

charging the digester. All this is a mere question of dollars and cents. There is no absolute objection to using chips in the Mitscherlich process; wood would be saved, labor economized, and time of boiling probably shortened. But, it is claimed by the professor, the output is not so good. Hence, if the better product earns more, even at the expense of material, labor and time, than the so-called inferior, why of course it would pay to follow Mitscherlich's recommendations. It would not be a very significant item of expense to be prepared to use both disks and chips.

(To be continued.)

PIAT'S PORTABLE FURNACES.

MR. A. PIAT exhibited in class 48 of the exposition his system of portable oscillating furnaces, that had already appeared in their novelty at the exposition of 1878. These furnaces have received notable improve-

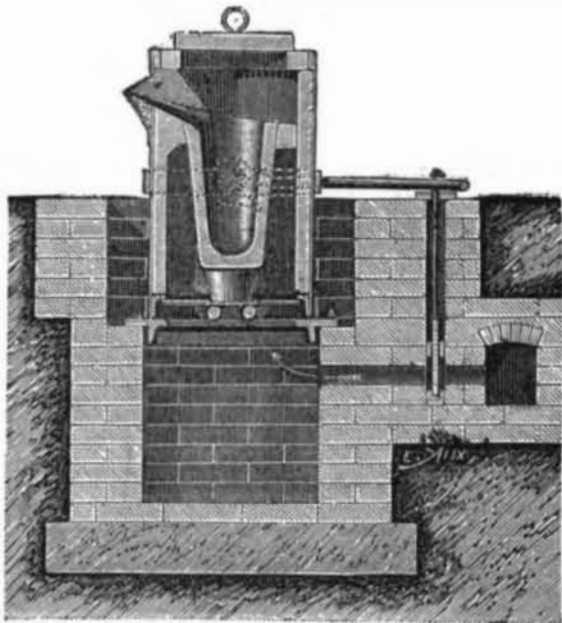


FIG. 1.—SIMPLE FURNACE.

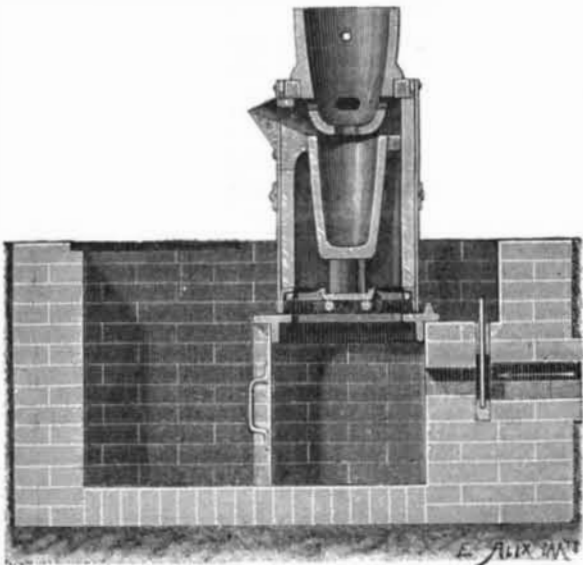


FIG. 2.—DOUBLE FURNACE.

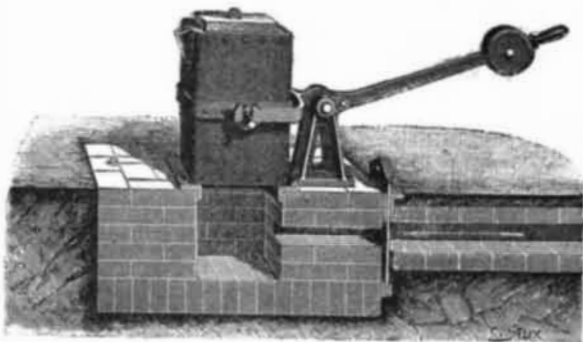


FIG. 3.—FURNACE OSCILLATED BY A LEVER.

ments that adapt them to the melting of bronze as well as of cast iron. They are of boiler plate, and, as shown in Fig. 1, are square, a shape that permits of effecting a great saving in fuel, as the coke lodges in the corners, and the part of the crucible tangential to the sides of the furnace can, without inconvenience, be very close. A steel band provided with trunnions surrounds the furnace at a proper height to allow it to be tilted easily in either direction by means of a lever. It is by means of these trunnions, upon the shoulder of which is mounted an iron handle, that the furnace is raised by means of a lifting apparatus. A spout in front permits of discharging the molten metal.

The base of the furnace is formed of angle irons that receive the refractory lining. These angle irons are provided with sockets in which are adjusted two round bars designed to receive a part of a steel grate and four or six bars, according to the size of the furnace. These bars are allowed a certain mobility that permits of varying their spacing in order to facilitate cleaning and the exit of the scoria.

A support made of plumbago receives the crucible, which is adjusted at the spout against a piece made of refractory clay. This piece forms a part of the body of the furnace into which it is set. At the part exactly opposite the spout there is inserted a refractory clay

wedge, in order to keep the crucible in place. The furnace is then ready to receive the fuel.

