MANUFACTURE OF ARTIFICIAL BUTTER IN NEW YORK.

Milk is a mechanical mixture of butter, casein, and water, the latter holding in solution sugar of milk, or lactin, and several salts. The butter is held suspended in the milk by the caseous or cheesy matter, and the whey, with which it is intimately blended. Milk is thus a true emulsion, resulting froma mixture of these three ingredients, and owes its opacity and white color to the diffusion through it of the butyraceous oil. The particles of butter in milk consistof very minute globules $\frac{1}{2500}$ inch in diameter, suspended in the surrounding serous fluid.

FIG. 1.

MANUFACTURE OF ARTIFICIAL BUTTER.—THE HASHING MACHINE.

When milk is allowed to stand for some time, the lighter particles of butter rise to the surface, constituting, with a certain quantity of the other ingredients, cream, leaving the casein, from which cheese is made, and the whey below. All the particles of butter, however, are not eliminated by this means. Still the remainder is by no means rich in oily matter, as the poverty of skim milk plainly shows.

When the cream is agitated for some time, or churned, the semi-solid particles of fat aggregate, and we have a mass of butter. The remaining fluid, termed buttermilk, contains casein and lactin, or sugar of milk, in solution. This sugar very soon decomposes, forming lactic acid (from *lac*—Latin for milk), which gives to buttermilk its sour taste.

In the manufacture of cheese the casein (Latin, *caseum*, cheese) of course is the principal ingredient. The casein is coagulated by an acid, usually obtained from the stomach of a young calf, and called rennet. The curd thus obtained is pressed, and, after a variety of manipulations, becomes cheese.

Butter is a rather complex organic compound, consisting chiefly of olein, margarin, and stearin. The olein is the largest and most important constituent, and one most familiar to our eyes, in the shape, more or less pure, of the fixed oils, of which olive oil is a good example, as it contains seventy-five per cent of olein.

The three substances named exist in all natural fats, from which chemists have long been enabled to produce butters which, owing to bad odors and flavors, have never been suited to human wants.

M. Mouriez, of France, was the first to solve the difficulty, and some six years ago gave to the world an excellent method of making good butter from hard beef fats, known as beef suet. This process will be found in the SCIENCE RECORD for 1873.

The process, with modifications by M. Paraf, has latterly been introduced in this country, and is now in successful practical operation in this city, on a large scale, at the establishment of the Oleo-Margarine Manufacturing Company, in 56th street, near Third avenue, where one or two tuns of the new butter are now daily turned out, and find a ready market.

The article to which we refer does not differ materially in composition from ordinary butter, olein (and that of a very pure character) being the principal ingredient, no casein being present, which is the primary cause of rancidity in butter. The olein from which this artificial butter is prepared is obtained from beef suet.

The general process of manufacturing artificial butter is as follows: The suet is first washed thoroughly, for two hours, in water, to remove all superfluous animal matter, and is then, by means of a "hashing machine," shown in our illustration (Fig. 1), ground thoroughly, and pressed through a fine sieve or plate of iron pierced with fine holes, which forms one side of the machine. The machine consists of a series of sharp blades set on an axis like the thread of a screw. These are contained in a closely fitting chamber or cylinder placed horizontally. The cylinder is divided into two portions, hinged together on one side, and capable of being securely fastened or bolted on the other, when the machine is in operation. The upper half can be readily thrown back, should the machine become clogged or when it becomes necessary to cleanse it. The shaft on which the knives are fixed extends through one end of the cylinder, and is geared in the ordinary way, by means of a belt and pulley, to the shaft of the engine transmitting the power.

A large iron trough lined with porcelain is supported above the cylinder with its revolving knives. This trough or feeder has an aperture in one corner, which fits over a corresponding hole in the upper part of the cylinder, through which the suet is fed to the machine. When the machine is in operation, the suet is not only effectually hashed in the cylinder, but forced by the screw thread set knives through fine holes bored in the opposite end of the cylinder. The machine we saw in operation was capable, it was stated, of hashing 1,000 pounds of suet in an hour. The fat comes out of the hasher in the form of a jelly considerably whiter than when put in, owing to its finely divided state, and the uniform distribution of olein through it.

The material is now in a proper condition for the second operation, which has for its object the separation of the fluid olein, and the solid margarin and stearin from the animal

FIG. 3.

