

The smoke box also is provided in front with an arrangement in the form of a paraboloid or large plowshare. These arrangements will be further improved after carefully conducted experiments shall have exactly indicated in what direction it is well to carry this system of protection.

The idea of providing locomotives with surfaces of least resistance is not new. The illustrious Stephenson, it appears, thought of it at the outset. In truth, it seems as if this man of genius worked out the entire programme of the most improved locomotives, in their least details, at the first stroke.

Nevertheless, the putting in practice of surfaces of least resistance has been retarded for a long time, and this may well be explained, not by an indifference to progress, but by the fact that the cut-wind arrangement becomes truly advantageous only for the realization of high speeds. It has, therefore, been possible to neglect it for a number of years, but now it has become imperative.

It is well to recall here some experiments that were made in this direction in 1887 by Engineer Ricour, and which defined and determined the evolution that is being accomplished at this moment. Mr. Ricour, in his locomotives, substituted planes inclined in the ratio of three of base to four of height for all the surfaces at right angles with the running direction. Besides, he filled the intervals between the spokes of the wheels with plates of wood, and connected the smoke stack and steam dome by continuous surfaces. Under such circumstances, it was found that the resistance of the air diminished by one half. The result was a notable increase in the effective work, and a saving of about ten per cent. in the consumption of fuel.

In 1890, some analogous experiments were made by Mr. Desdouts, engineer-in-chief of the state railways. An engine was provided with surfaces of least resistance and tried for a prolonged period, making a total run of 180,000 miles. The saving in fuel was from six to eight per cent. and at times reached twelve. It is true that the engineman and fireman were excellent ones. The direct measurement of the resistances,

model and of those having a central passageway that are beginning to be seen upon our railroads. Then it will be well to use screens to close the intervals that exist between the cars, and that permit the wind to produce a retarding effect by acting upon the plane surfaces of the cars in the direction of the motion.

These are fundamental modifications that will conduce to an almost complete renovation of the material now in use. While approving of the introduction into these reforms of such compromises as are compatible with the necessities of the exploitation and with those of the amortissement of the materiel, it is to be hoped that they will be accomplished as soon as possible, with the unity of views and persistent research for an improvement that is universally needed.—La Nature.

#### THE MANUFACTURE OF SALT.\*

By THOMAS WARD.

SALT, in one form or another, is perhaps the most widely spread of all minerals. It is a constituent of all sea water, and there are few brooks or rivers that have no traces of it. Salt lakes abound in many districts of the earth, and saline springs are very widely distributed. Salt appears also in the solid or mineral state in beds of rock salt in most of the geological formations, with perhaps the exception of the very earliest. Not only is salt thus widely distributed, but it is also equally widely used, being a necessity of life.

The object of this paper is to deal with the various methods by which salt is manufactured or produced in different parts of the world, but more especially in England.

Brine is the foundation of the salt manufacture, and it will be necessary to define what is meant by it. Brine is water holding salt in various proportions in solution. By salt in this paper is meant chloride of sodium ( $\text{NaCl}$ ). Brine exists naturally in the sea, in salt lakes and in some rivers and springs. It is formed also by water coming into contact with mineral salt. Fresh water will take up more or less salt, according to its temperature, varying from  $35\frac{1}{2}$  lb. at freezing

"salt licks," which are of a similar nature. From the sea, salt lakes, salt springs and salt marshes, salt has been at all times obtained, and is so still.

It was a long time before men attempted to find stronger brine than that of the springs flowing away at the surface near brooks and streams. In searching for other minerals, chiefly coal, rock salt has occasionally been discovered, and frequently accompanying it strong brine, often fully saturated. It was not till the year 1670 that rock salt was discovered in England, near Northwich, when prospecting for coal. Brine was found on this rock salt, and was described as more "sharp and vigorous" than that found in the springs rising to the surface, which had been used for making salt from the time of the Romans or earlier. In Canada rock salt was found at a depth of over 1,000 feet in boring for petroleum.

In Germany bore holes have been put down where brine springs of a weak nature existed, and, in the majority of cases, rock salt and strong brine have been discovered. In the United States, within the last few years, many bore holes have been put down, in some cases to the depth of 2,500 feet, and rock salt discovered, but no natural brine. The same has been the case at Fleetwood and Middlesbrough in England. In all these places water has been put down the bore holes, or permitted to enter from the water-bearing strata passed through, and allowed to saturate itself on the salt, and is then pumped up. This system of obtaining brine has been used in Germany and the east of France for many years. Rock salt being very easily soluble, the water quickly becomes saturated. The plan usually followed is to have a double pipe or tube, that is a small pipe or tube within another rather larger. The larger tube is usually five inches in diameter, the smaller about  $3\frac{1}{2}$  inches in both England and America. The ring, or space between the two pipes, is used to put the water down, while the internal pipe serves as a pump up which the brine rises. A column of 120 feet of water balances one of 100 feet of saturated brine. Occasionally, in America, the water is forced down at a pressure of 160 lb. or so to the square inch, which pressure forces the brine up the inner pipe to the surface, and no pump is needed.

At Tully, in New York State, some 15 miles or so from Syracuse (one of the oldest salt manufacturing districts in the United States, and where only weak brine existed), a bed of rock salt has been discovered at a spot some 400 feet above the level of the salt works at Syracuse. About 400 feet higher still, and further up the valley, several lakes exist. The water of these lakes is conveyed by pipes to the beds of rock salt at Tully, which are some 1,800 feet below the surface, and the head of water is sufficient to lift the brine to the reservoirs on the surface, whence it flows by gravitation to the alkali works at Syracuse. The system of making bore holes and allowing water to get to the salt has extended very rapidly.

In the Northwich salt districts, in Cheshire, there are a large number of abandoned rock salt mines. Fresh water has broken into these, and saturating itself from the rock salt, has formed enormous underground reservoirs containing a practically inexhaustible supply of strong brine.

The brines formed immediately on or in the rock salt are nearly or quite saturated, and therefore much stronger than the natural brines found in seas, lakes and springs. In the Carrickfergus district in Ireland, where there is no brine on the rock salt, and where no water is put down bore holes, the rock salt is mined and put into reservoirs, and the water added to it.

