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## EDITORIALS.

### THE QUALITY OF PLATINUM.

IN recent years there have been many complaints about the quality of the platinum ware used in the chemical laboratory. It has been said that platinum ware of the present day is not as good as that manufactured some years ago. Very recently several large lots of platinum dishes and crucibles have been returned to the makers on account of alleged inferiority, by different Bureaus of the United States Government. Platinum is of fundamental importance in analytical chemical work. In spite of the substitution of silica ware and apparatus for platinum for certain purposes, the metal remains indispensable for many chemical operations. But it should be pure. If pure, durable platinum ware could be manufactured in former years, there is no reason why as good or better ware cannot be made to-day. With improved gas and electric furnaces, and a variety of means for obtaining and controlling high temperatures, the working of platinum should be easier to-day than ever before; methods of chemical analysis have also been improved even if methods of chemical purification have not to any great extent. The chief complaints which have been made would seem to indicate gross carelessness or lack of skill in manufacture, for it is said, for example, that certain plat-

inum ware developed a white layer on exposure to high temperatures; other pieces developed cracks when heated; other pieces gave up several milligrams of iron when digested with hydrochloric acid. All platinum ware is expected by the chemist to withstand certain simple tests. It should not change color, lose weight, develop cracks, or show a whitish coating after being heated to a high temperature for several hours in the blast flame or furnace. It should not be brittle and should be durable. It should show only an insignificant loss in weight when digested with hydrochloric acid. It is to be hoped that the reported inferiority of some of the modern platinum ware will speedily be corrected. This would be to the best interest of the manufacturers. Poor platinum ware inevitably leads the chemist to look for substitutes—in some cases successfully. It is said that the Bureau of Standards at Washington has contemplated for some time an investigation of the whole subject of the quality of platinum apparatus and ware. It would be well if the manufacturers would lend their coöperation in this work. That the results of such an investigation would be of the greatest interest to the chemical profession does not require emphasis.

### THE PRICE OF POTASSIUM SALTS.

ACCORDING to the calculations of Dr. F. W. Clarke, potassium ranks seventh in point of abundance among the elements composing the chemically-known earth. The elements and their relative abundance down to and including magnesium are: Oxygen, 49.78 per cent.; silicon, 26.08 per cent.; aluminum, 7.34 per cent.; iron, 4.11 per cent.; calcium, 3.19 per cent.; sodium, 2.33 per cent.; potassium, 2.28 per cent.; magnesium, 2.24 per cent. In commerce the greatest outlet for potassium is in the fertilizer trade. Of the ten or twelve elements which enter into the composition of the higher plants and which are necessary for their growth, potassium occupies an important place. Without potassium in the form of soluble salts the higher plants cannot grow and develop to maturity. And, unfortunately, it is one of the elements in which soils are likely to be deficient in available condition. Therefore it is necessary to apply potash salts to the soils as fertilizers and the use of potash salts for this purpose is increasing at an enormous rate. Potassium is found in insoluble condition in the feldspathic rocks and others, and in

BIBLIOTEKA POLITECHNIKI WARSZAWSKIEJ

soluble compounds in the ocean. In insoluble condition in the igneous rocks it is found to the extent of about 2.45 per cent., in the ocean about 0.04 per cent. Thus the world's great source of potassium is locked up in insoluble condition. It is true that weathering converts insoluble potash into soluble salts, but it is also true that these soluble salts have a great tendency to leach away. And unless the process is continuous in the soil it will be lacking in potash. Practically, the whole world is dependent on one source of supply of potassium salts, namely, the so-called Stassfurt beds in Germany. These beds were formed by the crystallization of the salts in the mother liquors of ocean water from which common salt had separated. In most localities where salt beds and gypsum are found—for example, in the states of Michigan and New York—no potash deposits are found. Evidently the mother liquors in these cases drained away without crystallizing. The German deposits are therefore unique. In them Germany has a great national asset. The United States, a great agricultural nation, is dependent on the German supply of potash for fertilizer. We consume annually more than one-half the total amount exported from Germany, at a cost of about \$8,000,000 per year. Before the first of the present year many large American fertilizer manufacturers had signed favorable contracts with certain potash mines which were "independent" in the sense that they did not belong to the "Syndicate." When it became evident that potash salts would be sold in America largely by producers who were not in the Syndicate, a law was passed by the German Reichstag which in effect, by indirection, made these contracts ineffective and non-operative. American manufacturers have been forced to buy potash salts at Syndicate prices in spite of their contracts with the independent mines.

The price paid per ton of muriate of potash is now \$34.00 instead of \$20.40, the price fixed by the contracts. The price of sulphate of potash has risen from \$25.00 to \$43.50 per ton. The very ingenious law by which these changes were brought about in international trade, under the plea that it was a purely domestic affair, is worthy of more than casual perusal. It has aroused the greatest interest at home and abroad and has led to many diplomatic representations. The German government stands by the Syndicate and thus far all the proposals of the American representatives have proven fruitless. What the final consequences will be it is impossible to foretell. A tariff war has been predicted. It is said that the United States government is considering the advisability of imposing maximum tariff rates—25 per cent. above the minimum now enjoyed—on imports from Germany. German newspapers say the Americans are only bluffing.

It has been said that in the United States a man runs the risk of fine or imprisonment if he belongs to a trust; on the other hand, abroad, a man runs the same risk if he does not belong to the trust. Recent developments in the German potash situation lend argument to these assertions.

With the advent of high-level potash prices, the search for new and cheaper sources of supply will go forward with renewed energy, and probably with success at no far distant day. The supply of insoluble potash in feldspar and other silicate minerals will offer tempting possibilities to the industrial chemist, and as the successful solution of the problem rests largely on the ability of the product to stand freight charges it is not improbable that at the present prices an industrial process will be devised which will be cheap enough to interest capital.

#### THE APPLICATION OF SCIENCE TO INDUSTRY.

IN one of the ponderous volumes containing the works of the Honourable Robert Boyle is to be found an essay entitled "That the Goods of Mankind may be much Increased by the Naturalist's Insight into Trades." To the modern ear these words have a wonderfully familiar ring. In our own times there has been laid increasing emphasis on the necessity for closer interrelationship between science and industry for the betterment of both, so that the doctrine, if not the application of it, has become a commonplace. Some of us have supposed that our views on this subject were quite modern, not to say one of the signs of our times. Nevertheless, much of this essay of Robert Boyle's, written in the sixteen hundreds, if it were divested of its oft-times painful precision of expression and undue elaboration and transposed into a modern English style, would do credit to a present-day document. In thought it belongs to the present, not to the past. At the beginning of his discourse Boyle says: "To make out what is proposed in the title of this discourse, I shall endeavor to show two things. The one, that an insight into trades may improve the naturalist's knowledge. And the other, that the naturalist, as well by the skill thus obtained, as by the other parts of his knowledge, may be enabled to improve trades." This is a most concise and comprehensive statement of the whole modern situation. Boyle continues: " \* \* it seems to me none of the least prejudices \* \* \* that learned and ingenious men have been kept such strangers to the shops and practices of tradesmen. For there are diverse considerations that persuade me, that an inspection into these may not a little conduce, both to the increase of the naturalist's knowledge and to the melioration of those mechanical arts." Throughout the essay Boyle shows a keen appreciation of the materials of education

which exist in the workshop and factory, and how they may be utilized to advantage by the scientist. That he himself frequently utilized knowledge acquired in the shops is shown further on.

"And I consider, in the first place, that the phenomena afforded by trades, are (most of them) a part of the history of nature, and therefore may both challenge the naturalist's curiosity and add to his knowledge. Nor will it suffice to justify learned men in the neglect and contempt of this part of natural history, that the men, from whom it must be learned, are illiterate mechanics, and the things that are exhibited are works of art, and not of nature." "For besides, that many of those productions which are called artificial, do differ from those that are confessedly natural not in essence, but in efficiency; there are very many things made by tradesmen, wherein nature appears manifestly to do the main parts of the work: as in malting, brewing, baking, making of raisins, currants, and other dried fruits; as also hydromel, vinegar, lime, etc., and the tradesmen does but bring visible bodies together after a gross manner, and then leaves them to act one upon another, according to their respective natures; as in making of green or coarse glass, the artificer puts together the sand and ashes, and the colliquation and union is performed by the action of the fire upon each body."