MANUFACTURE OF ARTIFICIAL BUTTER.—FILLING THE BAGS FOR THE PRESS.

tissues which enveloped them. For this purpose it is put into a number of steam vats, shown in the illustration (Fig. 2). These vats are of the ordinary wooden description, with steam pipes entering the bottom, the steam being admitted or cut off at pleasure by stop cocks. Here the fat is raised nearly to the temperature of boiling water, the steaming being continued for two hours. The heat causes a separation of the olein and stearin from the animal matter, the former rising to the top, while the latter sinks to the bottom. The material is well stirred during the time the heat is continued, and when the process is completed the oil is drawn off while still hot, and then allowed to cool slowly in

FIG. 2.

MANUFACTURE OF ARTIFICIAL BUTTER IN NEW YORK.—THE STEAMING VATS.

tanks placed below the steam vats. About 90 per cent of a mixture of olein, margarin, and stearin are thus obtained from a given weight of suet, the remainder (10 per cent) being, of course, the tissue and muscular and fiberous parts of the material.

The real fat being thus separated from the superfluous animal matter, the next step is the separation of the fluid olein from the solid margarin and stearin. One of the lower tanks, seen beneath the steam vats in the large illustration (Fig. 2), containing the mixed fluid and solid parts of the fat, is moved to a small table in another part of the room. On the table are small tin molds, six or eight inches long, four or five wide, and two or three deep, each containing a small cotton bag, with sufficient margin of cloth to form a double lap from each side. Here may be seen the operation of bag filling (Fig. 3).

The partly crystallized and lumpy fat is ladled into these molds until full, when the laps of cloth from each side are turned over upon the top, and the material inclosed. The bags contain about two pounds each, and after using once are carefully washed to avoid any taint or rancidity which might injuriously affect the butter. Our sense of smell being acute in some directions, we applied one of the bags to the nostrils. It was clean and sweet. This, though apparently a small matter, the proprietors of the establishment have not overlooked. The floor, indeed, and all the articles in use gave evidence of care and cleanliness, which is next to godliness.

When the bags are full they are put between sheets of galvanized iron and placed in the oil press (Fig. 4), which is a combination of the toggle joint with a closely cut thread screw, as shown in the engraving. The pressure is gradually applied to the contained fat, and there presently issues from the pores of the cotton a fine yellow oil, which drips into a receiving trough at the bottom of the press, and is afterwards dipped or ladled into ordinary galvanized iron milk cans.

It is this oil, olein, containing in solution more or less margarin and stearin, from which the butter is now to be churned, as we shall presently describe. This expressed oil has neither taste nor smell, and is a very pure article of olein. The residuum left in the bags is solid stearin, which, the proprietors informed us, is worth two or three cents per pound more than the ordinary stearic acid, and is used chiefly for candle-making.