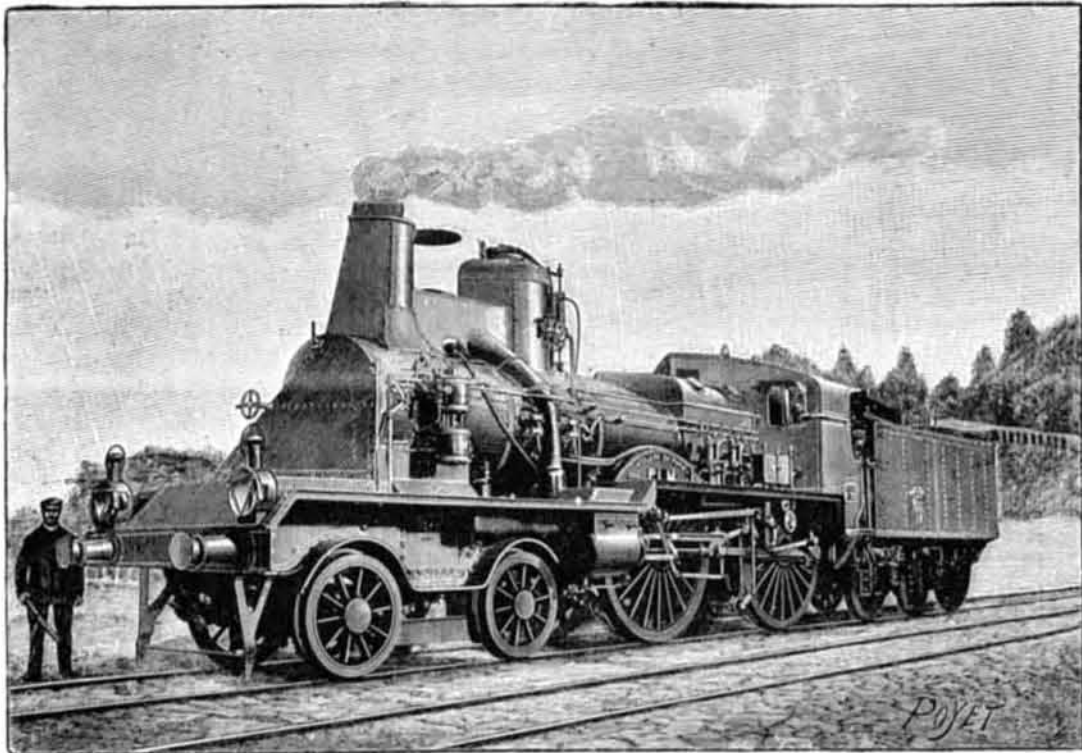
Rock salt has been used to strengthen weak brines, or to mix with and strengthen sea water, for a considerable time. There are salt works along the coasts of Ireland and Scotland at the present time, where the brine is formed in this way; and in Belgium, Holland, and Denmark, large quantities of rock salt are imported for dissolving and making brine, which is then used in the manufacture of white salt.

Brine is present in all parts of the earth, and of all degrees of strength up to saturation point. Until it reaches this latter point, however, no salt will form; hence it is evident that such a thing as a salt deposit at the bottom of the sea is impossible, sea water containing, on the average, only 3 per cent. of salt. When it is said that the huge beds of rock salt, met with in so many places, were deposited at the bottom of the sea, it is evident that the statement is incorrect, or else that the sea water must have been a saturated brine. This, however, could not be; for animal and vegetable life cannot exist in a fully saturated brine. When brine is of full strength a state of equilibrium is reached, and any decrease in the quantity of water or increase in the quantity of salt destroys this equilibrium, and a portion of salt is deposited. The water once saturated will take up no more salt, and it is a common saying in the salt districts, that the safest way to keep rock salt from dissolving is to put it into saturated brine.

Salt, in brine, is not held in suspension, but in solution. Hence, however long the brine is allowed to remain, say in a closed vessel, no salt will deposit. The business of the salt manufacturer is to remove the water, when the salt will crystallize out and form a deposit. During the whole time of the removal of the water the salt deposits in such quantity as to keep the brine just saturated. The best, and almost only way, to get rid of the water is by evaporation.

The problem to be solved in the manufacture of salt is to so regulate the evaporation that the kind of salt required is produced. The great factors in evaporation are heat and dryness. A moist heat is almost useless, hence, in tropical countries where there is great moisture, little or no salt can be made. A dry wind, without much heat, causes rapid evaporation, and in Germany, where the natural brines are very weak, huge thorn hedges are built up in the line of the prevailing dry winds, and the weak brine is allowed to trickle among the thorns so exposed, and a large portion of the water is evaporated. The brine caught at the bottom in troughs is in this way much strengthened. This graduating of the brine, as it is called, is frequently resorted to.

In rock salt mines, where the air is dry, and neither sun nor wind can penetrate, evaporation takes place, and when brine has flooded the sole or floor of the mine, as has happened occasionally, the water, in process of time, becomes evaporated, and splendid crystals of rock salt are left behind.



BEAK LOCOMOTIVE OF THE PARIS-LYONS-MEDITERRANEAN RAILWAY COMPANY.

at a speed of 43 miles an hour, and with 120 tons in tow, showed a gain of from nine to ten per cent. Admitting, as an average, a gain of from four to five per cent. resulting from the use of surfaces of least resistance, that is still more than the compound and other systems of locomotives are capable of giving, and a use of which cannot be made without great complications of mechanism and operation.

Mr. Desdouts likewise made an experiment of another kind, which was very curious and worth mentioning. He ran an engine coupled to a train at a speed of 36 miles an hour. In front of it, at a short distance, ran freely another locomotive which masked it. The diminution of resistance noted upon the locomotive of the train under such conditions was 600 pounds.

Cycling, which is so popular at the present time, has furnished data upon the subject of surfaces of least resistance that are not to be neglected. It has been calculated that the cyclist, clad in a fitting suit and bending forward upon his machine in order to diminish the surface presented by his body to the action of the wind, develops, in order to conquer the resistance of the air at a speed of 20 feet per second, a power of 67 foot pounds per second; that is to say,  $\frac{1}{2}$  horse power. Hence the utility of trainers when they act as a wind cleaver, and hence also the idea that has occurred, but which does not appear to have been carried out in a very practical manner, to provide bicycles with a sort of prow in the form of a plowshare designed to cleave the air. Aluminum appears to be indicated as a material for such prows and for realizing the beak bicycle. We know, in fine, if we consider the case of navigation, that upon giving a vessel a tapering bow instead of a square one, we diminish by four-fifths the stress necessary to haul her.

These various observations and the experiments that we have mentioned allow us to think that the Paris-Lyons-Mediterranean Company will congratulate itself for having put in service its forty beak locomotives that have obtained so just a success as a curiosity. Afterward, for making up the very fast trains that the future has in store for us, it will remain to make use of the long cars of the excellent dining saloon

point ( $32^{\circ}$  Fah.) to 40 lb. at boiling point ( $226^{\circ}$  Fah.), for every 100 lb. of water. Saturated brine at  $60^{\circ}$  Fah. contains  $26\frac{1}{2}$  per cent. of salt. Brine is rarely fully saturated, so it is customary to speak of a good brine as 1 part salt, 3 parts water.

This, for practical purposes, is sufficient to remember. In England, especially in Cheshire, the salinometer is graduated in ounces of salt per gallon of brine. The old wine gallon of 231 cubic inches, and not the imperial gallon of 277.274 cubic inches, is the one referred to, and a fully saturated brine is described as a 2 lb. 10 oz. brine. It is a curious fact that the specific gravity of saturated brine is to that of water in exactly the proportion of the imperial gallon to the old wine gallon, or 1.2 to 1.

Natural brines are scarcely ever fully saturated. The water of the sea varies very considerably, containing about  $1\frac{1}{2}$  per cent. of sodium chloride in the Black Sea;  $2\frac{1}{2}$  per cent. in the North Sea;  $2\frac{1}{2}$  to  $2\frac{3}{4}$  per cent. in the Atlantic, and nearly 3 per cent. in the Mediterranean. Where the sea is an open one the salt content rarely exceeds 3 per cent., and varies very little from top to bottom. In salt lakes we meet with brine from less than 1 per cent., as in the Caspian Sea, to more than 10 per cent. of chloride of sodium (to say nothing of the other salts) in the Dead Sea. There are numerous salt lakes on the steppes of Russia; as also in Central Asia, and many other parts of the world. The salt content of these lakes varies according to the season of the year. In the rainy season the brine is weak; in the dry season, saturated. There are in deserts and dry districts, where salt abounds, salty brooks and streams, as the Looni in Rajpootana, in India, and the brooks running into Lake Elton, in the Russian steppes. Natural salt springs, like the seas and salt lakes, are rarely saturated, many being merely brackish; but there are a few where the water contains considerable quantities of salt, as in Cheshire and the Luneberg Heath in Hanover, and when this is the case it indicates the existence of beds of rock salt in the neighborhood. In some parts of the world salt marshes abound, and what are called in America

\* A paper lately read before the Society of Arts, London.—From the Journal of the Society.