There must have been a great change of sentiment among chemists from Boyle's time to ours. Then it seems it was necessary to persuade them of the advantages of entering into factories and workshops to observe the operations; on the contrary, to-day it takes the best efforts of many manufacturers to keep them out.

"I have several times observed trades deal with things unknown to classical writers, and unused, save in their shops. And these are not only factitious but divers of them natural; as manganese (by some called magnesca), zafora (if at least it be what many repute it), emery, tripoli, etc., and of both sorts there are some that are exceeding useful; as of those formerly mentioned, the two first are to glassmen and potters; and the two latter to a number of other tradesmen; and as among artificial concretes, soaders are of necessary use to goldsmiths, locksmiths, coppersmiths, braisiers, pewterers, tinmen, glasiars, etc., amels to goldsmiths, glassmen, etc., lakes of several softs to painters, heralds, etc., and putty to amel founders, potters, stonecutters, goldsmiths, glass grinders, and divers other professions."

"And I freely confess to you, *Pyrophilus*, that I learned more of the kinds, distinctions, properties, and consequently of the nature of stones, by conversing with two or three masons, and stone-cutters, than ever I did from Pliny, or Aristotle and his commentators."

That the science of chemistry owes a great debt to

the arts and crafts, and particularly to chemical manufacturers, cannot be gainsaid. The phase of Boyle shown by these quotations, wherein he, the aristocrat in this search for truth, is seen conversing with workmen in the various trades, inquiring into factory processes and in general availing himself of materials of education which in his day were too evidently considered unprofitable and undesirable is most interesting. He speaks of brewers, tanners, glassworkers, goldsmiths, locksmiths, pewterers, tinsmiths and many others as though he were on easy terms with them and their professions. He also learns matters of historical interest for he says: "By frequenting the workhouses and shops of craftsmen, a naturalist may often learn other things, besides the truth and falsity of what they relate. concerning the history of the arts they make profession of." And a little further along he shows his appreciation of the historical treatment by remarking: "For I look upon a good history of trades, as one of the best means to give experimental learning both growth and fertility, and like to prove to natural philosophy what a rich compost is to trees, which it mightily helps, both to grow fair and strong, and to bear much fruit." He tells how he learned the art of making fine powders by elutriation and sedimentation from the plaster of Paris molders. He even thought "to bind several ingenious lads apprentices to several trades, that I might the better, by their means, both have such observations made as I should direct, and receive the better historical accounts of their professions, when they should be masters of them." But not alone did he receive instruction from the trades. He suggests ways in which the scientist may contribute to the development of manufacture, and he shows how he himself in several instances was able to improve the methods of his day in certain lines. As to the improvement of manufacture by the scientist, he says:

"This he may do by several ways, and especially by these three. The first, by increasing the number of trades by the addition of new ones. The second, by uniting the observations and practices of differing trades into one body of collections. And the third, by suggesting improvements in some kind or other of the particular trades."

"The artificer may be too much confined to certain materials, some of which may be scarce, or dear, or ill conditioned, in comparison of others that the naturalist might propose. As I remember, that being in a place, where we could not produce good vitriol to make aqua fortis with, after the manner of our English refiners, by a substitution of burnt alum for vitriol, but in a far less proportion, we made solvents for silver, as good as theirs, if not much better."

"For there are many things, which he who is acquainted with variety of bodies, and the accounts on which they work on one another, will either quickly

discern to be performable by other materials, than those that tradesmen confine themselves to, or probably guessed to be performable by other agents more in the tradesmen's power; and by making trials of his conjectures, it is like he will within a few trials discover what he seeks."

He also sets many practical problems for the scientist to investigate and solve: " \* \* \* \* the cracking of glass of its own accord, and particularly that which is complained of by divers who deal in telescopes, that the object-glasses, which are wont to be made, as I was saying, of fine Venice glass, will sometimes, especially in water, flaw of themselves, and so grow useless, to prevent which, some, that are very curious, carry them in their pockets."

" \* \* \* the fading of the bow-dye of water colors in liming, and the rust of shining arms, and other polished steels. Divers of these inconveniences also the naturalist may obviate or remedy; as some of the virtuosi above-mentioned, by teaching the glass-grinders to make the object-glasses of their telescopes of green glass, have taught them a way to make them durable in spite of the vicissitudes of weather."

These are only a few of the problems which he outlines. Many of them would appear foolish or impossible of solution to us. In the first burst of this enthusiasm they did not to Boyle. His clear insight and his great appreciation of the necessity for closer coöperation between science and industry mark him as one who lived before his time. In no other of his essays does his genius show more conspicuously.

## ORIGINAL PAPERS.

### THE BORAX INDUSTRY.

By F. M. DUPONT.

Received October 26, 1910.

It is now about half a century since borax has been commercially manufactured. Since that time the industry has undergone some radical changes. Before going into the details of the process of manufacture, I will mention the different sources of supply. The element boron is widely distributed through the earth crust, even sea water being known to contain minute amounts of borax.

Boric acid is found free in nature in many volcanic districts, as in Tuscany, where the vapors issuing from the saffioni charged with the acid are passed through vats of water until the water becomes sufficiently concentrated, or, are deposited as a crystalline crust around the margins, as in the neighborhood of Sasso. When these little lagoons are sufficiently concentrated with boric acid they are run into crystallizing vats and the product put on the market as sassoline or Tuscany acid:

#### TUSCANY ACID.

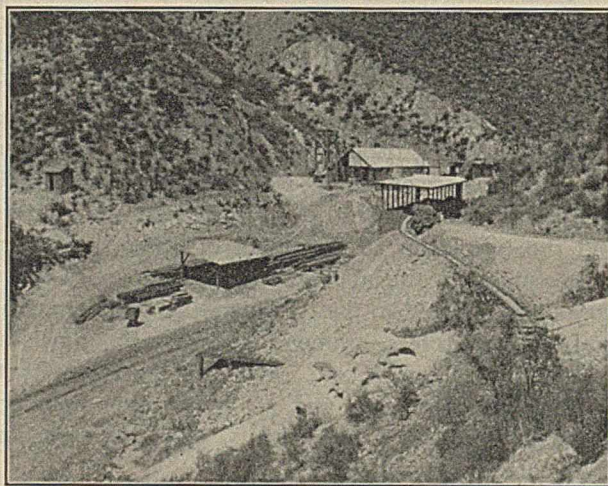
	Per cent.
B <sub>2</sub> O <sub>3</sub> + 3H <sub>2</sub> O.....	83.46
Water.....	1.44
Am. sulph.....	5.30
Mg. sulph.....	7.50
Fe and Al.....	0.30
Sand and organic matter.....	2.00
	100.00

In the United States, it was first found in the water of Clear Lake, in Northern California, which waters, when evaporated, gave borax. Then borax was found in the surface crust of desert marshes in California and Nevada, and later on borax was leached out of the clay formations of the marsh deposits. Lately great deposits of a fairly pure calcium borate have been found in various parts of California, embedded in old tertiary sediments.

There are three varieties of calcium borate which correspond to the varieties of calcium carbonate: calc spar, marble and chalk, *viz.*, colemanite, pandermite and priceite, each found in different parts of the world in large quantities and of a well defined and constant composition.

Further, there is the boronatrocalcite, ulexite, tiza or cotton balls, a sodium calcium borate and the stassfurtite or boracite, a magnesium borate. There are a good many more varieties of natural borates and borosilicates which are of more interest to the mineralogists than to the manufacturer or which belongs to the class of gems and precious stones. The ore most extensively used in the United States is the colemanite.

There are two localities which are now the principal source of supply, the mines in Death Valley and the mines at Lang, near Los Angeles.



Colemanite mine at Lang, California.

The geological formation of the surroundings consist of black lava, sandstone, limestone and clays of different colors. Mining is carried on by means of shafts.