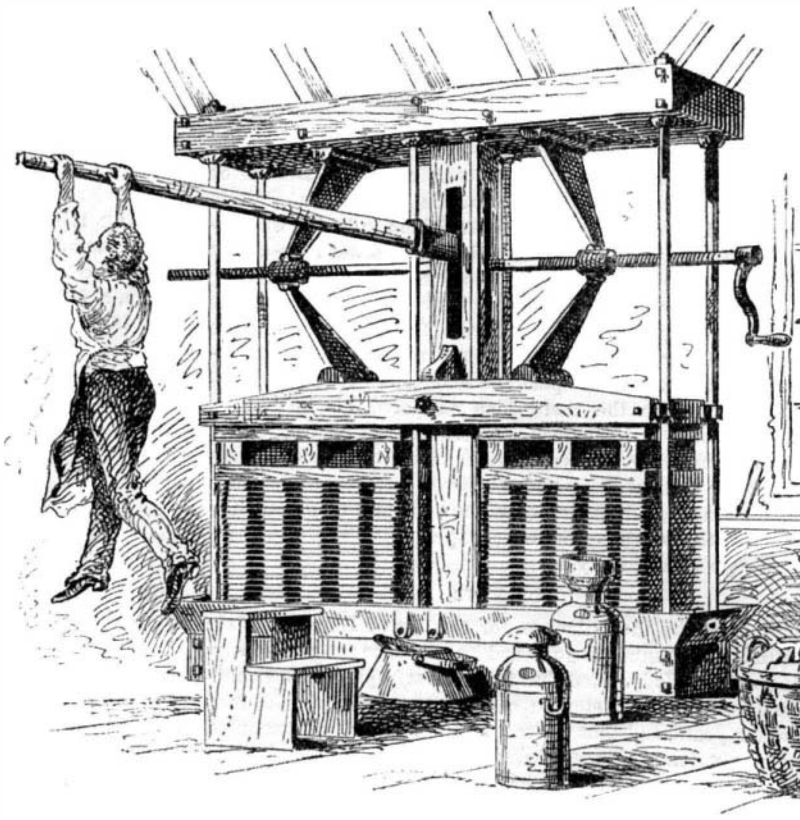
We now come to the last operations connected with the manufacture of the artificial butter, to wit, the churning (Fig. 5), which is the same as the ordinary churning of cream. The churns have revolving paddles, and the oil on being placed in the churns is mixed with one fifth of its weight of sour milk. The churning operation is continued for twenty minutes, when the compound has assumed the semi-solid condition of soft butter, which a slight diminution of temperature renders firm. The churns are worked in a cool chamber, rendered so by means of a reservoir of ice suspended overhead. The butter is now colored yellow by admixture of a little vegetable annatto, which is harmless, and after being salted is worked like ordinary butter on a working table, with a presser, as shown in the illustration (Fig. 6). The churning of the oil with the sour milk increases its weight from the absorption of water, so that three pounds of oil will make four pounds of butter. From one hundred pounds of suet, seventy pounds of butter are produced, twenty pounds of stearin, and ten pounds of scraps. The change from the liquid to the semi-solid condition is due probably to some molecular change or oxidation of the oil during the process of churning.

We tasted some of the butter thus made and prepared for the market. With the exception of a slight granular consistency, we could perceive no difference between it and good ordinary firkin butter. This peculiarity, it is stated, disappears after keeping for some length of time.

The butter made in this way can be afforded much cheaper than the ordinary article, but it must not be supposed that the cow's occupation is forever gone. Suet is an article the supply of which is limited, and it is only in large cities, or localities where beef cattle are largely slaughtered, that it will prove profitable to engage in the manufacture of this artificial butter. The company expect, we were told, to enlarge their works to the capacity of some twelve tuns of butter per day. This is only about one tenth the quantity daily consumed in the city of New York.

The butter made can be transported to and will keep in warm climates, owing, as before stated, to the absence of the readily putrescible compounds existing in ordinary butter. Shipments have already been made to South America; and as regards home consumption, it is said that hotels in this city, and even a fashionable club, are customers of the company for this artificial butter.

FIG. 4.



MANUFACTURE OF ARTIFICIAL BUTTER.—EXPRESSING THE OLEIN.

FIG. 5.

MANUFACTURE OF ARTIFICIAL BUTTER.—CHURNING THE OLEIN WITH MILK.

FIG. 6.

MANUFACTURE OF ARTIFICIAL BUTTER.—WORKING THE BUTTER PREPARATORY TO PACKING.

Preparation of Pure Chlorophyll.

"The plant used in my experiments," says F. A. Harsten, "was the ivy (*hedra helix*) which possesses two advantages; first, that it can be obtained at all seasons of the year; second, that it is very rich in chlorophyll. Beside this, the chlorophyll of this plant is not easily decomposed by such agents as light or alkalies. The leaves are chopped up fine and mixed with alcohol of 55° to a *magma*, which is pressed out after standing 12 hours. The object of this is to prepare the leaves for the action of the benzole. The alcohol extracts the water from the leaves and also the bitter principle (*hederin*) and especially large quantities of a soapy substance. After the alcohol has been removed by pressing, the leaves are mixed with benzole, and let stand for 24 hours, in which time the benzole extracts the chlorophyll. The benzole is now pressed and distilled off. The residue remaining in the retort is of a fatty nature and dark brown color. Three hundred grains of leaves furnish about 8 grains of residue which contains fat, chlorophyll, and a yellow coloring substance.