There is another way in which salt is sometimes produced in intensely cold regions, viz., by making shallow reservoirs, and allowing the watery portion of the brine to freeze, and the salt to deposit. A short time since a patent was submitted to me for artificially freezing brine, and thus obtaining salt. The great drawback to any such system of salt making is, that there will always be threestons of ice produced for every ton of salt made. Besides this, it would not be possible to manufacture the different qualities of salt required. Practically, the evaporation in making salt is caused by heat, and the water evaporated dissipates itself in the atmosphere in the form of steam or vapor and requires no further attention.

The heat used in salt making is either natural or artificial. Natural heat is that of the sun. All salt made by the heat of the sun is technically known as solar salt. Solar heat is the cheapest obtainable; but it has its drawbacks. The greatest of these is that it cannot be regulated; consequently it is not possible to make the various grades of salt required, which all need different degrees of heat properly regulated. Another drawback is that the heat is not continuous. After the sun is set the evaporation is very slow, and the time required to make salt is much lengthened, and in the rainy season or winter no salt can be made. Again, if the air is very moist or rain falls, not only is there no evaporation, but a good deal of the work previously done is undone. Part of the water evaporated returns, and to restore the brine to saturation some of the salt already made is dissolved, the water saturating itself at the expense of the crystals already formed. At Syracuse, in New York State, and also in Michigan, men are constantly on the look-out to run wooden covers over the pans in which solar salt is making, as soon as any sign of rain appears. Solar salt making can only be carried on successfully where the summers are hot, and at the same time fairly dry. It has often happened that a spell of wet weather has set in before the salt harvest has been gathered, and has blighted the prospects of the salt makers. Where, as along the shores of the Mediterranean, and along the Atlantic shores of Spain, Portugal and France, the seasons are regular, and fine weather is tolerably sure, much solar salt is made. The shores of the Red Sea and Indian Ocean are in many places suitable for solar salt making. The numerous salt lakes on the Russian steppes produce immense quantities of solar salt, as also does Lake Sambhur, in Central India. In the Dead Sea and along the eastern shores of the Caspian Sea, where there are both heat and dryness, salt is deposited very largely, and huge beds of rock salt are being formed. From these modern deposits the method of formation of rock salt in past geologic ages can be easily determined.

In places where solar heat cannot be relied on in the manufacture of salt, or where qualities of salt are required that the heat of the sun will not produce, artificial heat is used. In early days we are told that the brine was sprinkled over burning wood, and the salt collected from the ashes. Wood has at all times been used as a fuel for obtaining the heat for evaporating brine. In England, until comparatively recent times, it was almost exclusively used. In a letter of February, 1605, it is said that the wood consumed annually in making salt was, at Nantwich, of the value of £1,728; at Middlewich, £1,435 4s.; at Northwich, £2,056 10s.; or as the letter says, "Spent in the wich houses yearly in wood, £5,219 14s." Wich house was the name for the house in which the pans were kept for boiling the salt. The word is still frequently used at Northwich for the panhouse. The pans at this period were called "leads," being made of lead. Wood is still used on the Continent, where coal is scarce, for boiling the brine, and it is used either by itself or in conjunction with coal in Canada for the same purpose. In the lumber districts of Michigan the refuse wood and sawdust from the saw mills are used under the boilers to generate the heat for the steam required in making salt.

Slack, or small coal, is almost exclusively used in England, and most parts of the world; being more plentiful and much cheaper than wood. The average price of this fuel at the salt works in England is from 5s. to 6s. per ton. In England, direct heat is chiefly used; that is, the fires are made underneath the pans of vessels containing the brine. In America and Canada the heat is first used to generate steam in large boilers. This steam is conveyed in pipes to the pans in which the salt is made, and the pipes pass through the brine, communicating their heat, and causing evaporation. The chief business of the salt manufacturer is to utilize to the best purpose, for the production of salt, the heat obtained from the fuel. To this end innumerable patents have been taken out, but few have been so successful as the simple application of direct heat to open pans. The method seems a very primitive one, and most visitors to salt works think they can improve upon what they consider a rude, antiquated system. I have brought before me, and have seen working, scores of patented plans. In all, or nearly all, the idea was to economize heat; and if the whole of salt manufacturing consisted in evaporating the greatest quantity of water with the least quantity of fuel, doubtless many of the schemes would succeed instead of failing, as they do now. The majority of the plans are schemes for generating steam and using the heat, but occasionally (as just recently) gas under pressure, mixed with air, is lighted under a small kind of diving bell, and all the heat thus generated is communicated to the brine in which the heater is immersed. Perhaps the most successful method of utilizing heat is by what is called the vacuum process. In this, again, steam is generated in a boiler, and used to cause evaporation in a closed vessel. Thus, roughly speaking, salt manufacturers employ either direct heat from the furnaces or steam generated in a boiler and conveyed through pipes.

Before describing more at large the methods used for producing the various kinds of salt, it may be well to recall the composition of brine.

In sea water, and the water of salt lakes and of most brine springs, the proportion of salt is comparatively small, and that of water very large. Hence, before any salt can be made, the water must be reduced so as to leave the proportion of 76 water to 24 salt; or, as before stated, 3 parts water to 1 part salt. To evaporate this water requires a great amount of heat, and it will at once be seen that if the heat obtainable is small, it must be applied for a long time. In artificial

brines, or such natural ones as are found on beds of rock salt, the proportion of water to salt is usually 3 to 1 to commence with; so that it does not take long before there is sufficient evaporation to cause the salt to form or crystallize out of the brine. Brine boils at 226° Fah., but it is not necessary to heat it to this point before evaporation commences and salt forms. The whole business of salt making consists, as was said before, in using the proper amount of heat to produce the kind of salt wanted. The greater the heat, the more rapid the evaporation and the finer the grain of the salt. The lesser the heat, the slower the evaporation and the coarser the grain of the salt. The fine or boiled salt is taken frequently out of the pan, the coarse less frequently, according to the degree of coarseness wanted.

With varying exceptions, adapted to suit different localities, the method used in making solar salt on the sea shore is to allow a quantity of sea water to run into a reservoir or pit, at the top of the tide. From this reservoir the brine is conducted to a series of shallow pits or pans, having a considerable area but little depth; the object being to expose as great a surface as possible to the heat of the sun. The shallowness allows the brine to soon become heated, and evaporation to commence. There is a series of these shallow pans or basins, and the brine, as it becomes stronger by the evaporation of the water, is passed on from one to another, till in the last, being fully saturated, the salt begins to form.

As the heat of the sun obtainable is small compared with fire heat, the process of evaporation is slow, and the salt formed coarse in the grain. This salt is "harvested" at considerable intervals, and only during the hot, dry season. At Syracuse, in New York State, and at Zilwaukee on the Saginaw River, in Michigan, solar salt is made from the brine of the districts. In Syracuse, where the brine is weak, it is first run upon a "flat" or wooden floor with a slight rim round it, only allowing a layer of very shallow brine to lie upon it. When strengthened, this brine is passed to a series of shallow wooden pans about 18 feet by 16, and 4 to 5 inches deep, of which there are many thousands constantly in use. The salt is taken out or "harvested" as it is called twice in the year.