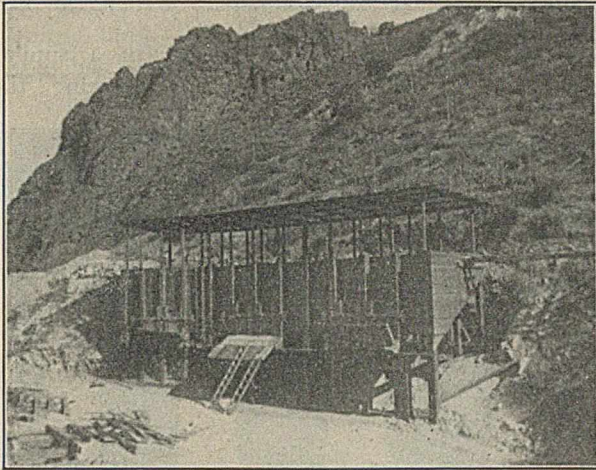
Colemanite is of a crystalline nature and resembles

closely, in its appearance, the calc spar or Iceland spar, for which it has been very often mistaken. Frequently colemanite is also called borspar. The color of the crystals is colorless to white, yellow-white, and gray. The hardness is 3.5 to 4.5. It pulverizes easily but the crystals have very sharp edges and cause a good deal of wear and tear in the pulverizing plant. In the ore, as it is mined, some parts of the colemanite

rocks, such as granite, trachyte and basalt. Several basaltic hills protrude in different portions of the basin and the presence of hot mineral springs further testifies to the volcanic influences which have been at work and in which, doubtless, originated the boracic acid mineral.

Pandermite occurs in an enormous bed of gypsum, which is covered with several feet of clay. The mineral exists in closely packed nodules of very irregular shapes and sizes, from the size and weight of a walnut up to one ton. The outside crust of this ore is extremely hard. It is easily separated from the dark-colored gypsum in which it is embedded. It is sold on the European market on a basis of 44 per cent.  $B_2O_3$ . The chemical combination is the same as that of the colemanite, only if heat is applied to it it does not exfoliate but sinters together and fuses to a transparent mass. It resembles closely, in its outward appearance, a fine-grained marble.

Boronatrocalcite is found in Peru and Chile, Province of Otocama, and Ascotan and Maricunga and Copiapo. The crude material, also known as Tiza, occurs in both places, in lagoons and troughs. These, instead of being filled with common salt, as is usually the case, in the desert, contain zones or layers of boronatrocalcite, alternating with layers of salty earth. The raw material from these places varies from 25 per cent. to 45 per cent.  $B_2O_3$ . It is shipped



Bins, colemanite mine at Lang, California.

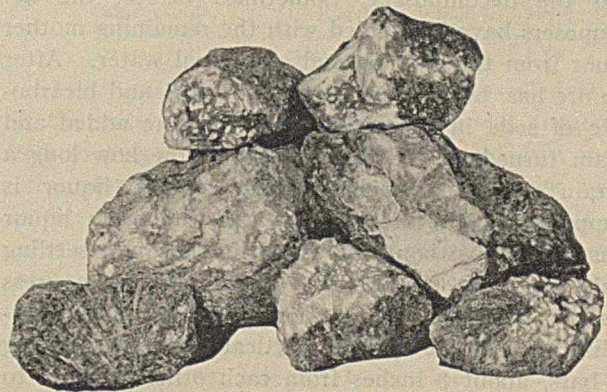
are of a different character and of an exceptional hardness. Chemically speaking, colemanite is a hydrated sesquiborate of lime, differing only in composition as regards water of crystallization. The formula is  $(CaO)_2(B_2O_3) + 5H_2O$ . In the blow-pipe it exfoliates and decrepitates violently and then sinters and finally fuses completely. The ore, as it is mined, runs from 33 per cent. to 35 per cent.  $B_2O_3$ .

The analysis shows, besides boric acid, other impurities differing according to the locality from which the sample came. Below is the analysis of a sample of colemanite from Lang, California:

	Per cent.
$B_2O_3$ .....	36.10
CaO.....	23.74
$Al_2O_3$ .....	1.27
$Fe_2O_3$ .....	1.32
MgO.....	2.36
$CO_2$ .....	5.14
$SiO_2$ .....	13.97
Water.....	16.10
	100.00

As borax contains 36.67 per cent.  $B_2O_3$ , 1 pound of ore will make nearly 1 pound of borax.

Pandermite, or Turkish boracite, is found in Asia Minor. The field is near the Rhyndamus river, whose outlet is in the sea of Marmora, near the Port of Panderma, on the Asiatic shore. This port is regularly frequented by sea-going vessels and gives, therefore, ample facilities for shipping. The field embraces the villages of Sultan, Thair, Yildiz, and Omerly, and covers about twenty square miles and is situated in a basin of tertiary age surrounded by volcanic



Colemanite.

to European ports from Arequipa, Ascotan, Iquique, Bolivia, Tocopilla, Chilcaya and other small places. The chemical formula is  $Ca_2B_6O_{11}Na_2B_4O_7 \cdot 16H_2O$ .

BORONATROCALCIT FROM ASCOTAN.		Per cent.
$B_2O_3$ .....		38.04
$H_2O$ .....		19.86
$Na_2O$ .....		15.91
CaO.....		12.34
MgO.....		0.37
$Fe_2O_3$ and $Al_2O_3$ .....		0.24
$SiO_2$ .....		4.95
Cl.....		9.64
$SO_3$ .....		0.84
		100.00

It is a soft, silky, fibrous mineral, brilliant white

when pure, but generally found in nodules of yellowish white color.

Another, but small source of supply, is stassfurtite or boracite, near Stassfurt in Prussia, in the kainite beds. It is a magnesium borate and looks like fine marble, sometimes a soft, slimy mass and sometimes of hardness 7.

I believe this covers all the borates which are at the present time used in the manufacture of borax and boric acid.

The manufacture of borax differs according to the raw materials used, also according to the personal preference of the superintendent and chemist. There is more than one method practicable for the same ore. We will first discuss the methods used if the raw material is colemanite. The ore, as it comes from the mines, is crushed in a stone breaker to the required fineness, which depends on the kind of mill to which it is fed afterwards. The size varies from one-half to one and one-half inches. As the mineral passes through it is taken up by elevators and carried to the mill and from there to a sifting machine. The powder is so fine that it has to go through a bolting-cloth, known as silk No. 8. The fine material is conveyed by means of a screw and elevator into bins capable of holding a certain stock, which seems necessary to have on hand in case an accident occurs to the mill. From here the weighed ore is dumped into the decomposers. Sometimes before, the decomposers have been filled with the remaining mother liquor from the crystals and additional water. After the ore has been dumped in, carbonate and bicarbonate of soda in the right proportion are added and steam turned on. Experience will show how long a certain ore needs boiling. The mother liquor is pumped through filter presses and the clean liquor runs with or without aid of an intermediate settling tank into the crystallizers. The mud in the press chamber is leached out and disposed of. The crystallizers are fitted up with vertical iron rods hanging on bars, about 8 inches from each other. In six to ten days all the borax will be crystallized save a small per cent. which will always remain in the mother liquor. The liquor is siphoned off and the crystals are washed, broken off the rods and sides, dried, and granulated or powdered.

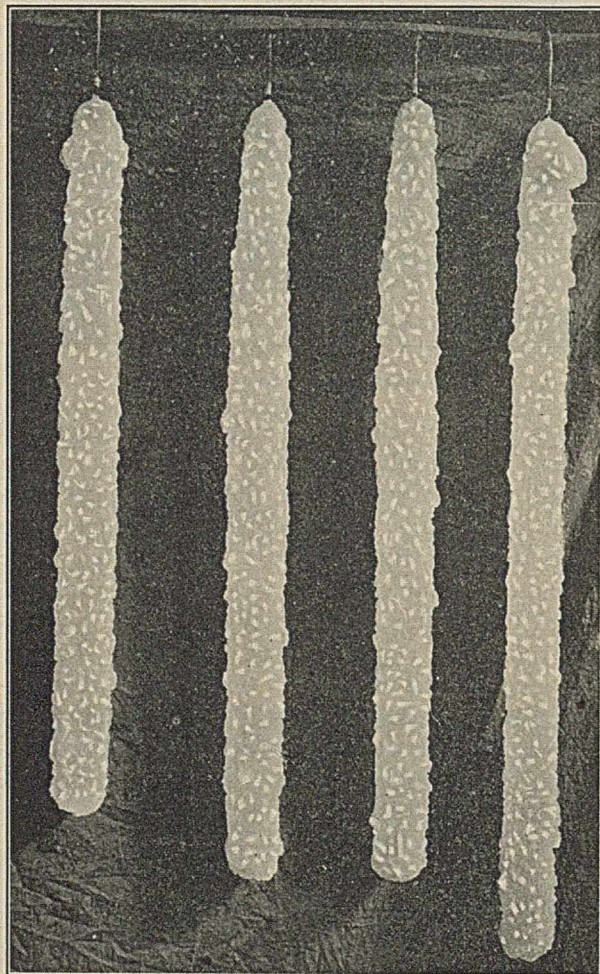
Pandermite cannot be decomposed under the same conditions. The mineral is reduced in about the same way, only a different type of mill is used. The mixture of ore, soda and bicarb and mother liquor is boiled in closed vessels and at a pressure of 60 pounds steam overnight.