As refractory clay is not adapted for the manufacture of crucibles of over 200 lb. capacity, plumbago crucibles are especially employed in these furnaces. These are very simply mounted. The crucible is placed upon a plumbago support of the proper height, and is connected with the spout by means of a mixture of refractory sand and plumbago. At the first firing, the spout and the crucible are firmly united. The air introduced beneath the crucible should have a pressure of from 12 to 18 cm. of water.

With this arrangement, copper and its alloys are no longer introduced directly into the crucible, but rather into what is called a "rehausse," an arrangement (Fig. 2) that permits the flame to attack the metal directly and to melt it much more quickly without affecting its quality. This device, which much resembles a crucible, contains an aperture in the bottom, and, in the circumference, at a proper height, there are several other apertures. At the top there are two apertures that serve to put the rehausse in place on the furnace and to remove it, through an iron bar. The whole of the metal to be melted is put in succession into this rehausse, and all the crucible has to do is to receive it and keep it at the heat of fusion. With this style of furnace, 220 lb. of bronze can be melted in from 20 to

This apparatus is very convenient for making castings that require no more than from 220 to 650 lb. of metal. It permits, too, of making special mixtures that may be needed in certain cases. As the metal traverses only a very thin stratum of coke, and falls scarcely melted into a crucible raised to a good temperature by means of an ordinary blower, it has not the time to take impurities from the coke, and preserves all of its qualities. This device serves likewise for casting brass filings into ingots.—*Revue Industrielle*.

CALIFORNIA BORAX.*

By C. NAPIER HAKE.

Features of the Region.—Between the Sierra Nevada, on the west, and the Rocky Mountains, on the east, and from 35° N. lat. to the Columbia, may be found a succession of interior depressions of a particular character, inasmuch as the rivers and watersheds do not empty themselves into the sea, but are absorbed by the sands of the great desert or lost in the salt lakes. The most remarkable of these depressions, which is known as the Great Basin, is situated from 4,000 to 5,000 feet above the sea-level and occupies an area of 202,500 square miles. Its form is almost a square and its diameter from east to west about 500 miles. Sur-

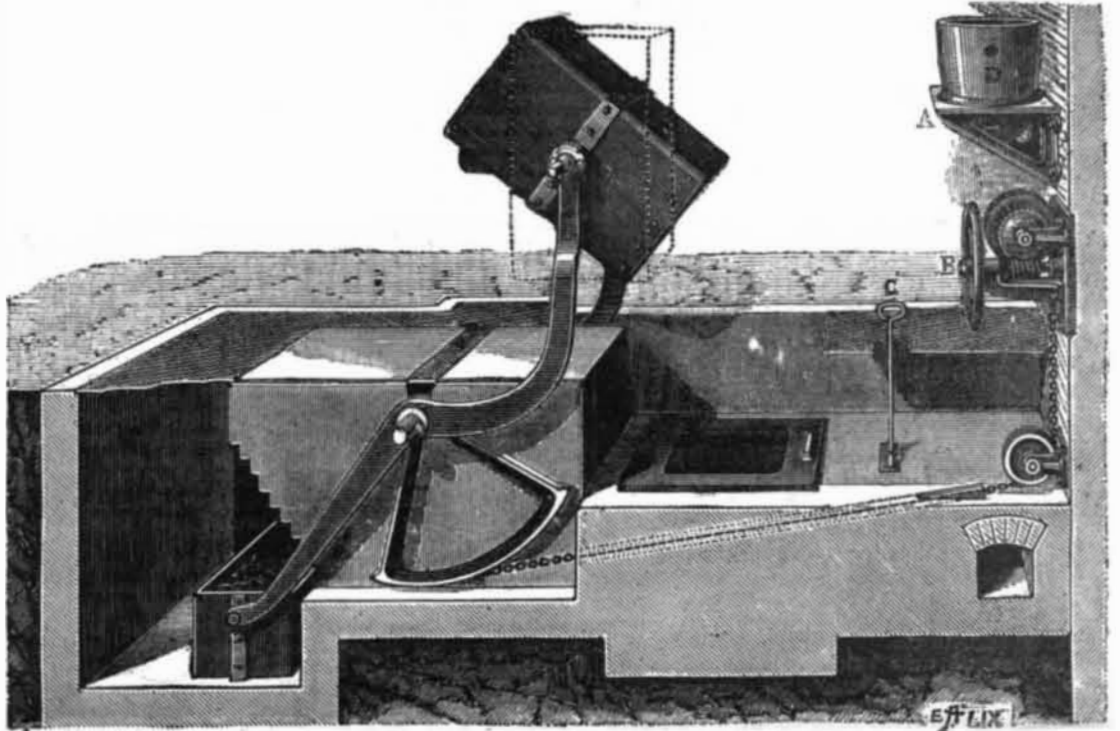


FIG. 4.—FURNACE WITH SUSPENSION APPARATUS.