The salt obtained from the Salt Lakes on the Russian steppes, and from Lake Sambhur, in India, as well as from other salt lakes in various parts of the world, is only got in the dry, hot season. At this season of the year the lakes shrink very much in area, and the salt forms in the shallow pools left behind by the receding lake, and in the shallow portions of the lake itself. The salt is taken from the bottom of the pools, or shallow portions of the lake, and stacked on the shores. Lake Sambhur in the wet season is from 15 to 20 miles in length; but in the dry season not more than from 3 to 4 miles.

One of the most interesting deposits of solar salt is that in the Kara Boghaz Gulf, on the east coast of the Caspian Sea. This large gulf, covering an area of more than 2,000 square miles (German), is connected with the Caspian Sea by a narrow entrance about 150 yards wide and 5 feet deep. There is a bar at the mouth of this entrance over which there is a constant flow of Caspian Sea water at the rate of 3 miles per hour, containing slightly less than 1 per cent. of salt. So great is the evaporation over this extensive body of water that it is estimated by the best authorities that at least 350,000 tons of salt are being deposited daily, and an enormous bed of rock salt is being formed on the bottom of the gulf. This is one of the most instructive salt deposits in the world, and shows how, by continuous evaporation, even so weak a brine as 1 per cent. can be made to deposit its salt.

The vessels, if they may be so described, in which solar salt is made are natural basins, such as lagoons and salt lakes, or ponds and pits made along the sea shores. The earliest artificial vessels used in evaporating brine were very small. As the demand for salt increased, the size of the vessel increased in a corresponding ratio, till now pans of enormous size are in daily use. The first pans of which we have any record in this country were made of lead, and were very small. There are two in the Salt Museum at Northwich, which were discovered a few years ago. The smallest is, roughly, 2 feet 1 inch square by 3 inches deep, and holds about 7 gallons. The other is 3 feet 8 inches by 2 feet 8 inches, and 4 inches deep, holding about 20 gallons. This latter pan is about the size used in the sixteenth century, and six of these leads, as they were called, were included in each wich house. In Hall's "History of Nantwich," p. 203, we have the following interesting description: "The ancient way of making salt with us was in lead pans, whereof every wich house had six of equal gage; and in those they boyled their salt with wood cloven and fitted for ye purpose. This was ye way and usage of making salt in this towne till the Vith yeare of King Charles I. (1632). And then it was, that some fancifull persons thought it would be more for their profit to boill their salt in iron pannes (of equal gage with the six leads) with pitte coale, pretending that wood grew scarce."

Thus, at the time that iron was substituted for lead, coal took the place of wood. In 1659 we find a great dispute caused by the substitution of two "great pans," instead of the previous four or six. In 1675, it would seem the large pans were in general use, as in a report made in that year it is said, "Each wich house hath two ovens, a ship, a chamber, or store, and two iron pannes." By a "ship" is meant a long wooden trough, generally a tree trunk hewn out, to contain a store of brine.

Shortly after the proper way of using iron for the making of salt pans was found out, the size of the pans began to increase rapidly. In 1745 Dr. Brownrigg, in his book on "The Art of Making Common Salt," says, "The length of some of these pans is 15 feet, the breadth 12 feet, and the depth 16 inches." In a note he adds, "At many works they use pans of a much less size than here described. But those used at Shields and other places near Newcastle are much larger, being commonly 21 feet long, 12½ feet broad, and 14 inches deep, being the largest salt pans used anywhere in Great Britain." According to a small pamphlet published at Leipsic, in 1776, by a German named Chrysel, who had been in England experimenting at the salt works, the largest pans in the country then were two at Northwich, being respectively 36 feet by 25 feet and 13 inches deep, and 40 feet by 27 feet

and 13 inches deep, and one giant at Winsford 52 feet by 26 feet and 13 inches deep. The average pan at that time is described as 24 feet by 15 feet and 12 inches deep. At the same time Chrysel speaks of the German salt pan being 8 feet square by 9 inches deep. Little by little the size of the pan grew, more especially the length of it; the width being determined chiefly by the length of the raker the man taking or drawing the salt out of the pan could comfortably use. From 1694 to 1823, salt paid a heavy duty, so that the manufacture did not grow so rapidly as after 1823, when the duty was repealed. During the great French war this duty was as high as £30 per ton.

The pans used at the present day are very large. Those actually working in Cheshire and Worcestershire range from 30 feet by 24 feet and 15 inches deep (this being about the smallest now used except in a few of the oldest works, where pans about the size of those in use a century ago still remain) to 130 feet by 25 feet and about 18 inches in depth. The usual size for pans that are required to boil is from 30 feet to 40 feet in length, and from 20 feet to 27 feet in breadth. For pans making coarse salts, the usual size is from 60 feet to 70 feet in length by the usual 25 feet to 26 feet in width, though at many of the modern works these pans are from 70 feet to 130 feet in length, and up to as much as 30 feet, or, in one or two cases, 32 feet in breadth. The most approved width is about 26 feet.

There is no absolute rule for size of pans. There are pans, under which exhaust steam is used, as much as 150 feet in length. Should it be found necessary to use a long pan for boiling purposes it is "mid-feathered" off, as it is called; that is, a portion is divided off by a wooden partition, making a "front pan" for boiling and a "back pan" for coarse salt.

The pans spoken of, so far, are all open pans, and the heat is given to them by fires underneath. Besides these open pans there are a number of circular inclosed pans, known technically as "patent butter pans," from the kind of salt made in them. This salt is the finest made in England. The pans are from about 21 feet to 27 feet in diameter, and are completely covered in. The fires are made under these pans as under the open ones, and the waste heat from the fires and steam from the pans are conveyed under other open pans, where coarse salt is made; or else the waste heat is carried in flues to the stove, where the salt made in lumps, or squares as they are called, is dried.

The growth of the pans from the one holding seven gallons, or the average one of 20 gallons, to that in use now containing 30,000 gallons, is comparable to the growth of the trade. In 1675 the three Cheshire "wiches" are stated to have produced 20,000 tons of salt annually. In 1875, when the large pans were in extensive use, the same district produced about 1,750,000 tons.

The pans in use in America differ very considerably, with few exceptions, from those in use in this country. In Syracuse, New York State, and Zilwaukee, in Michigan, "covers" are used when solar salt is made. In Syracuse, Warsaw, Saltville, in Virginia, and at a few small works in other parts of the country, "kettles" are used. These are very similar in appearance to the ordinary washing boiler found in cottages in this country. These kettles are set in a double row, sometimes to the number of 100, and the flues go underneath. In several cases, instead of the kettles being set directly over the flues, they are set in what are called "jackets," and steam is forced into this "jacket" or steam chamber. The pans, however, in most common use are called "grainers." These are made of wood, the general size being about 120 feet by 11 feet, and 22 inches deep, though some are as long as 190 feet. Lying near the bottom of these grainers are iron pipes, about four inches in diameter, which pass up and down the pans, and through which live steam is passed. In the lumber districts, however, the exhaust steam from the saw mill boilers is used to heat the brine. In the St. Clair district, Michigan, and the Kansas salt districts, iron pans, similar to those in England, are being generally adopted. At St. Clair a circular pan—similar to the patent butter pan in use in England—was being worked four years ago. At Silver Springs, in New York State, and, more recently, at Cayuga, in the same State, and also at several places in Michigan, vacuum pans are being used. These pans are the most successful patent pans now being worked. They consist, generally, of a cylindrical vessel, containing a set of pipes. The brine to be evaporated is either contained in the pipes, and the chamber heated by steam, or the chamber contains the brine, and the pipes the steam, which is used direct from the boiler. As fast as the steam produced by evaporation rises, it is carried away by a powerful air pump and a vacuum kept. Evaporation is by this means rapid, and the salt forms very quickly. It is proposed to use the steam thus drawn off to heat another similar vessel, and in some cases a third. The vacuum pan has its advantages, but brine is difficult to deal with, and the pipes get coated with sulphate of lime and rendered almost inoperative.