This residue is boiled for 10 minutes with soda (80 grains of extract to 10 grains soda and 150 grains water). When cold it is filtered through 4 or 5 thicknesses of paper, and a dark green alkaline fluid obtained, while the insoluble fatty soap and the yellow coloring matter remain in the filter. From the green solution the chlorophyll soap and soluble fatty soaps are separated by common salt, or nitrate of soda, and the soaps washed with solutions of the same salts. After the soap is freed from alkali, it is dissolved in water and sulphate of copper added. In this way a beautifully colored powder is obtained, which contains chlorophyll oxide of copper and a copper soap. It is washed rapidly to remove all the sulphate of copper, and then dried. The dry powder is boiled with absolute alcohol and then washed with ether and benzole. These solvents remove all the copper soap and some of the chlorophyll compound. The chlorophyll oxide of copper which remains is suspended in alcohol and decomposed by a current of sulphuretted hydrogen. By exposure to the air, the alcohol evaporates, leaving the chlorophyll in the form of fine brittle grains of a dark green color, almost black. It is insoluble in water, but dissolves in alcohol and hydrochloric acid with a very beautiful green color. This green color differs, however, from the green of the leaves, since the latter is modified by the yellow coloring matter.

I have the following grounds for considering the chlorophyll free from fats: 1. It was dry and brittle; 2. On heating it, no smell of acrolein was produced; 3. It is easily soluble in alcohol and hydrochloric acid.

I have also prepared compounds of chlorophyll with lead and silver, but neither can be employed for preparing pure chlorophyll. The chlorophyll oxide of silver blackened easily in the light. The lead soap could not be removed so readily from the chlorophyll lead compound, by the use of absolute alcohol, ether and benzole, as the copper soap."

New Plan for Obtaining a Powerful Light.

Herr Edelmann, of Munich, has devised a very simple and satisfactory mode of obtaining a powerful light, well suited for photographic purposes, if the materials employed be judiciously selected. He has found that the oxyhydrogen flame produced from common coal gas and oxygen at ordinary pressure produces an intense light, of any desired color if, by means of it, we burn a mixture of picrate of ammonia with a suitable metallic salt.

To this end a hollow cone of hard gas carbon—similar to that used in electric lamps—is prepared of the following dimensions: Hight, one and three quarter inches; diameter, one inch, tapering to three quarters of an inch, and pierced by a tube tapering in the same direction from half to one quarter of an inch. This conical carbon tube is placed, narrow end down, upon an upright oxyhydrogen jet, the compound nozzle of which fits into the narrow end of the inverted cone of carbon. The oxyhydrogen jet is the usual kind of double tube, the coal gas issuing round the oxygen nozzle; and when the gases are ignited, they burn through the center of the cone, which then resembles a small carbon furnace one and a half inches in depth.

The number of these cones to be made corresponds with the number of intensely bright colored flames required. When the gases burn in the ordinary way, scarcely any light results; but in order to produce the desired effects, we spread over the inner surface of a cone, with a spatula, a paste made by rubbing together in a mortar picrate of ammonia, the metallic salt desired, and alcohol. The cones are then allowed to dry at ordinary temperature, and placed over the double tube when light is required. To produce the flame, the oxygen tube, which should be movable in a vertical direction, is raised as high as possible, the coal gas lighted, and the oxygen then turned on. By moving the oxygen tube slowly downwards, and regulating the gas supplies, the point at which the greatest brilliancy is produced can be readily ascertained. The light obtained is very intense and steady while it lasts.

If a white light be desired, sulphide of antimony or magnesium filings can be mixed with the picrate of ammonia; but if it be desired to use the light for showing on the screen metallic spectra, the chlorides of sodium yellow, thallium green, iridium blue, and calcium are most suitable; while Herr Edelmann finds that the chlorates or nitrates of strontium red, barium pale green, and copper deep green, afford the most satisfactory results. For photographic purposes the antimony would be most suitable, but it should be mixed with the picrate of ammonia with caution.

This plan of obtaining a powerful metallic light is specially recommended for illustrating some of the phenomena of spectrum analysis. At present it is usual to employ the electric light for the purpose of projecting spectra on a screen in order to exhibit them to a large audience. The cost and inconvenience of the electric light is, however, so great as to debar many from trying to exhibit these beautiful experiments. Edelmann now proposes the above plan for producing intensely brilliant metallic flames as a substitute for electric method, and states that he has succeeded perfectly in projecting the spectra on a considerable scale when using the very simple and inexpensive source of light above described.—*British Journal of Photography.*

LETTER FROM UNITED STATES COMMISSIONER PROFESSOR R. H. THURSTON.

NUMBER 14.

BRUSSELS, September, 1873.