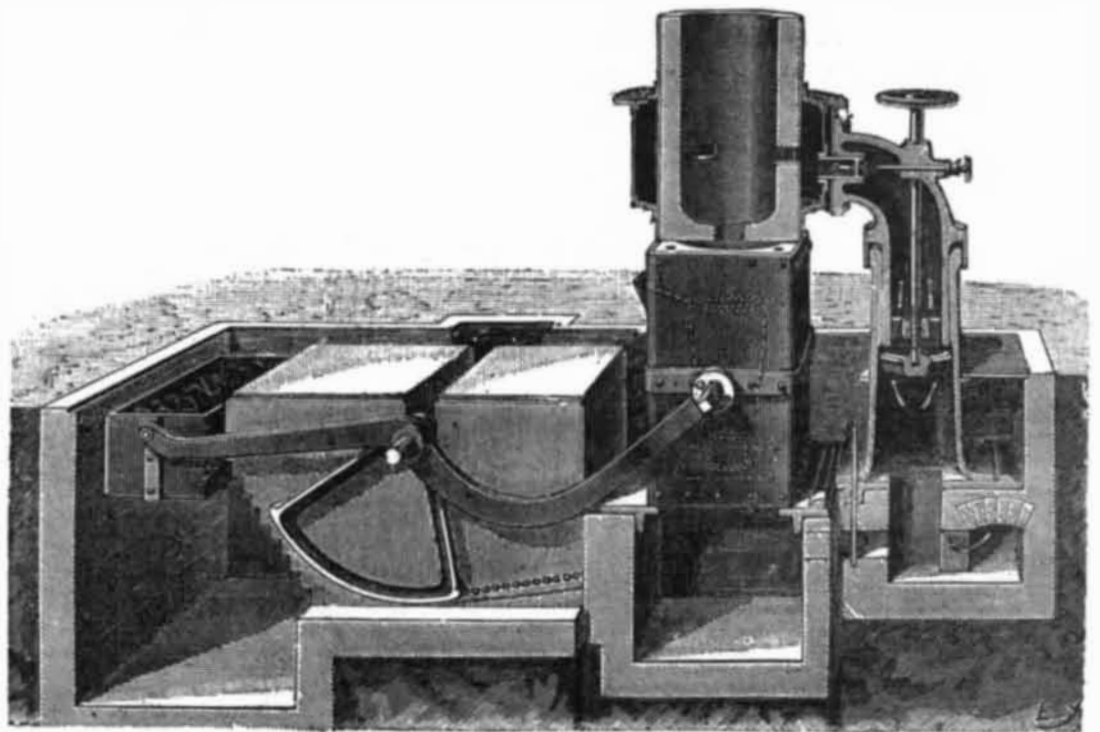


FIG. 5.—FURNACE WITH CUPOLA.

25 minutes, and with a mean supply of coke that ought not to exceed 15 per cent.

When the fusion is finished, the rehausse is raised and the adjustment of the crucible is examined, and if the metal is all right, the air is shut off.

In establishments in which space does not permit of installing cranes or other lifting apparatus, the furnaces may be mounted upon cast iron frames and be made to oscillate upon trunnions (Fig. 3) in the direction of the spout in order to pour the metal into a ladle, or backward in order to clean them. They can even be turned completely around in order to clean the grate thoroughly.

They may also be mounted upon a special apparatus, such as shown in Fig. 4, and which gives the workman a free space around the furnace.

The furnace just described is adapted for the melting of copper and all its alloys, and, when combined with a small cupola, to the melting of cast iron. This arrangement is shown in Fig. 5. The cupola, which is of small dimensions and has an aperture in the bottom, is placed upon the furnace and is carried by a hollow column which serves also as an air conduit. The introduction of the air is regulated by a cock. When the metal is melted, a screw permits of slightly raising the cupola, which then turns freely in its socket.

rounded on all sides by lofty mountains, its lakes and rivers have no visible communication with the ocean. Partly arid and scarcely inhabited, the feature of this vast country is that of a wilderness.

The interior of the Great Basin is dotted with mountains of a uniform aspect, each rising abruptly from a base of from 9 to 20 miles in circumference, to a height varying from 2,000 to 5,000 feet above the plain; their slopes are covered with trees and verdure, and their summits are capped with snow during the greater portion of the year. This on melting causes innumerable torrents, which are afterward lost in the lakes or sucked up by the sand.

Another grand characteristic of these deserts is the phenomenon caused by the river rolling with a crashing noise through the enormous ravines which the Mexicans call *canons*. These ravines, which are often impenetrable, are hollowed out by the action of the waters to a depth of 300, and even in some places 900 feet, their faces being usually quite perpendicular and so close that you could easily cross from one bank to the other by means of a bridge a few yards in length.

Among the rivers irrigating the Great Basin, the

* A paper read before the London section of the Society of Chemical Industry.—From the *Journal*.

finest is the Humboldt. This river has two branches, which take their source in a group of mountains situated to the west of the Great Salt Lake. After a course of 55 miles the two branches unite in one bed. For upward of 300 miles no obstacle whatever impedes its course and no tributaries run into it. As it advances toward the west it gradually loses part of its volume, owing to the absorption and evaporation of its waters, and finally is lost near the Sierra Nevada in a muddy lake or "sink," the borders of which are flat and whitened by saline incrustations.

The other rivers of the Great Basin on the west are the Salmon River, which flows into Lake Pyramid, the Carson, the Walker, and the Owen, which descend with a terrific noise from the Sierra Nevada, and then disappear in lakes to which these rivers give their name.