In many places it is customary to heat the brine before passing it into the evaporating pans. Most frequently this is done by waste or exhaust steam, or the pipes through which the cold brine passes are carried at the back of the fires or along the flues. Occasionally the brine heaters are placed at the back of the pan, and between it and the chimney, so as to still further utilize the heat.

In England the pans are made of either iron or steel plates, riveted together. The usual thickness of the plate is ½ inch for steel and ¾ for iron, with ½ inch or ¾ for the rims. The sizes of plates vary very much, from about 3 feet to 8 feet in length, and from 1 foot to 4 feet in breadth. The pans are heated by fires made under them. These vary from 2 to 4, according to the width of the pan. The usual number is 3 for 24 feet, though many 25 and 26 feet pans have 4 fires. The fire grate is about 5 feet in length, and has fire bars from 4 feet to 4 feet 6 inches, and a dead plate, as it is called, in front of them. The distance of the fire bars from the pan bottom is usually from 2½ to 3 feet, though in special cases more. The heat from the fires passes under the pan along flues to the chimney.

There are many systems of arranging these flues, but the object in all cases is to economize heat by



making all possible use of it under the pan, and not letting it escape too soon up the chimney. It is impossible to utilize all the heat, for the draught up the chimney, which is necessary to make the fires burn briskly enough to sufficiently heat the brine, carries much heat with it.

In the case of the short pans, where the brine is required to boil, so that salt suitable to form the squares or lump salt of commerce may be made, the surplus heat, not used in making salt, is passed through flues and utilized in the stove or drying room at the rear of the pan.

It is not necessary to enter into all the details of construction of the pans or the hurdles upon which the salt is placed when taken out of the pans or the pan houses, or other common arrangements; it will be more interesting to describe how the numerous salts of commerce are produced and fitted for the purposes for which they are used.

From what has been previously said, it will have been seen that the whole process consists in the right manipulation of the heat employed. To produce very fine salts the brine must boil, which it does at 226° Fah. The coarsest salt does not require more than about 90° Fah., and between these ranges the various kinds of salt are produced.

The grades of salt manufactured in this country may be classed under the heads of either (a) fine salt or (b) coarse salt. The fine salts are such as require the brine to boil, and are technically known as butter salts and stoved salts. The butter salt is divided into patent butter, fine butter and coarse butter. The stoved salts are usually known as handed squares and factory filled squares or lumps. There is no difference in the quality of the salt in butter and stoved salt. Both kinds are boiled salts, but the butter salt is drawn out of the pan in bulk and allowed to drain, then taken into a storehouse and stored in bulk. The stoved salt is drawn out and placed in moulds or tubs, as they are called; then, after draining, it is turned out of the tubs and carried into a hothouse or stove to be thoroughly dried. The coarse salts are known as common salt and fishery salt, and there are varying grades of both. Common is chiefly known as either fine common or coarse common. Fishery salt is usually classed as second fishery, best fishery, or best Scotch and extra fishery, described as either X or XX. There is a kind of salt coarser still, known as bay salt. These classes include really all the salts of commerce. There are special grades made for special purposes, or to meet special fashions, that have particular names given to them, such as cheese salt, brisk salt, middle grain, marine, Boston common, light Lagos, special coarse, besides numerous brands of factory filled salts, having particular names, as well as many kinds of table salt, sold under all sorts of names and descriptions.

The pans are worked by men known as firemen and wallers. The men drawing the salt into moulds very often combine both the fireman and the waller in themselves, and are generally known as lumpmen and salt boilers. The business of the fireman is to "put the salt into the pan," as it is termed. He is indeed the real maker of the salt, and it is his business to attend to the fires and see that the proper degree of heat is maintained to produce the salt required. He has a damper placed in the flue near the chimney to regulate the heat. The regulation of the heat is almost entirely a "rule-of-thumb" question. It is very rare, indeed, that a thermometer is used. The technical knowledge acquired enables the man to see at a glance whether the pan is working properly; and the quantity and quality of the salt produced show whether he has done his duty. Besides attending to the fires, it is part of the fireman's duty to "rake off," as it is called, that is, to rake the salt back that falls over the fires, so as to prevent the plates burning. In some cases he has to rake the salt from the middle of the pan to the sides. He has also to see that the pan is kept properly supplied with brine, which is usually allowed to flow gently into the pans during the making of the salt. The whole of the brine is never evaporated, or the salt would be difficult to draw out, and would often be completely discolored and spoiled.

The man whose duty it is to draw the salt out of the pan is called a waller, from an old Saxon name meaning a boiler. In early times, when the pans or leads were small, one man boiled the salt and drew it out of the pan. When pans increased in size, the waller got an assistant to help in the firing and to wheel the ashes away. Now, in many cases, the fireman and the waller are entirely distinct. The fireman having put a proper quantity of salt into the pan, the waller proceeds to lift or draw the salt out, using a peculiar bent perforated shovel called a skimmer. His only other tool is a raker, either with a long or short handle, to bring the salt near enough to the side of the pan to be lifted out. As the brine is not all evaporated, the salt in being lifted through it is washed, and much of the brine runs back into the pan through the perforations in the skimmer. All salts, except such as are put into moulds to be stoved, are thrown on a flat floor or hurdle, sometimes raised as high as the rim of the pan, so as to allow the brine draining from the salt to run back into the pan. Where, however, brine is plentiful, the hurdle is level with the "standing side" or place where the waller stands to draw the salt. After the salt has remained some hours on the hurdles, for the bulk of the brine to drain out of it, the waller fills it into carts and wheels it to the storehouse. The quantity of salt drawn out of a pan depends upon the size of the pan and the length of time the salt remains in the pan, and varies from five to eight tons per day in the case of handed squares or factory filled squares. Where pans are drawn once a day the quantity of salt varies from seven to ten tons or more; where every two days, these quantities are doubled. Fishery pans, drawn every seven, ten or fourteen days, usually have from twenty-five to thirty-five tons of salt in them.

The brine from which the salt is made in Cheshire and Worcestershire is found just overlying beds of rock salt. It is simply the ordinary spring or well water of the district that has come into contact with the salt beds, and has thus become nearly or quite saturated with salt. A shaft or well is sunk to this brine and it is pumped up and conveyed to large reservoirs made either in the earth or made of wood. From these reservoirs the brine runs through iron pipes (though perforated tree trunks were formerly used) to the pans.