Leaving Berlin immediately after breakfast by express train, after a ride of four hours across a level and frequently sterile country, which is remarkably devoid of interest, we arrived at the pleasant and quaint old German town of

HANOVER.

Here we dined, and then spent two hours strolling about the principal streets and the noble park, and calling at the celebrated polytechnic school, of which our venerable and distinguished friend, Dr. Karmarsch, is the head. The curious architecture of the older buildings of the town, in which wooden framing with brick filling produce an odd and not unpleasing effect, contrast remarkably with the pretty cottages and fine modern residences which have been built in brick and stucco near the railroad station. Hanover is well known as the capital of the late kingdom of the same name, but is not less widely known as the birthplace of Herschel and the home of Leibnitz.

Resuming our journey toward Cologne, we were entertained by the conversation of an intelligent young Turk, whose place of residence was Constantinople, but who had left his home and his harem to see the great exhibition and to travel in Europe. We were pleased to learn that the women of his country are, at last, offered some opportunities of acquiring knowledge. There are twenty-four advanced schools for young women, in his native city, which are fully attended, the students being from fifteen to eighteen years of age. The seclusion of females is, however, quite as carefully looked to as ever, and our fellow traveller was greatly shocked and surprised by our accounts of the progress and of the aspirations of the strong-minded of the sex in the United States.

Crossing the Rhine on a fine specimen of a very bad kind of iron bridge, the lattice girder, the traveller finds himself in

COLOGNE,

or *Cöln*, as the Germans call the city. It is a curious old town, with exceedingly narrow and labyrinthine streets; but it contains almost nothing to attract the stranger, with the important exception of its great cathedral. This famous structure is well worthy of the reputation it has acquired, notwithstanding the fact that that it is still far from completion, although commenced six centuries ago. Its immense size and its symmetry of form, and the beauties of its architecture, make it probably the finest specimen of the gothic style in existence. The length of the building is something over 500 feet, its breadth 231, and the hight of the principal towers, when finished, will be 532 feet. The ridge of the roof is 250 feet above the pavement, the nave rises 165 feet, and the aisles 80 feet. No description can do justice to this magnificent and colossal pile; and only repeated visits and comparison with surrounding objects enable the traveller to obtain a just idea of its immensity. The gracefulness and the richness of gothic architecture are nowhere in the world, probably, more fully illustrated than in the cathedral of Cologne. The work of completion is now progressing rapidly, but the building has been so long in course of erection that the repairing of the decaying stonework of the earlier must accompany the labor of completing the later construction. The excursion up

THE RHINE

is always anticipated by the traveller in Europe with a degree of interest which is perhaps unequaled by that felt in any other part of his journeyings. And he is probably seldom disappointed. Our little party certainly was not, and the long sail from Cologne to Mayence, occupying the whole day, was one of extraordinary pleasure, while the return next day over the same route was hardly less enjoyable.

There is probably no point on the Rhine at which the natural beauties of the scenery exceed those of our own noble Hudson where it breaks through the Highlands at West Point; no part of the Rhine can equal in its picturesque and wild beauty those northwestern examples of fine river scenery, the Dalles of the St. Louis or of the St. Croix, and nowhere on the Rhine can be found any one spot of as great historical interest as many that might be named in Great Britain; yet it may well be asserted that in no other part of the world can the intelligent traveller and the appreciative observer of Nature find such a combination of these attractions, in one uninterrupted series, as upon this splendid German river, between Cologne and Mayence. Magnificent scenery of ever changing but never intermitted beauty, picturesque old ruins of castles, around which cluster the most interesting and important reminiscences of a thousand years of German history, and each of which is founded upon some promontory or craggy mountain side which itself is often the subject of an old and romantic tradition, or of some still more improbable but none the less interesting fairy tale, in which sprite or gnome or nymph lures an unfortunate victim to destruction or leads him to unimaginable bliss, are seen at every turn. Leaving Cologne, and passing Bonn, the noted *Sieben Gebirge* (seven mountains) rise into view, their rugged sides and ruined castles awakening in the traveller a sensation of mingled admiration, surprise, and interest which is not again lost until he reaches Mayence. On the one side, at an imposing hight, is the splendid old ruin of