Such is the general aspect of these deserts. Except in certain valleys where fertility and beauty afford a most striking contrast to their bleak surroundings, the soil is to all intents and purposes sterile. It is chiefly composed of the debris of volcanic rocks. Beds of lava rich in soda feldspar cover the country to an ex-

discovery of borax and borates in Nevada may be briefly summed up as follows:

In 1864 some borate of lime in the form of cotton balls (ulexite) was found in Columbus Marsh, but no particular notice was taken of this discovery beyond sending specimens to Washington, where they found a place in the cabinet of the State Museum. Between 1869 and 1871 a systematic search was made, which resulted in the rediscovery of the deposits in Columbus Marsh and other deposits of ulexite near Salt Wells. These deposits were worked for a short time only. In 1873 the deposits known as Borax Lake and Teel's Marsh were discovered. The former lies in the Mojave Desert, the latter in Nevada. Both deposits are very extensive. A little later a third deposit was discovered near Dagget, consisting of borate of lime (colemanite).

Situation of Borax Lake.—The Borax Lake, which specially interests us this evening, is situated in the extreme northwest corner of San Bernardino County, and is 450 miles distant from San Francisco in a southeasterly direction.

Mojave station, on the Atlantic and Pacific Railway, the nearest point of shipment, is connected with the lake by a good wagon road, 72 miles in length.