The brine as pumped from the earth is generally as perfectly clear as the purest spring water. When thus pumped up it may, however, be either weak, that is, not fully saturated, or may contain impurities. Brine is rarely if ever a solution of pure chloride of sodium and water; and often requires a certain amount of treatment either before or during the manufacture. When the brine is merely weak it is a simple question as to the cost of the fuel necessary to evaporate the water, whether it will pay to make salt out of it or not. The chief impurities in solution are sulphate of lime, chloride of calcium and chloride of magnesium. There are, at times, impurities in suspension, such as marl, or clay, but these can be allowed to settle in settling tanks or to be filtered out. Occasionally a gelatinous mixture, chiefly jelly from calves' feet, made into a broth, is used. This is put into the brine, and as the brine heats a scum forms on the top which is taken off. The impurities in solution are more difficult to deal with. The sulphate of lime deposits at a less heat than the chloride of sodium, and forms a scale on the bottom of the pans. A portion of salt deposits on the lime, and the whole forms a hard crust of salt and sulphate of lime, known as pan scale. Over the fires, where the salt that falls is continually raked back, only a very thin lime scale forms, which is very hard and almost insoluble in water. Every brine contains more or less of sulphate of lime. It is this sulphate of lime that interferes so materially with the vacuum pan process, and many other patented processes that might otherwise succeed. It is necessary, where the lime is in excess, to scale or pick the pans very frequently. Boiling pans scale much more freely than the pans used in making coarse salts, and require letting out at intervals of two or three weeks to be scaled or "picked," as it is called.

The chlorides of calcium and magnesium are only present in small, almost inappreciable, quantities, in English brines; but in the American brines, especially in the older salt districts, they are present to a serious extent. Where these chlorides are in excess the salt very readily imbibes moisture, and, at the same time, it is nearly useless for curing purposes.

It is usual to treat the American brines with quicklime in the reservoirs, and this is allowed to gradually settle, so that some time must elapse before the brine can be used. Hence numerous small tanks or reservoirs are required. Where kettles are used flat sheets of iron are suspended in them, and as the brine heats the objectionable ingredients, to a considerable extent, deposit on these plates, which are then removed. Where, as in pans or grainers, this cannot be done, the salt is often washed in a solution of saturated brine and soda, which removes the chlorides. Brine is very easily affected by various ingredients, and small quantities of soap, glue, resin and similar things are used for various purposes difficult to explain. This is called, technically, "poisoning" the brine. The grain of the salt is chiefly affected by these things. A small fragment of butter will change the working of a pan, and a very small quantity of several very simple, but very mischievous, materials will entirely alter the working of the brine and change the quality of the salt. It is the knowledge of these various apparently trifling things that distinguishes the old salt maker from the novice; and the lack of this knowledge that renders so many patent processes useless.

The natural salt crystal, when heat is used to evaporate, and the crystals form on the surface of the brine, as is usually the case, is in the shape of a hollow, inverted pyramid, technically known as a "hopper." This hopper only forms when coarse salts are being made, and the surface of the brine is quite still. The hoppers float on the surface and keep increasing in size and thickness until they will no longer float. They then sink to the bottom of the pan, and if allowed to remain become solid and lose their regular shape by others falling on them and forming an irregular mass. In boiled salts the crystals which first appear on the surface of the brine are broken by the motion caused by boiling and do not form hoppers visible to the eye, but sink quickly to the bottom as minute flakes or grains.

The crystal of rock salt is a perfect cube, with a line of cleavage parallel with each face of the cube. This crystal is of very slow growth, and forms at the bottom of the brine when the evaporation is very slight. Rock salt crystals are semi-transparent.

The following will give an idea of the processes pursued in salt making:

**Patent Butter Salt.**—This salt has the finest grain of any salt manufactured. The pan used is circular and covered over, and the brine is kept boiling. There are sets of rakers kept moving by machinery, so that the salt, owing to the constant motion of the brine, does not crystallize except in very small grains, and these are carried by the rakers into the pocket at the side. There are two sets of men employed at these pans, as they are constantly at work, and the salt is removed twice every twelve hours.

**Fine and Coarse Butter.**—These qualities of salt are made in open boiling pans, and the fine butter approaches very near in grain to the patent butter, but is only taken once in twelve hours out of the pan. The pans used for butter salt are shorter than those used for the coarser salts. There is a gradual merging of butter salts into common salts, so much so that it is difficult to tell whether to call some qualities coarse butter salts or fine common salts. The coarse butter salts do not require the brine to be kept constantly boiling.

**Common Salt.**—This salt, which is the next in coarseness to butter salt, is made at various temperatures, but generally from 170° Fah. to 190° Fah. Common salt, called in some districts broad, is the most cheaply made of any salt. The pans are very long, and there is a greater utilization of the heat under them than under any of the pans where the brine is boiled, and, consequently, more salt is made per ton of fuel consumed. It is usual to consider two tons of common salt made for each ton of fuel used as satisfactory. This is about the average, though it varies with the quality of the fuel. As much as two and a quarter tons of salt per ton of fuel is at times produced. It must be understood that saturated brine is used, or these results could not be obtained. Common salt is the salt used at the alkali and other chemical works; also at soap works, glass works, and a variety of other works. It is used also, under the name of broad salt or agricultural salt, for land. (Sometimes by agricultural

salt is understood refuse salt or soiled salt of any kind.) Common salt is taken out of the pan every twenty-four hours, if it is to be required to be fine, but only once in two days for the ordinary or coarser kind, and every three days for the special coarse.

**Fishery Salt.**—This salt—which obtains its name because of its extensive use for curing fish—is a coarse solid grained salt. Fishery salt approaches most nearly to solar salt. The degree of heat necessary to produce this salt is less than that required for common salt, and the salt is allowed to remain longer in the pan, so that the salt crystals can grow and "feed," as it is called. Some brines are more favorable for making fishery salt than others, though it seems difficult to say why this is so. The chemical composition of the different brines is so similar that only by practice can it be known which brines are most suitable for any particular class of salt. A few pounds of alum put into a pan of brine cause the crystals of salt to form of a harder and more solid kind. For what is called second fishery, which is the most extensively used, the salt remains in the pan seven days. This is the usual time, though with a few brines four or five days will suffice, while with other ten days will scarcely be enough. Best fishery, or best Scotch fishery, as it is called, is coarser and solidier in the grain, and remains 14 or more days in the pan. When the salt has been so long in the pan, a portion of it near the fires is much coarser than the rest, and this forms the extra fishery or X and XX.

**Bay Salt,** of which very little is specially made, is the coarsest salt manufactured. Before any brine is put into the pan, thorns are laid all over the bottom of the middle portion of the pan, and strings are stretched across from side to side, a few inches apart; the brine is then put into the pan, and the fires made hot enough to nearly boil the brine. As soon as this point is reached, the fires are raked out, and the brine allowed to quickly cool down. In this process of quick cooling, the crystals of salt form in cubes all over the strings and thorns. Brine, when nearly boiling, will contain more salt than when cold, so that the sudden cooling causes the salt to rapidly crystallize out. When the crystals have "set" on the thorns and strings, small fires are put again under the pans and kept up continuously for about a month. The salt is then drawn out and the crystals taken from the thorns and strings. Besides these there are crystals on the sides of the pans. After draining, the large crystals are picked out by hand and the remainder of the salt is passed through riddles, and the coarse crystals all put into a warm room to dry or be stoved. It is a very pretty sight to see a pan with the strings and thorns all covered with crystals. In making bay salt and best fishery salt there is always a considerable quantity of inferior grained salt, especially at the back end of the pan, caused by the flaky, small grained salt formed on the surface being carried back by the circulation of the brine from over the fires to the back or cooler end of the pan.