In France the pandermite is decomposed with soda ash only in autoclaves. The liquor contains then the biborate and monoborate of soda and to this liquor enough boric acid is added to convert all into

biborate, and then it is handled in the same way as the other ore.

There are a good many more processes, which are of more or less value. In France there is made, besides the regular borax, the octahedral borax, which contains only five molecules of water. In this case the liquors are made more concentrated and then cooled down to 56° C. and siphoned off. This borax is also called jewelers' borax, because it is usually made for jewelers.

The boronatrocalcite is worked up in a similar manner. The operation consists of reducing the



Borax crystals on crystallizing rods.

material in a state of fine division, and for this purpose the mill used is so constructed as to tear the borate ore to pieces instead of grinding it, which, owing to the fibrous nature, is found more profitable. The borate is then mixed with proper proportion of carbonate and bicarbonate of soda. 100 parts of ulexite, 43 per cent.  $B_2O_3$ , require 10 parts of bicarbonate and 12 parts of soda for the conversion into 117 parts of borax.

The uses of borax are various and in nearly every industry borax is used in some department. The

largest use of borax is in enameled sanitary and kitchen ware, and it is the most essential part of the enamel. It is also largely used as a flux in the manufacture of pottery and earthenware glaze. Borax is used in the making of certain varieties of glass and in the manufacture of artificial gems and strass. It is an important substance in the manufacture of optical glass and glass which should not be susceptible to changes of temperature, such as incandescent lamps, lamp chimneys, etc., as such boro-silicate glass has a minimum coefficient of expansion.

It is also used for making vitrifiable pigments for staining glass and in the manufacture of encaustic tiles, which are rendered fusible by its admixture.

Borax is used in the tannery and in the currying shop. It is of great benefit in the soaks, where it dissolves the dirt and the blood and insures a more rapid liming. In the bates for sole and chrome stock, a borax bath has been found very commendable.

It is also used in the first stage of tanning in the liquor. It is used for cutting the oils and fats used in stuffing leather. Borax is also one of the best known agents for whitening and bleaching leather of all kinds; especially russet leather is treated with borax. It is the best known mordant for coloring leather. It really replaces any alkali used in tanning, on account of being more harmless, antiseptic and sweetening.

Borax, for its great cleaning properties, is used in the laundry in washing as well as in the starching. There are several starches on the market containing borax, its admixture helps to give the shirts and collars a very high gloss. Borax is also used as a wood preservative against dry rot.

Another very large use is as a flux for welding and brazing metals on account of its capacity of easily dissolving the metal oxides and leaving a blank surface. The jewelers use it also for the same purpose.

Varnish made by boiling one part of borax with five parts of shellac is used for stiffening hats. With casein borax forms a substitute for gum which is moisture-proof. The paper mills use it for making a kind of parchment which is fat and waterproof. It is also used in the making of certain sizes and coatings for glazed papers and playing cards.

On account of its antiseptic qualities it is used in pharmacy in cosmetics, mouth washes, tooth powders and salves. The dentists use it for cleaning the teeth. It is used as an admixture for powders for killing insects, roaches, etc. It is also used as a preservative for meats and other foodstuffs, and finally in the manufacture of other boron compounds.

## WATER PROBLEMS.

By WILLIAM M. BOOTH.

Received November 3, 1910.

On the average more than two hundred gallons of water fall annually per square yard on the territory east of the Mississippi river. This is soft and reasonably clean.

To ascertain some of the properties of precipitated water, I have analyzed samples of snow that fell two miles from the center of Syracuse, outside my residence. The first sample was taken one evening in February, 1910. This analysis is as follows:

### No. 1. (PARTS PER MILLION.)

Total solids.....	54.0
Free ammonia.....	0.06
Albuminoid ammonia.....	0.094
Nitrates, nitrogen in.....	0.00
Nitrites, nitrogen in.....	0.000
Chlorine.....	0.00
Alkalinity.....	1.25

Samples of rain water have been taken that were slightly acid, but usually this is nearly neutral.

Analysis of wet snow that fell the evening of November 4, 1910, at practically the same point as that where No. 1 was taken:

### (PARTS PER MILLION.)

Total solids.....	24.0
Loss on ignition.....	10.0
Free ammonia.....	0.020
Albuminoid ammonia.....	0.025
Nitrates, nitrogen in.....	0.005
Nitrites, nitrogen in.....	0.006
Chlorine.....	trace
Calcium oxide.....	3.6
Magnesium oxide.....	0.00
Alkalinity.....	8.00

Many industries demand rain or distilled water. If the natural product were collected and appropriated to power use, every thirty-six acres area would offer ample supply for a one thousand boiler horsepower plant, running continuously throughout the year and using the water but once; condensing water not considered. If made slightly alkaline, this would be ideal for power use.

Not until this free gift of nature has become hard and soiled do we attempt to use it. As the power house needs water in large quantities, any difficulty in this direction is felt at once severely.

Among the thousands of manufacturers, the larger percentage accept water as delivered and make the best of it, while a constantly increasing number place the matter in the hands of competent specialists who make recommendations resulting in economy. With the increasing use of resident chemists in manufacturing concerns, the water problem should be simplified and the water improved. The steam turbine, returning 65 per cent. of oil-free exhaust steam, is sure to produce great economy where water is expensive, but a manufacturing plant needs clean soft water for a variety of purposes and in such quantity that every commercial chemist should familiarize himself with the elements at least of the art.

For such, I can offer no better methods of analysis than those adopted by the Pittsburgh Testing Laboratory and splendidly described by Dr. James O. Handy.<sup>1</sup> For practical water purification, analyses made by this method leave nothing to be desired either regarding the quality of the water obtained or the quantity of lime and soda required.

In my own laboratory, the methods indicated by Mr. Handy are carried out as follows:

Fifty cc. of water are floated in a water bath in a weighed platinum dish. The dried residue is placed in a desiccator one hour and weighed. The difference between the first and second weights is termed "total solids." The phenolsulphonic acid method is applied to this residue for nitrates.

Two hundred and fifty cc. of the water are evaporated to dryness in a glass dish; also floated in the water bath. To the residue freshly distilled water is added. A policeman is used to free the sides of the dish from encrusting salts. The whole is warmed and filtered. The filtrate is saved for soluble calcium and magnesium. The precipitated carbonates of lime and magnesium are washed with the least possible amount of water until sulphates and chlorides disappear from the filtrate. The funnel with the precipitate is removed to another flask, filled with distilled water, and a few drops of hydrochloric acid are added. The whole is washed into the flask below. One of the last drops is used to carry a drop of methyl orange solution. Ammonia is now added to the filtrate to neutral reaction. About five grams of ammonium chloride are next added. When this has dissolved oxalate of ammonia is added, in excess. This solution is boiled for twenty minutes, cooled, filtered and washed with 150 cc. of hot distilled water. A few crystals of dry oxalate of ammonia are added to the filtrate to make sure of complete precipitation. Two hundred cc. of distilled water are placed in a flask. Five cc. of concentrated sulphuric acid are added. Liquid is heated to boiling. Permanganate is added to a slight pink. The filter paper containing the lime is now added to the flask. A slight rotational movement is given and the whole is titrated with permanganate until the first pink color is matched. If a smaller quantity of water is used, the filter paper is liable to be oxidized. Magnesium is estimated as pyrophosphate with the precaution that the filter paper is moistened with ammonia solution before filtering process is begun. The lime and magnesium in the neutral soluble filtrate are estimated in a similar way. One hundred cc. of water are titrated with standard silver nitrate solution, using 10 cc. of Mason neutral potassium chromate as an indicator. A blank is run with distilled water and the result obtained subtracted from the first. With waters high in carbon-

ates or heavily charged with other mineral matter, I never feel sure of a volumetric chlorine determination. Wherever accurate work is demanded the gravimetric method is far superior and takes but little additional time relatively. Sulphur trioxide is estimated in 100 cc. of water made slightly acid with hydrochloric acid at the outset and boiled until at least half the liquid is expelled. One liter of the water is evaporated to dryness with a few drops of hydrochloric acid. The residue is taken up with distilled water and filtered. The silica is estimated from loss when the ignited and weighed precipitate is treated with hydrofluoric acid. The oxides of iron and aluminum are precipitated in the filtrate from this residue, washed and weighed.