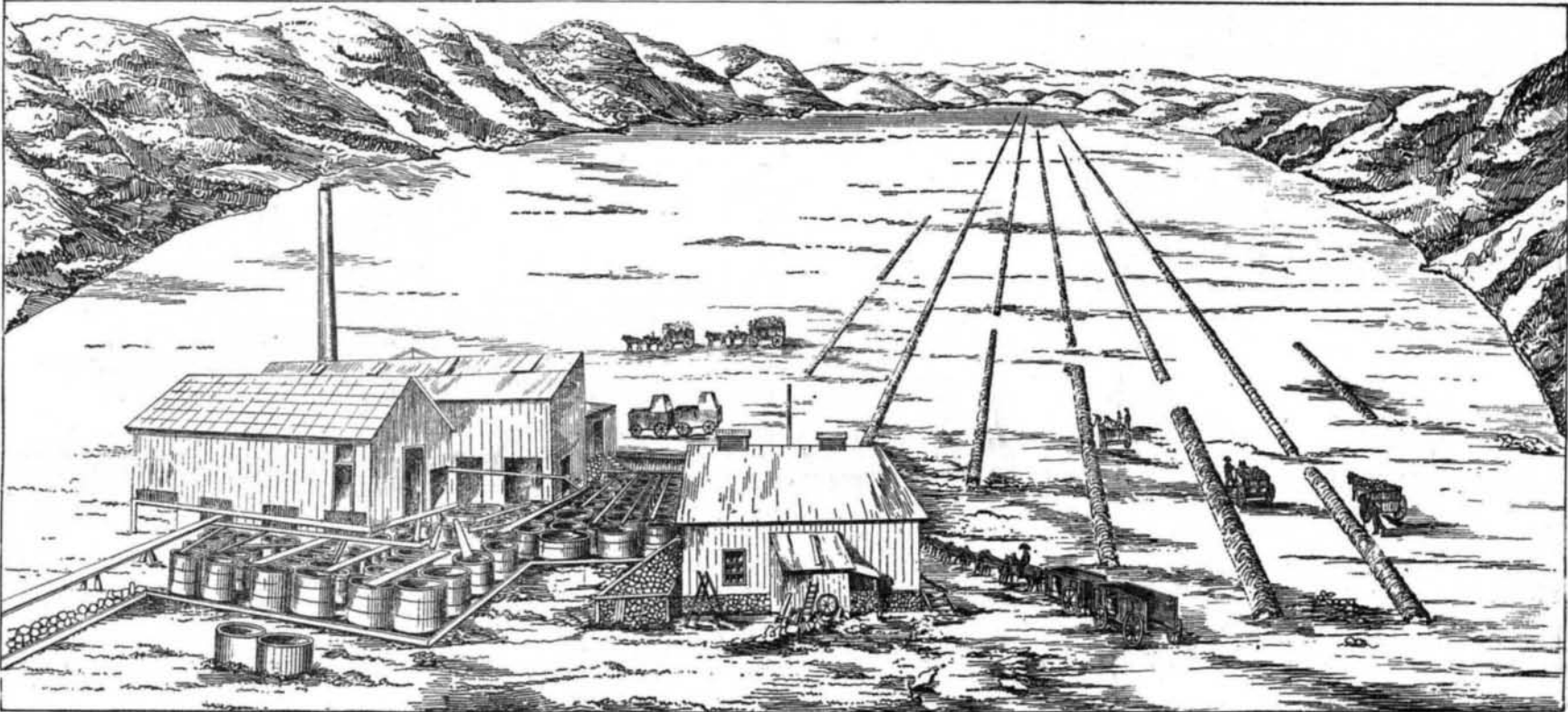
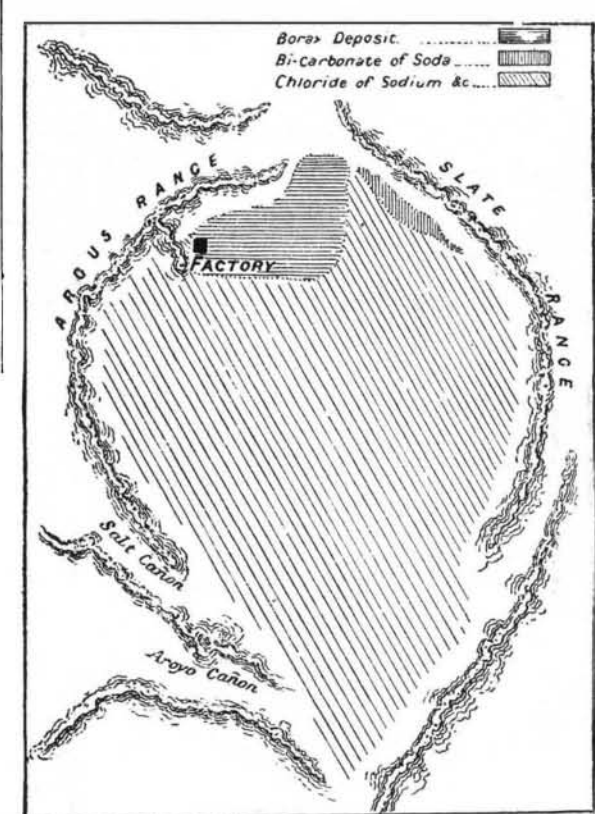
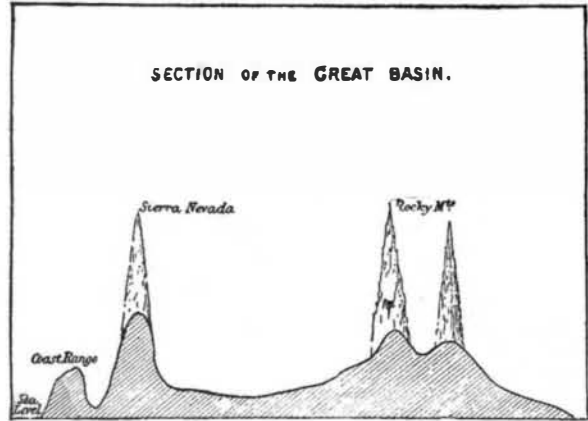
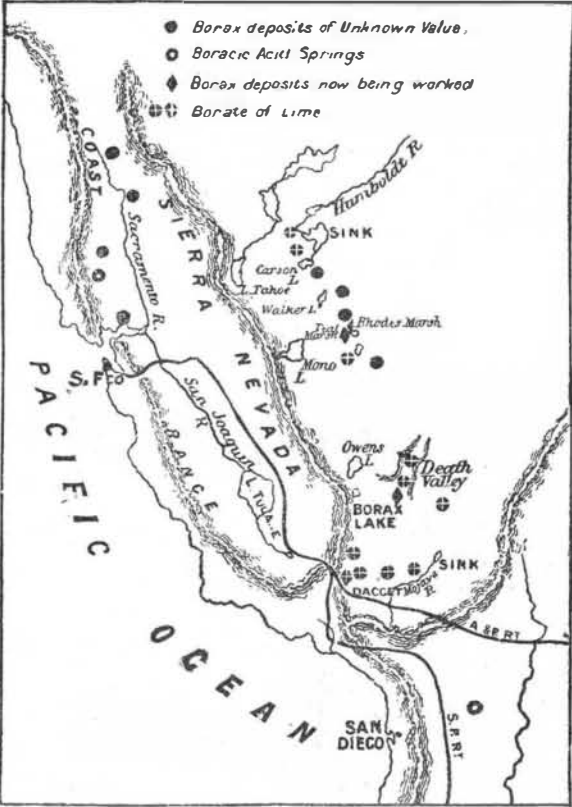
The lake lies in the valley of the State Range and Argus Mountains at an elevation of 1,700 feet above the sea. It is oval in shape and its greatest length and breadth is 12 miles by 8 miles. The greater part of it is covered with a hard saline incrustation varying in thickness from a few inches to several feet. The surface is covered with white efflorescent matter largely mixed with sand. Under the hard crust the lake consists of one vast bed of black mud containing a large proportion of iron sulphide saturated with saline matter and strongly impregnated with sulphureted hydrogen gas. The thickness of this mud bed has not been determined.

In the lake is contained common salt, carbonate of soda, hydrated and anhydrous bicarbonate of soda, baborate of soda, sulphate of soda, hydrated and anhydrous sulphate of magnesia, salts of ammonia, and traces of bromine and potash. Although I made a dili-

have at present no commercial value. The latter is, however, of considerable interest as an example of the ammonia soda process being carried on by nature. All the ingredients necessary for this process are contained in the waters underlying the deposit, viz., ammonia, carbonic acid, and common salt. The deposit is from 6 in. to 18 in. thick, and in many places almost chemically pure.

