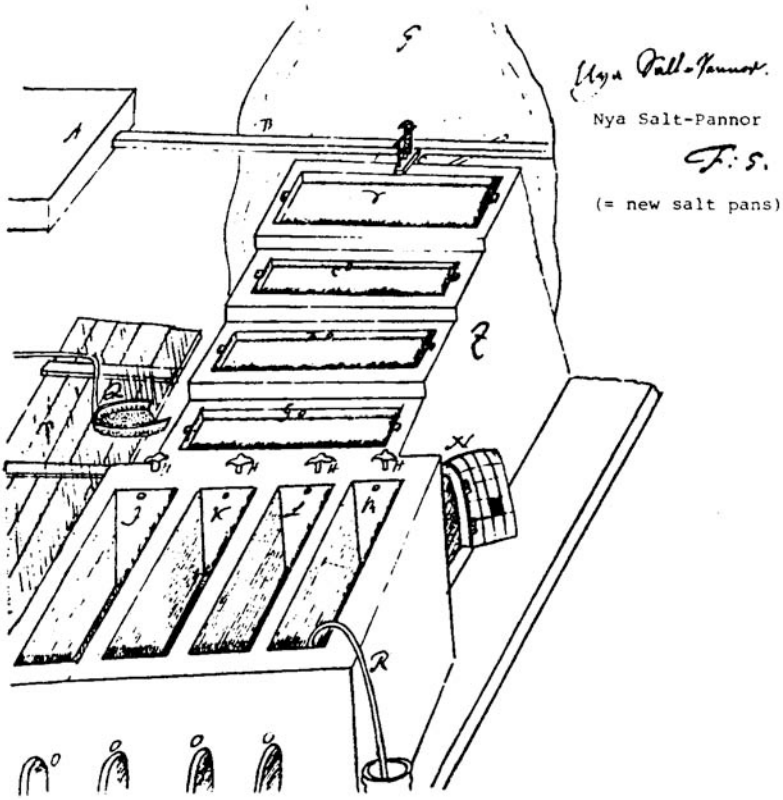
Fig. 4. Beam cd is driven back and forth constantly by a pneumatic machine or windmill. It turns the cylinders or axes e, e, e, e, and they raise the hollow vessels f, f, f, f, f, f and lower them on the other side,



where they refill with water. When raised on the other side they spill the water out again, and so continually. It is thought that thus the water, by being continually taken out and poured back, is dissipated as vapor, and that what remains will be rendered suitable for evaporation.

Someone has also invented a method of boiling, using pans or kettles uniquely constructed and put in the fireplace, which is supposed to promote boiling at less cost. But since I do not know whether this method has been demonstrated in action, and whether it fulfills the use claimed, I am only bringing forward a method which will remain hypothetical until actual practice casts the white or black stone[135].

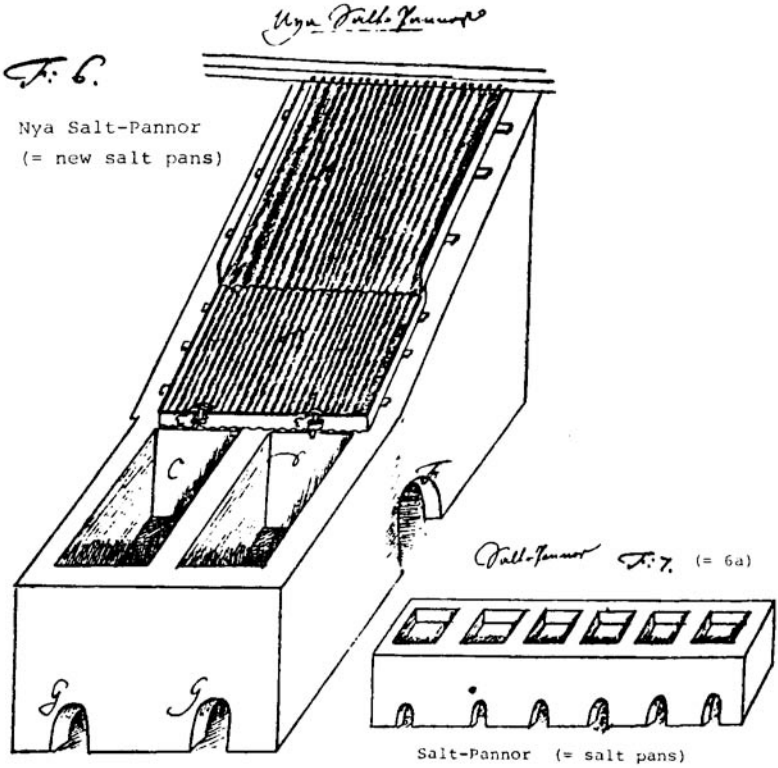
Fig. 5. These are evaporating pans. Z is the fireplace. N is a door