Alkalinity and hardness tests are made to check other results. With very hard waters, I suggest the use of not more than 10 cc. made up to 100 with distilled water for determining hardness.

It must be remembered that carbonates are slightly soluble in water. The inaccuracy can be confined between two and five parts per million by using proper precautions. Total ammonia tests should be made with all colored waters. Organic matter may cause severe corrosion in a boiler. For practical purposes the lime, magnesium, chlorine, nitrate, sulphate and ammonia tests are sufficient. The methods of combination are so generally known as not to require repetition. Water analysis is now an exact process, and uniform results can be obtained if care is used. As a check against the results previously obtained, I test 100 cc. of raw water for total calcium and magnesium. If these results vary from the sum of soluble or insoluble lime or of soluble or insoluble magnesium as much as five parts per million, the determination is made again. All water analyses should be checked by the method of Lunge, Vol. I, part 2, page 765. With such an analysis we are prepared to treat one liter of water.

Determine the lime and soda required. Make solutions, the strength of which is accurately known. Add these in quantities representing the salts demanded. Agitate the flask and set aside for at least four hours. Now filter and treat the filtrate as a new sample of water, making a complete analysis. Examine for excess soda and lime water. Once satisfied with the proportioning of the chemicals, try a barrel lot, and stir with a paddle or use such a device as shown in cut below, which can be gotten up for about \$25.

The laboratory difficulties of water purification are few. In the boiler house these multiply. Although the application of a very old discovery, the lime-soda process is far from ideal. Not until the lime and magnesium salts are removed without the consequent introduction of sulphate of soda can the art be said to be approaching perfection. Unfortunately we

<sup>1</sup> *Engineering News*, May 26, 1904, pp. 500-8.



are unable to employ anything else so cheap for the purpose.

Every water softening installation must be treated

Although water softening is a chemical process, machines and apparatus are required to incorporate the chemical with the water to separate any undissolved salts that may form or precipitate, if more than one hundred gallons of water are required per hour.

The question of the time required for complete softening both cold and hot and the precipitation of the salts formed are subjects that can be fully decided before an expensive machine is ordered or built.

There are two distinct classes of water purifying apparatus, the intermittent and the continuous. The continuous process may further be subdivided into apparatus that conforms to a varying draught of water and to another form that runs at a uniform rate but only when water is required for the supply tank.

For the benefit of chemists who may read this article, I suggest certain forms of apparatus that have been installed,

applicable to the softening of water from a few hundred gallons to two hundred thousand gallons per day.

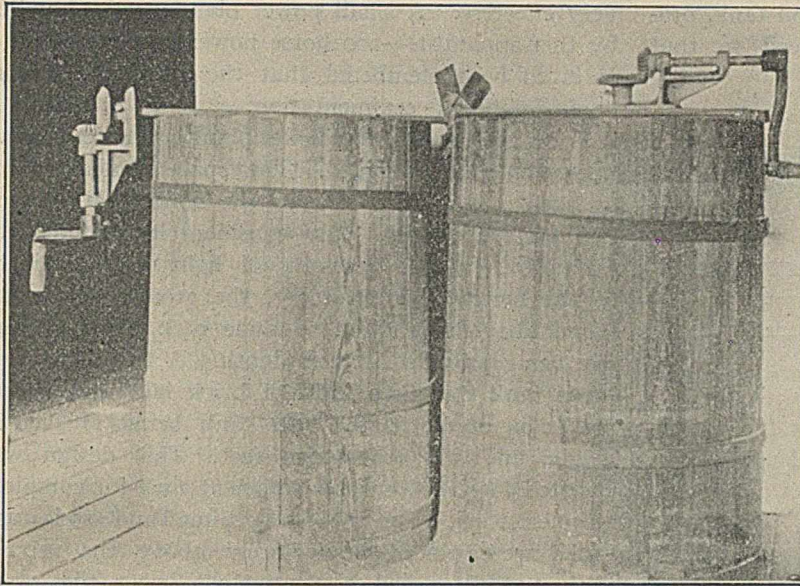


Fig. 1.—Simple mining tanks.

as a separate study. Owing to this fact, it is very difficult to get up a machine or apparatus for general sale as in the case of a heater or pump. The quality of the water may vary rapidly from day to day or from month to month; the boilers may be provided with water inlets at unusual places; the piping may be peculiar or the returns may at times contain large quantities of oil. To these add engineers and firemen who are positive that water purification plants are unnecessary and a constant bother, and one is able to see that the installation of a machine or apparatus under these circumstances may be accompanied by uncertain results. If given proper attention, a well designed water softening plant may be of great value to a manufacturer, provided the water has a hardness greater than 60 parts per million.

In preparation for any change in the water supply or a large plant, samples should be placed in the hands of a competent chemist at least one year in advance. Monthly analyses should be made with a full report. Having determined the quantity and quality of water available, tenders for the plant can be gotten up. This is the only fair way to prepare the contractors for proposals in connection with such a difficult subject.

I offer no criticisms regarding blank proposals usually sent out, excepting that many waters foam seriously if fully softened. A 90 per cent. removal of scale-forming salts is rarely necessary for practical purposes and is not desirable for boiler use. The scale building power of gypsum is often completely broken down when 50 per cent. is removed. The daily operating cost is thus much reduced.

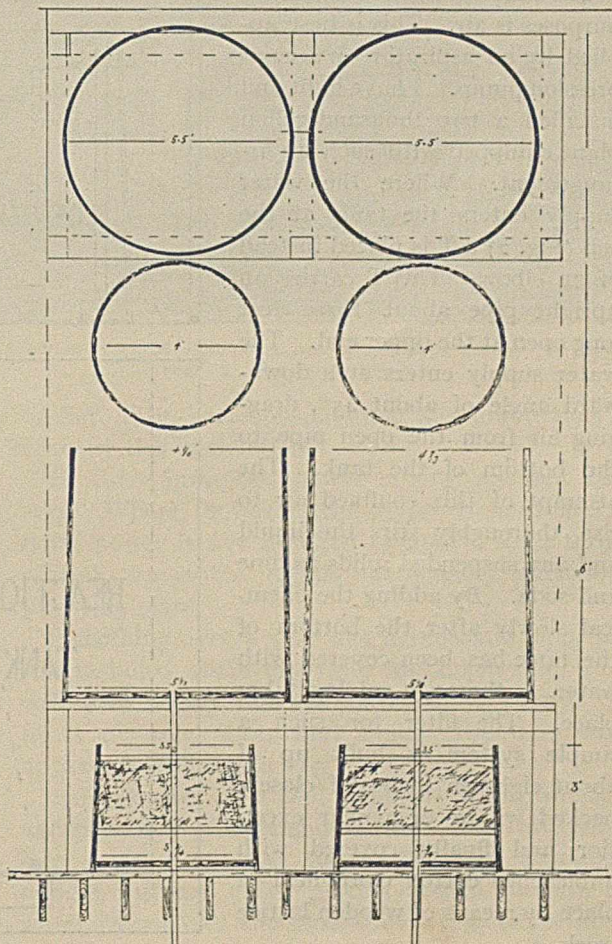


Fig. 2.—Intermittent process, 2000 gals.