DRACHENFELS,

near which Siegfried, the hero of that noble but sanguinary ancient German poem, the *Niebelungenlied*, killed the dragon so many centuries ago. On the other side is Rolandseck, another fine ruin, which has been rendered famous by Schiller, who here lays the plot of his "Knight of Gottenburg." In the river we notice the island in which was immured the beautiful girl who had supposed her long absent lover lost forever, one of the thousands who fell fighting the barbarians of the East; and above, on the top of the overhanging precipice which forms the river bank, is the castle built by the lover after his return from a long imprisonment, and where he spent the remainder of his life, looking down upon the roof which sheltered his lost bride. Farther on, the high rock *Erpelerlei* raises its basalt crest seven hundred feet above the river; and from top to bottom, wherever earth will lie and wherever terraces can be made to sustain them, it is clothed with a mantle of green vines laden with the wine-producing grape.

We pass the old city of

COBLENTZ

and, opposite, the immense fortification of Ehrenbreitstein with its four hundred guns and its immense range of outlying works. It is stated that this almost impregnable stronghold has sufficient storage capacity to provision 8,000 men for ten years, and that the cost of the fortification amounted to nearly ten millions of dollars. We pass the bridge of boats and go on up the river, meeting with beautiful gems of scenery and romantic ruins at every bend of the stream. We pass the extensive ruins of Rhinefels, and the beautiful remains of Rhinestein, the homes of the booty-loving and law-defying old robbers who, in ancient times, took toll of all who passed on the river. We pass around the projecting rock where, sitting high above the stream, the beautiful *Lurlei*, by her entrancing songs, draws the unfortunate fishermen resistingly into the raging whirlpool at her feet. Then we pass the two old castles, which, confronting each other, are called the "Mouse" and the "Cat." Near Bingen we see an island in the middle of the stream on which is an old tower, and, overlooking it from the river bank, is the equally old castle of Ehrenfels. Here, according to tradition, the rich and avaricious old Bishop Hatto (of Southey's ballad) stored his grain in the tower, and lived in comfort in his castle, while the people, far and near, were dying of famine. Holding his grain in expectation of a rich harvest of gold when the highest attainable price should induce him to sell, the miserly wretch finally removed, for safety, to the tower where he could better watch his treasure, as well as defend himself against the attack of the maddened people. He was there destroyed by an army of starving rats, which gathered from all directions to feast upon his stores, and to visit upon the wicked proprietor a righteous judgment. We pass

JOHANNISBERG,

the source of the finest of Rhenish wine, and, steaming along through a more level and less beautiful country, we gaze with intense interest upon the scenes which were, centuries ago, so attractive to Charlemagne, and which were so often visited by his successors.

At Mayence we find another bridge of boats, and we watch the operation of opening and closing, to allow the passage of vessels, with some curiosity. The rapidity and ease with which a section is dropped down with the current and swung out of the way is as remarkable as is the difficulty and the slowness with which it is hauled back into its place. Near the bridge are several *schiffmühle*, grinding away very busily, and, about them, are several small boats, either bringing grain to be ground, or taking to the city the flour which has been prepared for the market.

Some distance lower down, we passed a dredging machine, anchored in midchannel and dredging most effectively, its machinery driven, like the *schiffmühle*, by great paddle wheels turned by the current. With unusual reluctance we left this beautiful valley of the Rhine, the most fruitful of all regions of poetry and romance, and pursued our journey westward. A few hours were spent at

AIX-LA-CHAPELLE,

an interesting old town in which we found another of the the great German technical schools. With a splendid building, erected by private contributions of public spirited citizens, a fine corps of instructors, and a small but well selected and increasing stock of apparatus, and more than full of students, this school is doing its share of the important work which is so rapidly bringing continental nations into successful competition with Great Britain, in industrial pursuits. The current expenses of the institution are defrayed by the State.

Another moderately long ride by rail brought us across the frontier, and we made our next stop at

LIEGE,

Belgium, near which busy and pleasant city is the town of Seraing and the great establishment of the *Société Cockerill*, the largest of its kind in Belgium and one of the largest in the world. It was this Cockerill company which exhibited the immense blast furnace blowing engine, which, with their locomotive and marine engines, formed so striking a collection in the machinery hall of the great exhibition. The principal works are situated in the valley of the Meuse, six miles from Liége and upon a great coal formation which constitutes one of the principal deposits of Belgium. The works were founded by Cockerill Brothers, a half century ago, for the purpose of manufacturing steam engines and flax spinning machinery. The first blast furnace was erected in 1826.