Crystal Beds.—Near the center of the borax section, which is the lowest level of the lake, there exists a patch covering an area of about 300 acres, which is nearly always covered with water to a depth of from one inch to a foot. This patch is called "the crystal bed," from the fact that the mud underlying the water is full of large crystals. These crystals are not deposited regularly, but form nests several feet in thickness, and penetrating 3 or 4 ft. downward.

The spaces intervening between these nests are filled up with mud, and are comparatively free from crystalline deposit. By damming off the water I was enabled to make an examination of some of these nests. The crystals thrown out consisted of carbonate of soda and common salt, with a large proportion of borax, some of the crystals of which measured as much as 7 in.



GENERAL VIEW OF THE BORAX LAKE AND WORKS.

tent of many miles; the rain in its season falling on these causes their superficial decomposition and gathers up the soluble salts in its passage. Owing to the general dryness of the atmosphere which prevails, however, for the greater part of the year, evaporation follows solution, and whatever is dissolved tends to rise to the surface, there to crystallize and form what are called efflorescent crusts. These crusts, which at times measure from one foot to 18 inches in thickness, the rain again dissolves away, and if the region contains natural depressions or basins these are transformed into saline lakes. The saline deposits or incrustations so largely distributed over this great plain include common salt, carbonate of soda, sulphate of soda, sulphate of alumina, sulphate of magnesia, borax and borate of lime, sulphate of lime, and carbonate of soda and lime, etc.

Borax Deposits in Northern California.—The first deposits of borax discovered in California are situated in Lake County, about 100 miles north of San Francisco. Some of these deposits were worked successfully between 1864 and 1874, but they now lie idle.

Discovery of Borax in Nevada.—The history of the

gent search during the four weeks I remained on the lake, I was unable to detect a trace of iodine. A new and highly interesting mineral has been discovered in the mud of this lake in small hexagonal crystals, to which the name of "hanksite" has been given, after Professor Hanks, of San Francisco, whose name is so honorably connected with the mineral development of California. Its composition is expressed in the formula:

$4 \text{Na}_2\text{SO}_4, \text{Na}_2\text{CO}_3$

The lake may be for all practical purposes divided into three sections, each section representing well defined deposits of—

- (1) Biborate of soda,
- (2) Bicarbonate of soda, and
- (3) Common salt.

The borax occupies the northern portion of the lake. A very pure deposit of bicarbonate of soda lies on the N.E. shore. The remaining surface deposits consist chiefly of common salt, which becomes purer toward the southern extremity of the lake.

The common salt and bicarbonate of soda deposits

During one exceptionally dry season, when the water was low, about 700 tons of borax were refined from this source.

The underlying water at a depth of fifteen feet contains:

Carbonate of soda,
Chloride of sodium,
Sulphate of soda,
Borax, and
Salts of ammonia.

The ground around this crystal bed consists of a dry, hard crust about 1 ft. thick. This crust contains carbonate and sulphate of soda and about 1 per cent. of borax. On this hard crust there is, again, another deposit of efflorescent matter, containing about—

	Per cent.
Sand	50
Sulphate of soda	16
Common salt	12
Carbonate of soda	10
Borax	12

This surface deposit represents the chief source of raw material for the manufacture of refined borax.

The deposit is worked in the following manner:

Method of Working Deposit.—When the crude efflorescent surface has accumulated to a depth of about 1 in. in thickness, it is loosened by means of a shovel and swept into windrows, space being left between each windrow to allow of the passage of a cart.

The surface thus cleared of its salts begins to renew its coating. The moisture, as it creeps upward, is evaporated by the heat of the sun, leaving the solid matter, which is held in solution on the surface. This action is allowed to go on for three or four years before the surface is again disturbed. In order to get some idea as to the proportionate growth of the different salts contained in this efflorescent matter, I took samples representing 6 months' growth, 2 years' growth, 3 years' growth, and 4 years' growth. From all the sections from which these samples were taken, the surface has been removed three or four times during the last 12 years, and in most places marks of the old windrows were visible.

ANALYSES OF CRUDE BORAX MATERIAL FROM DRY LAKE.

	Six Months' Growth.	Two Years' Growth.	Three Years' Growth.	Four Years' Growth.
Sand....	58.0	55.4	52.4	53.3
Carbonate of soda....	5.2	5.0	8.1	8.0
Sulphate of soda....	11.7	6.7	16.6	16.0
Chloride of soda....	10.9	20.0	11.1	11.8
Borax....	14.2	12.9	11.8	10.9
	100.0	100.0	100.0	100.0

The analyses show that the first six months' growth is richest in borax, and that the proportion of carbonate of soda to borax appears to increase regularly. The presence of sand in such large quantities is due to the high westerly winds which blow periodically, and drive it from the mountain slopes across the lake. This sand, no doubt, facilitates the formation of the surface deposit by keeping the ground in a porous condition.

That only this section of the lake produces borax to any extent is due, no doubt, to its low level. The hard crust above mentioned dips in the water, which rises by capillary attraction. This contact appears to be a favorable if not a necessary condition, for during very dry seasons, when the level of the water is low, surface recuperation goes on very slowly, or even ceases entirely.