At a certain coal trestle a 35 h. p. engine is used. It was found very difficult to keep the boiler in good condition and a softening device was called for. A 1000-gallon cypress tank was made and placed on the platform above the boiler and a second tank, provided with an excelsior filter, was placed so that

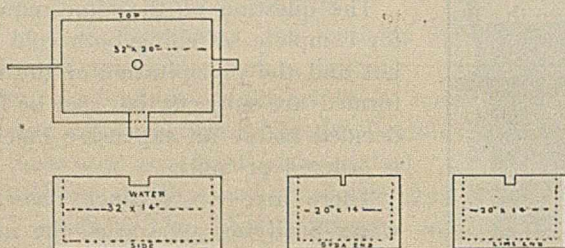


Fig. 3.—Fraction tank.

the top of the filter bed was a little below the bottom of the first tank. The larger tank is filled with water. The chemicals are mixed in a pail of water and added slowly. A long paddle is used to mix these thoroughly. After four hours this water is drawn through the filter. This proves very efficient and the boiler has been kept clean for several months. This is practically one-half of the plant shown in Fig. 2.

The simplest agent for mixing purposes is air. This is best applied by an aspirator or a compression pump. I have built and installed a two thousand-gallon plant equipped with such an arrangement. Where the water supply enters the tank at the top (Fig. 2) a T is placed instead of an elbow. This T carries an upright pipe about three feet long open at the upper end. The water supply enters at a downward angle of about  $45^\circ$ , dragging air from the open pipe to the bottom of the tank. The attempt of this confined air to rise thoroughly stirs the liquid and any suspended solids as lime and soda. By adding the chemical slowly after the bottom of the tank has been covered with water, a thorough mixing takes place. The filter for such a simple system is built up of about eighteen inches of closely packed willow or poplar excelsior and finally covered with unbleached cotton cloth held in place by means of wooden lattice work.

Such an apparatus in duplicate, softening one thousand gallons in each tank at a time, costs about \$250, including pipe, valves and suitable sludge outlets. Intermittent softening can in this way be made very effective. A small power plant can be handled by this apparatus—100 horse power is not too large. It is to be remembered that the chemicals require about four hours sedimentation.

For a 250 horse power boiler plant a more expensive apparatus was designed. The space available was an area 9 x 19 feet between the boiler house, stack and factory proper. Any considerable altitude was prohibited by the necessity of light for machinery in the factory. Accordingly, the ground was excavated above seven feet to shale rock, ample drainage being provided at this depth. A three-compartment tank was then built of brick laid in concrete and concrete-lined, the rear tank being 11 feet in height and the others ten feet. This design was adopted to give the water sufficient time for complete sedimentation. The necessary lime and soda ash tanks were placed immediately above the mixing tank and filter bed, respectively. Sewer tiles were

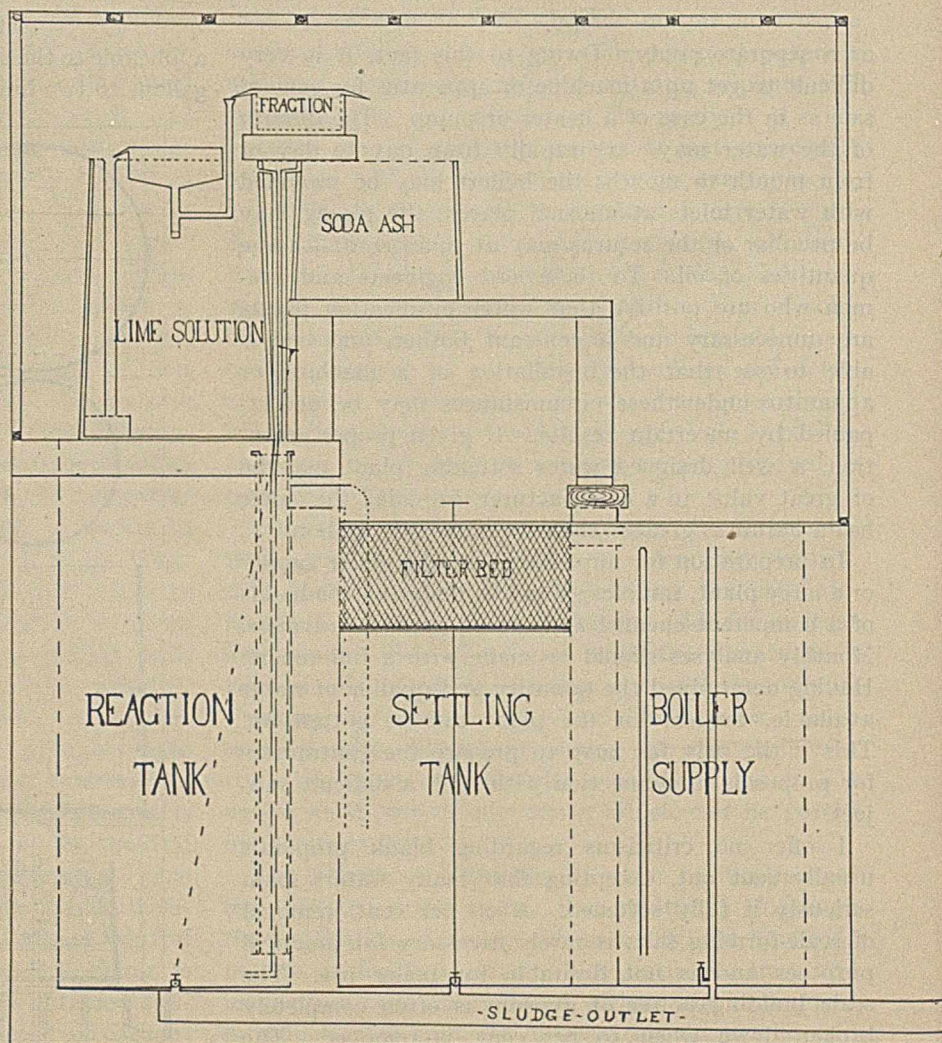


Fig. 4.—Section 250 H. P. plant.

used as conductors wherever practicable, no valves being necessary between the water inlet and sludge outlets. Those placed at the bottom of the large tanks lead into an eight-inch sewer tile drain which in turn opens into a sludge basin of brick and concrete.

Water enters the fraction tank (Fig. 3) and flows in three streams to the soda ash tank, the lime-mixing tank and the mixing tank proper. A float in the supply tank operates a quick-closing valve over the fraction tank.

The smallest stream of water passes into an iron supply tank provided with a partition extending nearly to the bottom. The water enters the larger compartment where the chemical is also placed and dissolved by steam. Raw water entering this tank rides on the top of the heavier soda solution and drives it under the partition and out over the top of the smaller compartment, where it mixes with the main stream.

The second water fraction flows directly to the bottom of the lime basket coming up through the particles of lime and then flowing to the bottom of the large lime-water tank, from thence to the main stream, where it mixes with the raw water and soda solution. The chemicals and water flow through a twelve-inch vertical tile pipe to a point about one foot from the bottom of the concrete tank where the entire mixture spreads out. The air bubbles start upward and thoroughly mix the entire mass. From this tank the water and sludge pass to the bottom of the filter apartment. The filter bed is of excelsior, twenty-four inches in thickness and has to be changed twice per year. Fifty square feet of filtering surface will take care of one thousand horse power unless very unusual draughts of water are demanded. This plant costs complete about \$800. The following analysis shows the nature of the water both in a raw and purified state:

	Parts per million.	
	Raw.	Purified.
Calcium carbonate.....	161.0	28.0
Calcium sulphate.....	421.0	0.0
Magnesium carbonate.....	0.0	Mg(OH) <sub>2</sub> 27.87
Magnesium sulphate.....	98.0	0.0
Calcium chloride.....	0.0	0.0
Magnesium chloride.....	0.0	0.0
Sodium sulphate.....	0.0	556.0

This plant was started by the engineer in charge with an efficiency of 75 per cent. This has been increased to 90 per cent. and can be maintained at this point. It has been found, however, that 75 per cent. efficiency is all that is necessary to prevent the formation of scale. The old scale of the boilers

was removed in three months. With returns, 13 pounds of soda ash and 12 pounds of lime are required to operate 200 h. p. thirteen hours, the whole cost for materials being seventeen cents. The engineer in charge spends about one-half hour per day in connection with the water softening plant. His time is occupied in opening and closing sludge valves, charging lime and soda ash and cleaning out the lime