**Handed Squares Stoved,** or lump salt, such as is carried about in hawkers' carts for sale, and is used largely for household purposes, is the same quality as fine butter salt. The name butter was given to the salt because of its extensive use in butter making. Instead of the waller drawing out the salt in a large heap on the hurdles, he puts it into tubs which stand inside the pan, generally on a little platform at the side. These tubs are of various sizes, and are known by the number of lumps that make a ton of salt. The most common sizes for home use are one hundred and sixties, one hundred and twenties, and one hundreds. The larger size, or eighties, are generally shipped coastwise. The waller proceeds to fill the tubs that he has placed inside his pan, and, as he fills them and the bulk of the brine has drained out, he lifts them out upon the hurdle to still further drain. After an hour or so the lumps are turned out of the tubs, and, being "happed," or patted, into proper shape, are carried into the hot house, where they are allowed to remain till thoroughly dried through. The temperature of the stove varies very much, but is generally about 130° to 140° Fah. When a lump is thoroughly dried, it will "ring" when struck. Unless a lump is thoroughly dried, it will break or go soft when in transit in the boats or vans. It is necessary that the squares or lumps made for sale should be of fine salt, as the finer the salt the harder it sets and the less easily is it broken. Only about one and a half tons of squares are made per ton of fuel used, much heat being required in the stove to dry the salt.

**Factory Filled Stoved Lumps.**—In some trades it is necessary to have stoved salt, but squares or lumps would be very inconvenient. When this is so, the lumps, after drying in the stove, are taken to a mill and broken and filled into sacks or bags. For the finer qualities of salt sieves are used in connection with the mill, and all degrees of fineness, from ordinary butter salt to superfine table salt, are produced. The trade in what is called packet salt is extending. Instead of the large lumps, which are apt to get dirty and soft, small calico bags, holding 12 lb., 7 lb., 5 lb. and 3 lb., are much used, especially in America. In England, jars, bottles, drums and paper packets are much used, and the penny packet, or even halfpenny packet, is coming into vogue. The salt in all these packages is a stoved salt, which has been milled and sieved. In America there is a general absence of stoves or drying rooms, and no moulds are used. The general use of grainers and steam leads to the production of what is known as common fine salt, a kind of coarse butter salt. As practically all the heat in the steam is used in making salt, none is left for stoves. To meet this difficulty, what are called "Hersey Driers" are used. These are iron cylinders, similar to an ordinary land boiler, of some 30 to 36 feet in length. They are set at an angle over a furnace, or have a jacket for steam. The salt, after being drawn from the pan and allowed to drain, is passed into the upper end of the drier, and as this latter revolves, the salt passes slowly over the heated surface till it reaches the lower end of the drier, where it is discharged perfectly dry and very hot. If a finer grade of salt is wanted, it is passed through small mills, and thence conveyed to the packing rooms, where it is filled by girls or young women into the various packages before described, and usually these are stowed in barrels, which in America take the place of sacks in this country.

It would take too long to describe the trade in salt

at home and abroad. The magnitude of it can, however, be conceived when the last government return for 1893 gives the following figures for the United Kingdom: Rock salt, 192,960 tons; salt from brine, 1,731,069 tons, or a total of 1,924,029 tons. The year 1893 was less than 1892 by some 34,000 tons.

The salt districts of England where white salt from brine is produced are Cheshire, where in 1893 1,213,362 tons were produced; Worcestershire, which produced 192,021 tons; Middlesborough district, 289,198 tons; Fleetwood, 37,488 tons. In Cheshire the trade has been carried on from the earliest times, and is now connected with Winsford, Northwich, Middlewich and Sandbach. In Worcestershire the manufacture has existed for centuries, at Droitwich, but of late Stoke Prior has produced most. Middlesborough and Fleetwood have only commenced to make salt within the last ten years.

Much more might be said about the salt manufacture did time permit, but it would not be right to conclude without referring to the results following the pumping of brine.

As before mentioned, brine is formed in the salt districts by the ordinary spring or well water coming into contact with the beds of salt. The moment the water reaches the salt it proceeds to dissolve it, and continues to do so until it has taken up sufficient to form a liquid containing 26 per cent. of salt. As fast as this liquid is pumped up, fresh water takes its place, and so the process of solution is continuous. The result is that the surface of the salt is eaten away in deep furrows, or miniature valleys, and the earths lying above follow the contour of the water-worn salt, making similar valleys and subsiding areas on the surface of the land. Where these sinking areas are in towns much destruction is wrought among the buildings, sewers, gas and water pipes, streets, roads and other property. In the neighborhood of brooks or rivers the subsiding areas soon become pools of water, and finally large lakes, continually increasing. In districts such as Northwich, where there are numerous worked out salt mines, the subsidence is much more serious, and enormous mischief is done. The salt districts of Cheshire are extremely interesting, showing the action of water on beds of salt on a gigantic scale, and demonstrating how changes of the earth's surface can be made by a very simple means. The question of subsidence, so interesting in itself, is too extensive to be dealt further with at the end of a paper already too long, I am afraid.

#### A GOSSIP ON TOBACCO.

WRITTEN UNDER THE INFLUENCE OF THE WEED.

AMONG plants of economic value none has been more generally abused than tobacco, and yet with all the blasts and counterblasts that have been written since the introduction of the habit of smoking into Europe, the soothing weed has defied them all; and, perhaps on the principle that "good wine needs no bush," the sturdy old friend of man, both in his solitary hours and convivial moments, not only maintains in this nineteenth century its reputation and veneration, but has increased it in a marvelous degree. This could be readily shown by statistics, but as statistics are for the most part dry facts, quite unsuitable for Christmas time, we will ignore them for the nonce and ask our readers to take for granted what we have said in this respect.

To use a common expression, which in this case is absolutely correct, "volumes have been written" on tobacco, and thousands of volumes, probably, under its soothing influence, to say nothing of the other thousands that are read and enjoyed with the accompaniment of the "pipe of peace." With all this before us, there would seem to be nothing new to say about tobacco, which, indeed, is the case, and on this account we have ventured to take the subject up at a season when a pipe or cigar, or tobacco in some form, is included among the luxuries which constitute the "good cheer" of Christmas; for though tobacco from the earliest period of its introduction among us has been from time to time severely condemned, the old writers who favored its use were much more enthusiastic in its praise than have been the writers of more modern days. It is both curious and amusing to note the opinions of its champions and its detractors ever since the smoking of tobacco became a fait accompli in this country. We may, however, dismiss this part of the question with a quotation from a popular and learned writer on the subject, who says: "Three hundred years ago a few American savages only consumed tobacco, and now it is consumed by all mankind, being the only commodity common to the consumption of all races and all social conditions. Are our lives shorter, our morals worse, or our intellects weaker than for the better part of three centuries the 'poisonous drug,' according to this hypothesis, has been circulating through the veins of ourselves and our forefathers?" Regarding the early history of tobacco the same writer says, "It was in the first week of November, 1492, that Europeans first noticed the Indian custom of tobacco smoking. The two sailors sent by Columbus to explore Cuba returned to the ships of their great commander, and told this among other things new and strange. They found the natives carried with them a lighted fire brand and puffed smoke from their mouths and noses; this their European notions led them to conclude was some mode of perfuming themselves. A more intimate acquaintance with the natives taught them that it was certain leaves of a herb rolled up in the dried leaves of the maize or Indian corn that they thus burned, and inhaled the smoke. It was a novelty to the Spaniards, but it was an ancient and familiar custom with the natives. The aborigines of Central America rolled up the tobacco leaf and dreamed away their lives in smoky reveries ages before Columbus was born or the colonists of Sir Walter Raleigh brought it within the precincts of the Elizabethan court."