The establishment now comprises four collieries, producing annually about 350,000 tuns of excellent bituminous coal, thirty iron mines from which are raised 150,000 tuns of ore per year, five blast furnaces yielding 55,000 tuns of pig iron, four new blast furnaces for the production of Bessemer metal, which are still unfinished, two iron and one copper founderies turning out 5,000 tuns of excellent castings, a rolling mill which turns out 40,000 tuns of rails and other sorts of rolled iron, a large steel works containing ten Bessemer converters and producing 17,000 tuns of steel per annum, a forge which has an annual production of 1,500 tuns, large machine shops employing 1,500 workmen, a bridge and boiler shop in which are built 6,000 tuns of boilers and bridges annually and, beside all this, the company has, at Antwerp, a large shipbuilding yard.

THE SERAING ESTABLISHMENT

covers an area of 200 acres, and employs 9,000 workmen. On the place are over 250 steam engines, having a collective power of 8,000 horses. Two millions of dollars are paid annually in wages, 350,000 tuns of coal are consumed, and the annual receipts from sales amount to five or six millions of dollars. This immense establishment has grown up from the small beginnings of John Cockerill and mainly through his energy and business capacity. The great engineer is now deceased, and the works are carried on by the "Société John Cockerill" among whom, it is said, is no less a personage than the King of the Belgians. The coal raised from the shafts within the works is of fine quality, and cokes well. The coking is done partly in ordinary ovens, and partly in Appold kilns, which are said to work finely. The coke is hard, clean, and bright, and seems capable of sustaining a burden nearly equal to that borne by the celebrated English Durham and Newcastle coke.

Pig iron for ordinary purposes is made, of very good quality, from ores of the neighborhood, but ores are imported from Spain and from England for Bessemer pig. Molding sand, fire brick, and fire clay are obtained from the neighborhood, and thus the principal part of the raw materials used in the works is obtained from deposits close at hand.

The castings made in the founderies are unusually smooth and clean. The work turned out in the machine and boiler shops is exceedingly creditable. An important feature of the practice here is the use of steel for nearly all moving parts of machinery. It has displaced iron almost entirely in forged work, and, to some extent, it is substituted for iron in even cast pieces. This introduction of steel has taken place here more than at any other place which we have ever visited, and the general success here met with may be taken as an indication of one of the directions in which improvement is going forward. The new steel plant will be expected to produce one hundred and fifty tuns per day of Bessemer metal. The riveting in the boiler and bridge work is, wherever possible, steam riveted. The work, in all departments, seems invariably well done, and is finding a market in all parts of Europe, and, to some extent, even in Great Britain and the United States.

The workmen are paid about three fourths as much here as in Great Britain. Molders receive about seventy-five cents per day, puddlers a dollar to a dollar and a half, pattern makers seventy-five cents, machinists from seventy-five cents to a dollar, riveters seventy cents, and foremen in the several shops from one to two dollars. A day's work is twelve hours, nominally; actually it is sometimes less and not infrequently more. A few women are still employed in the lighter kinds of labor.

The workmen of Belgium are probably more nearly equal in skill to the English mechanics with whom they compete than are those of any other European country.

R. H. T.

Solidification of Nitrous Oxide.

According to Wills, nitrous oxide may be easily solidified by causing a rapid current of air to pass through the liquified gas. Differing in this respect from carbonic acid, nitrous oxide may be kept liquid for some time in open vessels. Carbonic acid solidifies, as soon as it escapes from its containing reservoir, because the tension of the vapor of the solidified acid, even at the moment of its formation, is considerably superior to atmospheric pressure; while liquid nitrous oxide attains —133° Fah. and solidifies at —146°, so that the tension of its vapor is weaker than one atmosphere. The density of the liquid protoxide at 32° Fah. is equal to 0·9004; its coefficient of dilation is very considerable. It is insoluble in water.

A CORRECTION.—In our article on "Specific Heat," on page 208, current volume, the expression (lines 45 and 46) "Specific heat at temperature 39· 1° (T)=1(C)," should read: "Specific heat at temperature 39· 1° =1; specific heat at temperature T=C."

IN Saginaw county, Mich., a poor man named Reif, while boring a well, is reported to have been greatly frightened by the upward flow of gas, the escape of which shook the earth, produced a noise like thunder, and, when fired, shot up a flame fifty feet high.