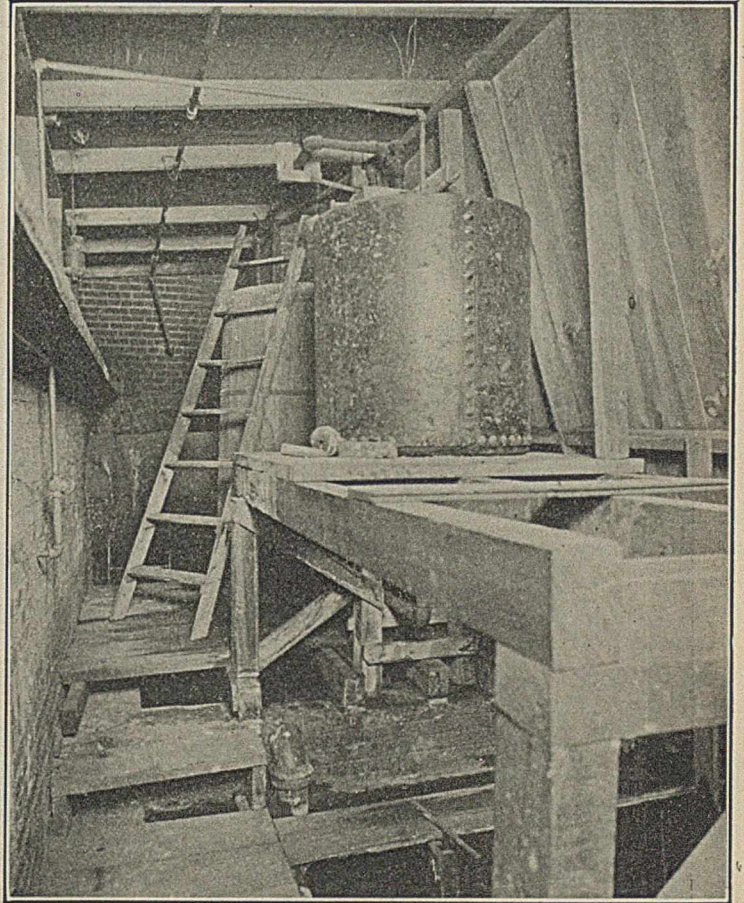


Fig. 5.—View of 250 H. P. softening apparatus looking toward soda tank and into filter compartment.

basket. The coal consumption was lowered 25 per cent. by this installation.

In these instances, power mixing was not necessary. Where, however, the water is hard and the horse power is five hundred or above, some form of stirring apparatus should accompany any water purifying plant.

Something over a year ago a thousand h. p. plant was installed where the water was taken from a deep well with a very uniform hardness, 14° Clark. The usual concrete tanks were built. The lime mixing apparatus is shown in Fig. 6.

This consists of a half cylinder within which revolves a heavy rectangular arm. Raw water flows into a weir and from thence, by three rectangular orifices, outward. The portion needed to form lime water passes into the lime stirring apparatus at one

end and overflows through a pipe at the other end, finding its way into an intermediate settling tank, falling from this into the vertical mixing column.

The portion of raw water required for soda solution passes to a slow pump (Fig. 7) which consists of two vertical cylinders concentric with two larger

steel tanks. Raw water flowing into the left-hand outer tank pushes the corresponding cylinder upward, lowering the right-hand cylinder and driving out soda ash solution in proportion to the raw water entering at the other side. Steam keeps this soda ash in a heated condition. The lime saturator is

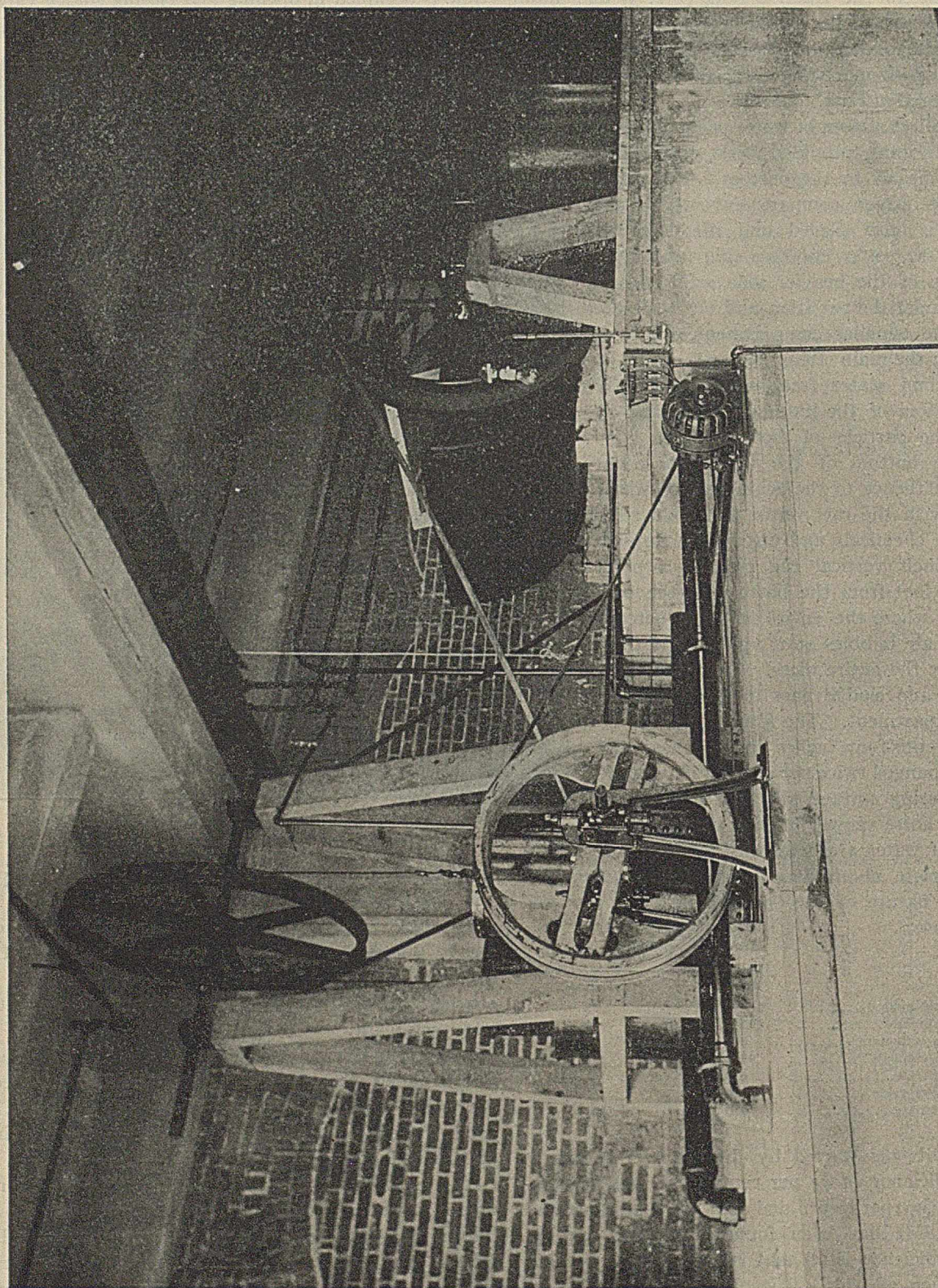


Fig. 6.—1000 H. P. plant.

driven by a 1 h. p. motor, which is run continuously. Although the amount of water used varies constantly, the quantity of lime and soda ash remains in very

both running under full head from the time the float trips the Cutler-Hammer device until it is again opened by the return of the float to its former position. This is the most satisfactory power arrangement that I have used, as the electric current is only required when water is needed.