Process of Manufacture.—The factory, which is situated on the northwest corner of the lake, consists of a dissolving house raised about 20 ft. above the level of the ground, concentration house, a refining house, and boiler house. The process by which the borax is extracted from the crude material is very simple, and comprises two operations, viz., dissolving and allowing the solution to crystallize.

The crude material is transported by means of carts from the lake to the works, and is passed through a mill previous to its being thrown into the dissolving pan, in which is contained a boiling saline solution, preferably mother-liquor, from the second crystallization. The solution is kept boiling by high pressure open steam as the crude material is being shoveled into it, during which operation free ammonia is copiously given off. The salts dissolve entirely, leaving the insoluble residue, chiefly sand, at the bottom of the pan. The hot solution, after standing for some time, in order to clarify, is run off into crystallizing pans and allowed to cool for from five to nine days, according to the season of the year.

The product of this first crystallization is a mixture of octahedral and prismatic borax, slightly impure and somewhat colored by organic matter. This product is either sold as "concentrations" or redissolved in boiling mother-liquor and the resulting solution allowed to cool to 120° F. From this solution refined borax of excellent quality is obtained. The works are capable of turning out over 100 tons per month, about 50 men and 65 animals being employed. The factory is exceedingly well arranged and substantially built, and under careful and intelligent management.

During the time of my visit at the lake the fuel used on the works was the sage brush, the only wood growth in this desert. The difficulties of collecting this material were enormous. Carts were sent out scouring the country for 10 miles round in search of fuel, and remained away often for a week at a time. This difficulty has been partially met by substituting crude petroleum, which has to be carted 72 miles across the desert. The results, however, I am told, show a saving of nearly 40 per cent. as against the sage brush, besides other advantages, such as greater regularity of working.

Water Supply.—The question of water supply is an extremely interesting one. The water is obtained from two sources. The one which is used for drinking purposes and for feeding the boilers is brought in iron pipes from a canon lying in the Argus range, 7½ miles distant from the work, at an elevation of nearly 300 feet. This canon, which forms an oasis in the desert, contains several springs, and where cultivated yields an abundance of fruit and vegetables.

The other supply is derived from artesian wells which are sunk to a depth of 55 feet on the shores of the lake. The water rises from 3 to 10 feet above the surface, and the flow is constant and regular.

This water is strongly alkaline, containing about 1 per cent. of carbonate of soda, strong traces of borax, and salts of ammonia equal to about 18 grains per gallon.

Labor.—The question of labor presents no difficulties; all common operations are carried on by Chinamen, and this class of labor can be procured in California at a comparatively moderate rate.

Transport.—The refined borax is packed in casks and transported to Mojave, in the so-called "desert schooner," a strongly built wagon drawn by 20 mules. The average load is 10 tons, and the trip to Mojave and back takes eight days. The road through the light

sandy soil of the desert rises gradually 1,000 feet during the first 25 miles.

This road is controlled by the owners of the lake, who possess the right to the water, which is supplied to the four roadside stations through iron pipes from a range of mountains 10 miles distant. These stations afford sleeping accommodations for the teamsters and stabling for the animals.

During my visit to California I took every opportunity of making myself acquainted with the extent and value of the borax deposits in the Pacific States, and I gathered that, though widely distributed, there are only three deposits of any great importance which are actually being worked at the present time. These deposits yield from 1,500 to 2,000 tons of borax annually, nearly the whole of which is consumed in the United States.

The lake which I have described has been regularly worked for the last 15 years under the direction of Mr. J. Searle, the chief owner, who is known all over California as the keenest bear hunter in the State; but he is not less known for his hospitality, high integrity, and intelligence. During this period it has supplied about one-third of the total amount derived from similar sources and with considerable profit to the owners. The supply of borax on this lake appears to be practically inexhaustible, and it only requires improved means of transport for its full development.

In conclusion, it may be of interest to briefly allude to Death Valley, which lies 400 ft. below the level of the sea. Borax and borate of lime deposits have been discovered and worked in this valley, which is probably the most desolate and least explored of any portion of the United States. The climate, owing to the intense heat and dryness of the atmosphere, is almost unbearable. It is absolutely devoid of either animal

ing with the pioneers John and Dennis Searle, and the shipment of the first cargo of natural borax to England; his high hopes of future profit from the trade, and his subsequent disappointment and trials on finding himself saddled with an immense quantity of borax, the selling price of which had suddenly declined from 90¢. to 26¢. per ton (a figure very little above the bare cost of transport), and which could not be readily disposed of even at that price, owing to the general ignorance of its many good qualities. Mr. Robottom concluded by expressing his conviction that the efforts which he had then made had given such a stimulus to the use of borax as could not fail to result in mutual benefit to traders and consumers.

BENDING GLASS TUBES.

WHEN one has some chemical apparatus to mount for an experiment, it is often necessary to curve glass tubes. In laboratories, chemists make use of gas burners, into the center of the flame of which air is blown. By means of the blowpipe the glass is worked very easily. But the amateur, or the professional in the country, has not apparatus of this kind at hand. In such a case, a simple spirit lamp may suffice by operating as shown in the figure. After the lamp has been lighted, the part of the glass tube that is to be curved is heated in the flame. It is necessary to be careful not to keep heating it at the same point, as this would surely break the glass, but to revolve the tube in the flame and at the same time move it from right to left and from left to right. When it is hot, the flame is allowed to act upon the same point, and the glass will soon soften and may then be bent. It may even be drawn out and be melted with a simple spirit lamp.