[135] i.e. casts the deciding vote.

into the fireplace, where wood is put in. D, E, F, G are vessels, fairly long but only 1/8 of an ell deep, made from iron sheets. Now when water is put in pan D, the heat hits the bottom of the vessel, and if water is put into it continually, it flows down from there into vessel E, and so into F, and finally into G. These pans are heated by one and the same fire, and placed on a slope so that the water can flow down from one pan into the next or lower one, and so that when it finally arrives in the fourth pan, the brine can be ready for evaporation and crystallization, helped along by the shallowness of that pan. With valves H, H, H, H passages may then be opened between the upper vessel G and any of the lower ones, where the brine can crystallize calmly. Laths are placed over these crystallizing vessels.

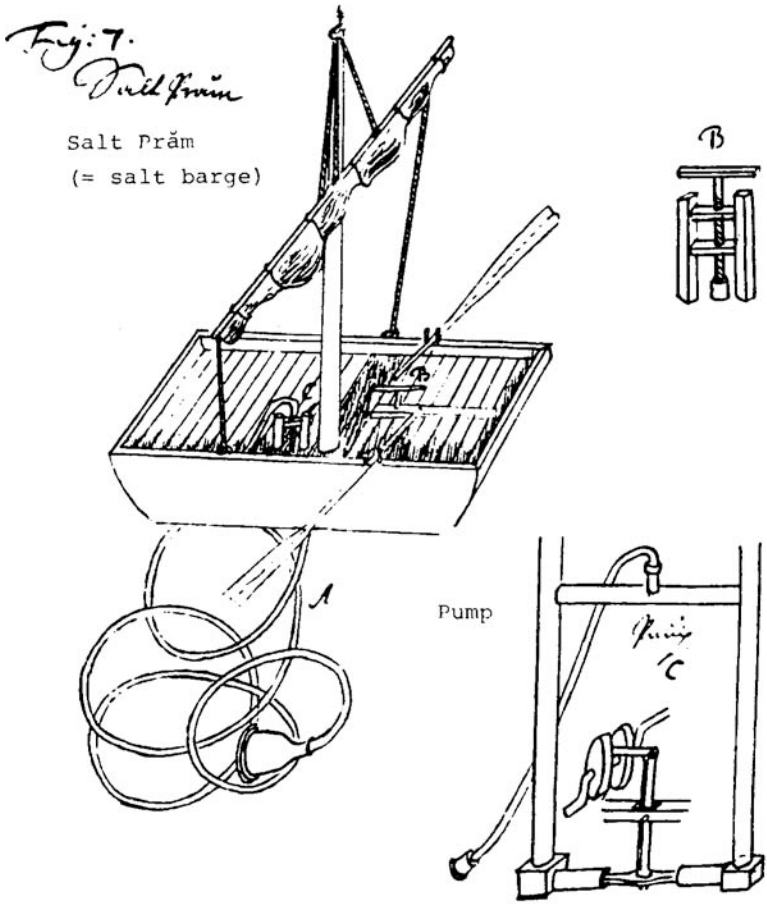
Fig. 6. The same work seems to be accomplished as by using pans.



Iron sheets are placed on a slope, A, [corrugated] with small channels in them. The water flows down these sheets into the lower vessels

heated by the fire, as are C and D, which also have fire under them. This arrangement is thought to require less wood and to reduce the water more quickly to solid salt.

Fig. 7. This is a certain kind of boat, elsewhere called a barge *(prám)*. It is especially constructed for the purpose of drawing up water from deeper in the ocean when they find that it is saltier towards the



bottom than near the surface. A leather hose [A] is thrown into the sea, with a weight on the end which pulls it down. When it has been let down all the way, they open a hole in the bottom of the boat with

a water-screw or with the mechanism at B, detailed in figure B. The water, under its own pressure, runs up from the bottom into the boat, and when enough water has come out, the hole is closed again and the hose is drawn up. The water can then be drained out of the boat with a siphon C anywhere you wish in your evaporating building.

As for the consumption of wood when different qualities of brine are available, some light can be shed on this with the following calculation: Suppose that a pound of water contains one loth of salt, and that 341 measures *(mensurae sesquipedales)* of wood must be consumed to boil out a certain quantity of salt. From this you will be able to tell the amount of wood that would have to be consumed if a pound of water contained two, three, four or up to eleven loths of salt. The rule is to be sought by an algebraic calculation: a = 32 loths, or 1 pound, b = 1 loth, m = any given greater number of loths, d = 341 measures of wood, x = the quantity [of wood] required if the brine is stronger. Thence we get the rule:

$$\frac{da - mdb}{ma - mb} = x$$

or:

$$\frac{d}{m} \times \frac{a - mb}{a - b} = x$$

Now if for "m" we substitute 2, 3, 4, 5 or 11 loths, however much occurs in a pound of water, the answer will be found. The same result can be obtained by an ordinary calculation. For if 32 - 1 or 31 loths of water are evaporated with 341 measures of wood, one can know how much wood is required for 32 - 2 or 30 loths of water. The result is to be divided by two (for the two loths of salt contained in the water), and in this way one gets the quantity of wood [required per loth]. In this case 31: 341 = 30 : 330; then dividing 330 by 2, one gets 165 measures of wood. Therefore, if a pound of brine contains one loth of salt, and 341 measures of wood are required to evaporate that much salt, then for a pound of brine with two loths of salt in it, 165 measures of wood are required; if it contains three loths, 106 1/3 are required, if four loths 77, if five 59 2/5, if six 47 2/3, if seven 39 2/7, if eight 33, if nine 28 1/9, if ten 24 1/5, if eleven 21, and if it contains twelve loths, 18 1/3 measures of wood will be required.

¶XXIX.

Purification and Boiling down of Salt by the French [Methods]

This purification or boiling down is called refinement *(rafinage),* and is done with salt of a grey color. This operation is carried out in the same places as solar evaporation, as in French Flanders. The boiling down is done in flat pans twelve to fifteen feet square and one foot in depth, called "pans" *(payelles*[136]*). A* large part of this salt is boiled down at Ypres, at Dunkirk and at Merville. Boiling out this brine eliminates all its sharp taste and increases its salt-content. Salt that is boiled down in the County of Nantes and Aunis keeps its grains better and the grains[137] come out more beautiful when the salt has not been subjected to more fire.

XXX.

Purification and Boiling down of Salt at Dordrecht in Holland

At Dordrecht and Zeeland[138] in Holland they purify and boil down salt that is coarse and impure. Salt that is contaminated with clay or earth is rendered whiter and purer, as well as better and larger in grain, by dissolving and boiling. French and Scottish salt, which is not valued very highly, is used for this process.

The salt is piled in a wooden container, as much as the container will hold. Around its sides, they pour in water from the sea, with five loths of salt [per pound]. That water is brought from places where the water is saltier, in ships made for this purpose. When part of the salt has liquefied at one corner, it is let out into a container hidden underneath, a hole being opened with a handle to let it flow through. These containers are filled with this solution. Still more water is poured in, and the resulting solution let down into the containers below. This continues until only a little salt remains. Before it is let out, this brine is tested with amber. If the amber floats on the water, it is a sign that the solution is very strong, but if it sinks, it means that the water is not yet saturated with salt. Brine containing enough salt should have thirty-nine loths in a hundredweight.

[136] *Payelle* would seem to be Old French for *poêle,* pan.
[137] ms. *granum:* Acton *quam.*
[138] ms. *Sealandia:* Acton *Scalandia.*

This water with a salinity of thirty-nine loths is syphoned out into channels which take it to the evaporating vessel. This kettle is made from iron sheets, and it is very large in size and capacity, having a diameter of twenty-seven feet, a depth of one and a third feet, and moderate thickness; and because it is so large, it is supported by seven poles, which are attached to the bottom of the pan and then connected to the crossbeam running above[139] the vessel, to hold the pan and prevent it from bending. Under the vessel a wall has been constructed matching its roundness and size, eight feet high. There are three doors around this wall. Smoke goes out through two of them, and combustible earth (peat) is thrown in through the third. They make no use of wood here, but evaporate salt by means of that earth.

The kettle is filled to the top with the solution. Once this is done, the combustible earth just mentioned is thrown in through the front door, and the boiling is begun with a very hot fire. This continues until they detect a sign that crystallization is beginning. When they observe this, they diminish the fire and close the doors, so that the fire will be deprived of any draft. Only then does crystallization begin, and salt sinks to the bottom. The salt is emptied out, new brine is added and boiled. This purified salt consists of rather large grains, and is mostly shaped like a pyramid, somewhat hollow at the base. The amount of salt increases from 100 to 165 [units?], and its price from 14 to 17 [units?], more or less.

It is to be noted that a better quality of salt is made if the boiling starts out strong and violent. Eventually, when crystallization has begun, the solution ought to be only lukewarm and without fire under it; but before this crystallization begins, half of the water must be thrown off by evaporation. Crystallization, which is accomplished at a moderate heat, begins not on the bottom but on the very surface: for there a kind of crust grows more and more, eventually breaking and sinking as if under its own weight. This crust looks quite a lot like ice. The sign that the crusting is beginning is that the granules on the surface of the water begin to collect themselves into one, and eventually combine in a film, and then in a thicker crust, which occurs while the solution is standing undisturbed. The brine at this stage appears of a reddening brown color.

When it first comes to a boil, foam emerges on the surface, consisting mainly of impurities and dirt; but as soon as that foam

[139] ms. *supra:* Acton *super*.