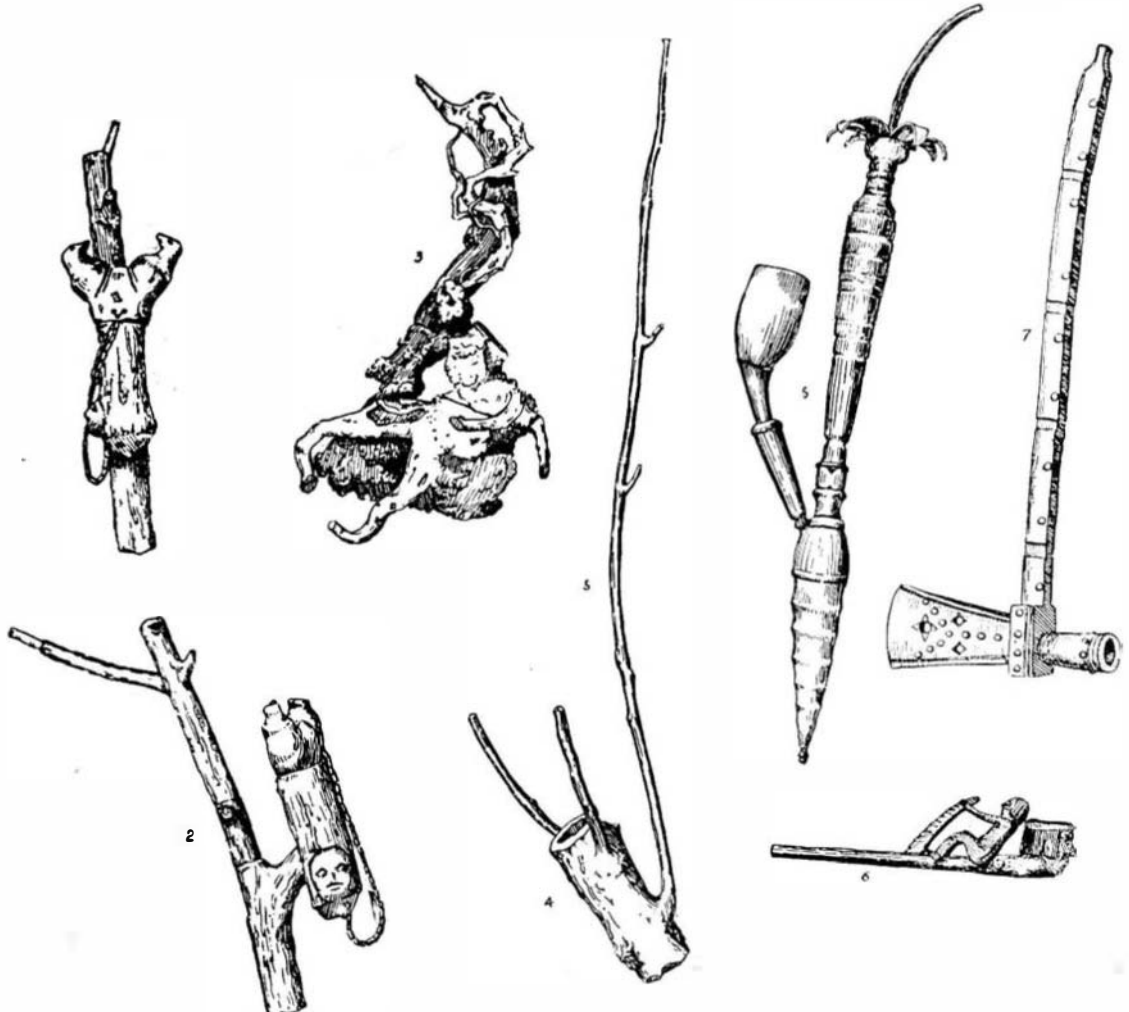
In a translation of the travels in America of Giralamo Benzoni, from 1541 to 1556, the experience of the writer among the native tobacco smokers is given in a very quaint manner, as the following extract will show:

"When these leaves are in season they pick them, tie them up in bundles, and suspend them near the fireplace till they are very dry, and when they wish to use them they take a leaf of their grain (maize) and

putting one of the others into it, they roll them round tight together; then they set fire to one end and putting the other end into the mouth, they draw their breath up through it, wherefore the smoke goes into the mouth, the throat, the head, and they retain it as long as they can, for they find a pleasure in it; and so much do they fill themselves with this cruel smoke that they lose their reason. And there are some who take so much of it that they fall down as if they were dead, and remain the greater part of the day or night stupefied. Some men are found who are content with imbibing only enough of the smoke to make them giddy, and no more. See what a wicked and pestiferous poison from the devil this must be. It has happened to me several times that, going through the

and giving it "a good standing in society," attributes its actual introduction to Mr. Ralph Lane, who was sent out by Raleigh as governor of Virginia, returning to England in 1586, and in proof of this, says: "The historian of the voyage, Mr. Thomas Harriot, and the learned Camden, who both lived at the period, unhesitatingly affirm that Lane has the honor of being the original English smoker."

The dislike of James I. to tobacco is such a well known matter of history that we need only refer to the monarch here as being the originator of a heavy duty which was at that time imposed upon it, and which has continued with more or less change to the present time. From an original twopence per pound duty, James at once raised the impost to six and tenpence,



CURIOSITIES IN PIPES.

1, complex pipe made of wood from Java, front view; 2, side view; 3, pipe made of laurel root, found on the battlefield at Chancellorsville, U. S. America; 4, pipe made of root of white ash from Canada; 5, pipe made of black horn from Java; 6, slate pipe from Vancouver; 7, modern American wooden pipe, made in the form of a tomahawk.

provinces of Guatemala and Nicaragua, I have entered the house of an Indian who had taken this herb, which in the Mexican language is called tobacco, and immediately perceiving the sharp, fetid smell of this truly diabolical and stinking smoke, I was obliged to go away in haste and seek some other place." Benzoni's view of tobacco, as here related, was not, however, participated in by all the early travelers. For a member of Sir Walter Raleigh's expedition in the discovery of Virginia at the end of the sixteenth century, after describing the uses and effects of tobacco among the people, says: "We ourselves during the time we were there used to suck it after their manner, as also since our return, and have found many rare and wonderful experiments of the virtues thereof, of which the relation would require a volume by itself. The use of it by so many of late, men and women of great calling as else, and some learned phisitions also, is sufficient witness."

To Sir Walter Raleigh is usually accorded the introduction of smoking into England, but Fairholt, while giving him the credit of making the habit fashionable,

which had the effect of almost suppressing its importation, and the plant began to be cultivated on English soil, until another act of the King made it unlawful as a home industry. Notwithstanding all this, the use of tobacco continued to increase till it has now become one of the most important articles of import, and one of the greatest sources of revenue, the imports last year amounting to 84,218,342 lb., of the value of £3,566,061. The tobacco plant is capable of cultivation in this country as has been more than once proved, the latest experiments in this direction being those carried on in 1886 by Lord Walsingham, Mr. Faunce de Laune, and Messrs. James Carter & Co., the results of which were embodied in a small book entitled "English Tobacco Culture."

Though the bulk of the tobacco of commerce is furnished by *Nicotiana tabacum*, the allied species *N. rustica* produces some portion of it. The true tobacco is a native probably of some part of South or Central America, but the precise country of its origin cannot now be determined. Martius considers it introduced in Brazil, and it is nowhere known in a truly wild



ROLLS OF NATIVE TOBACCO FROM THE RIVER NIGER.

(The long one measures 2 feet 6 inches high by 4 inches in diameter. The circular one is 18 inches across.)