It is well to heat the tube in the upper part of the



METHOD OF BENDING A GLASS TUBE.

or vegetable life. During several months in the year work has to be suspended, one reason being that the solution would not cool down to a temperature at which crystallization takes place.

The communication which I have made to you this evening will, I trust, prove of interest to the society, if only as an instance of what can be accomplished in manufacturing chemistry under stupendous difficulties when the enterprise is directed by intelligent perseverance.

DISCUSSION.

The chairman said that the hearty thanks of the meeting were due to Mr. Hake for his able paper on a subject of very wide interest and practical importance. When one remembered that, at a comparatively recent date, borax was selling at 90¢. a ton, and was a costly material, used chiefly for producing the most valuable glazes on pottery, whereas now it was not only extremely cheap, but was found to be available for a vast variety of purposes—even running a good second to some of the most widely advertised soaps—it was evident that the subject before them had an important practical bearing. The matter also possessed considerable interest in a geological aspect, as an example of the wide distribution of what was once considered a rare element. In the early part of the present century the only sources of borax were the tincal lakes in the north of India and Thibet, where it was obtained in a crystalline state from beds of semi-gelatinous mud. Then followed that triumph of technical engineering, the working of the lagoons of Tuscany, where the *solfioni* containing a small quantity of boracic acid were condensed by blowing through water, and the solution thus obtained evaporated down by the same volcanic steam. Italy thus became practically the sole source of the world's supply of borax, its product running the tincal deposits completely out of the market. Next came that singular deposit obtained from Peru, which in appearance closely resembled a very white potato; and lastly came this wonderful American deposit described by Mr. Hake, and rhodrate, the borate of lime of Turkey. Boron, therefore, instead of being an element of rare occurrence, as was once supposed, was found to be widely spread over different parts of the world. And its applications were likely to be equally wide. It was already known to be the finest of all glazes, a most useful detergent, and one of the most valuable of disinfectants, and its uses were not yet exhausted, seeing that this once chemical luxury was now cheaper than carbonate of soda was a few years ago. He was glad to see that Mr. Robottom was present. He could speak on this subject with more authority than any one else in Europe or America; and the meeting would, he was sure, be glad to have the benefit of hearing his views.

Mr. Arthur Robottom then gave the meeting a vivid and interesting account of his pioneer work in the exploitation of Californian borax; of his journey on foot at the rate of twelve to fourteen miles a day, and, disguised as a "busted" miner, across the 240 miles of sterile country lying between Los Angeles and the Mono Lake; his stay at Jim Bridger's shanty, his meet-

flame, which is hotter than the central part, and is what chemists call the oxidizing flame.—*La Nature*.

CONVECTIONAL CURRENTS IN STORMS.

By H. A. HAZEN.

THE most widely accepted theory of storm generation is based on a supposed heating of a limited portion of the earth's surface, which, in turn, sets up convectional currents of heated air, and from these our severest storms and tornadoes have their birth. There is another theory, that of M. Faye, of France, which considers that the origin of all our storms is in the upper atmosphere, and that the motions at the center are downward rather than upward. The wisest will find great difficulty in deciding which of these opposite views is correct, and many will conclude that after all we really know very little of the facts in the case, and, until we do know these facts, it will be best not to put much dependence on any theory. Both of these views are now being published side by side in the *American Meteorological Journal*, and it may be of some interest to discuss the inferences with which theorists support their views. It would seem as though the time had long since passed for us to rest satisfied with "glittering generalities." Any theory which is not capable of being put into exact language, and of allowing a definite, quantitative, computation from cause to effect, may be justly regarded with suspicion. The number of educated men who believe that present theories are entirely inadequate to account for a tithe of the energy developed in our storms and tornadoes is constantly increasing. What are the proofs of this convectional current?

1st. "Many observers have recorded the visible upward flight of large objects." Surely we are not to infer that this flight is due to a convectional current, nor is it due to a rush of the body into a partial vacuum above it produced by such a current, for a partial vacuum would cause the object to cling to the earth all the more closely. In all cases, the object is borne along by a violent rush of air or of the wind, and we may seriously doubt that there is any convectional current at all, or its efficacy in producing such a result even if it were present.

2d. "The upward motion about the center of a tornado is, moreover, proved in the same manner as in cyclones, by the continued oblique indraft, for which there must be some upward escape." This is the great argument, above all others, which has been advanced to prove the necessity of an uprush of air at the center of a storm. It is almost universally conceded that air in a storm has a motion normal to the isobars at the outer edge, and, as it approaches the center, this motion makes an angle with the isobars becoming tangential near the center. It was shown in the *Am. Met. Jour.* for September, 1884, p. 174, that all this air cannot find its way to the center of the storm, but that it would "rise uniformly along the whole interior advancing circle of wind." Let us take a concrete example. Suppose the air circulates about a storm and toward its center up to a height of 4,000 feet, and that