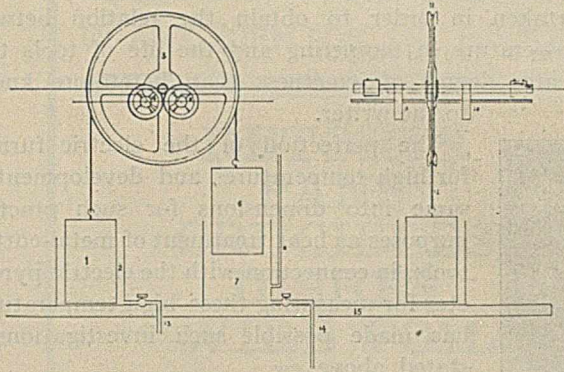


Fig. 7.

exact proportion to the water used. The following is a series of analyses taken at different times during the past year:

		(Parts per million.)			
		Sept.	Sept.	Oct.	May
Raw.		10, '09.	30, '09.	10, '09.	25, '10.
CaO.....	141	13	17.4	19	10.4
MgO.....	27	17	9.4	16	14.5

As shown by analysis, this water is kept nearly in a neutral condition. This form of saturator could be improved by raising the boiler plate about eighteen inches above its present height. However, it answers every purpose for the continuous and complete formation of lime water; of course with some milk of lime. By increasing the height and placing a porous partition over the stirring apparatus, clear lime water could probably be delivered.

Last spring a 1500 h. p. plant was required in a very hard water section. 250 pounds of chemicals had to be charged at a time for the day's run. This required a very substantial lime saturator. Accordingly, a steel tank stirring and proportioning apparatus were designed in one. This very thoroughly mixes the chemicals which are added together and are stirred constantly during the entire day. This apparatus is shown in Fig. 8.

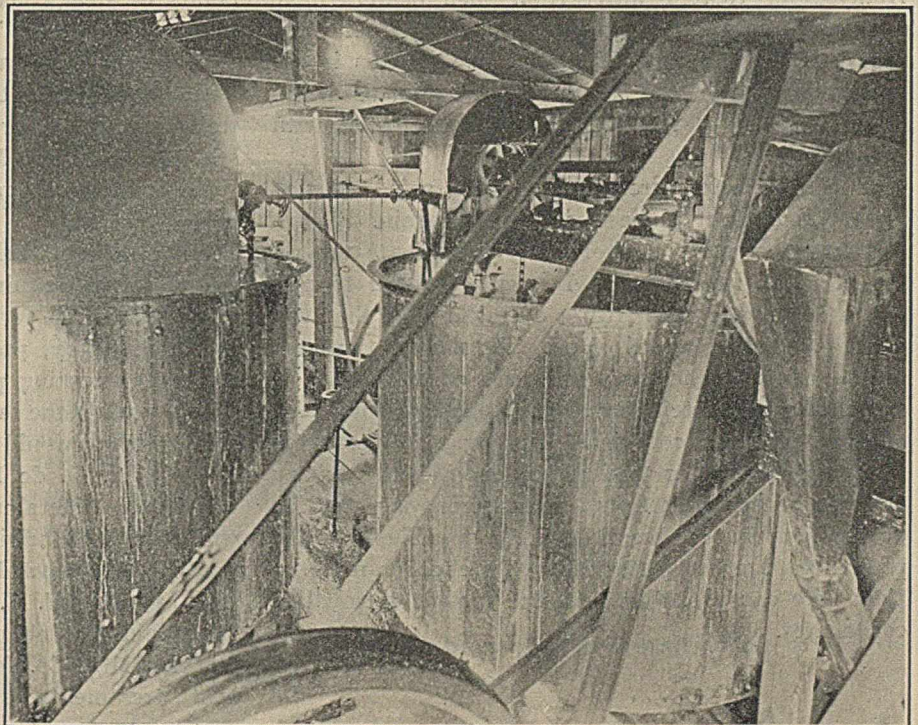
This plant is driven by electricity at a uniform rate with alternating current motor. A valve in the boiler supply tank controls water and electricity,

ANALYSIS OF WATER, BEFORE AND AFTER TREATMENT.

	(Parts per million.)	
	Raw.	Treated.
Calcium carbonate.....	162.50	Sulphate
Calcium sulphate.....	475.00	hardness re-
Magnesium carbonate.....	6.00	moved. Alka-
Magnesium sulphate.....	216.7	linity held at
Sodium chloride.....	28.8	170.

The lime-soda process has been successfully employed in boiler plants and in private residences where the water was saturated with gypsum, containing about 1600 parts per million, with 170 to 200 parts of calcium and magnesium carbonate per million. From boilers the sulphate of soda ormed must be blown out often, otherwise serious foaming results. To treat hard water uniformly, so that it will neither scale or foam, is the aim of the successful specialist.

Manufacturers are ready to accept the suggestions of their chemists if these are practical. As shown in the foregoing article, fifty gallons of water can be softened to show what such a process will do for the dyer, tanner, laundryman or the power plant. Engineers generally understand what can be done when you interpret your results by stating, for instance, that raw water containing twenty-five grains of hardness per gallon has been reduced to one containing but four.



Patent applied for.

Fig. 8.—Stirring apparatus.

The improvements in the art must come from the men equipped with chemical knowledge. I have been unable to discover a mechanical process that will fully separate encrusting salts from water inexpensively. Closed heaters separate a certain percentage of carbonates depending on the temperature, pressure and relative flow of the water. I

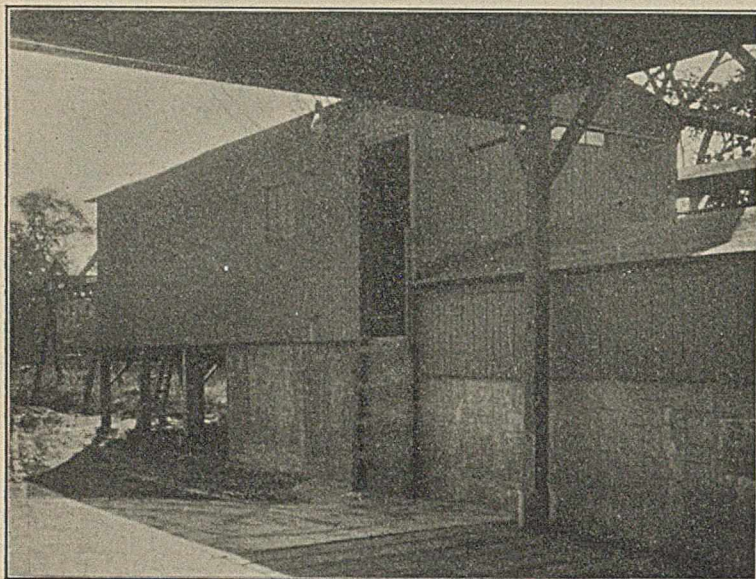


Fig. 9.—Housing for 2000 H. P. plant, 12' × 40'.

have found a removal of from 25 per cent. to 75 per cent. of these salts. High temperature and pressure heaters made to remove gypsum fail fully to do so. Analyses of treated water from such heaters have not shown more than 50 per cent. to 75 per cent. removal of sulphates. Moreover, the process is expensive both from the standpoint of steam used and labor required to remove the trays encrusted with heavy scale.

A considerable percentage of the soft returned water from a plant can be saved and used again. Chemical engineers need to thoroughly investigate the removal of oil from water. It seems possible to perfect a device provided with a chemical bath that will effect complete removal of oil. We need a thorough investigation of chemicals or processes that shall result in the complete removal of sulphates from water. Barium salts are considered dangerous by concerns using live steam for food purposes. Whether, when foaming occurs, such salts are dangerous is yet to be determined, but it seems entirely possible that the prejudices are fully founded. No cheaper material than lime can probably be found for the removal of carbonates.

## HEAT TREATMENT OF HIGH-SPEED TOOLS.<sup>1</sup>

By C. P. BERG, M. W. S. E.

Received November 1, 1910.

The experiments described in this paper were undertaken in order to obtain the relation between temperature in tempering and the life of tools to a greater degree of exactness than heretofore known to the writer.

The perfection of the electric furnace for high temperatures and development of same into dimensions for such practical purposes as heat treatment of metal-cutting tools, in connection with the electric pyrometer for measuring these high temperatures, has made possible such investigations as stated above.

The writer will confine himself conclusively to the attempt of solving the problem as it concerns the effect of various temperatures upon the life of high-speed tools, or the comparative values of the same.

Although the carbon steels are of decidedly earlier origin and have been experimented upon by several investigators, it is the hope of the writer to attempt an addition to the present available information in the near future.

Most notable of recent scientific work in this line is the paper presented by Mr. George W. Sargent, Ph.D., at the meeting of the Franklin Institute, June 3, 1909: "Some remarks upon the critical points of steel, their method of determination, and the value of same," in which he records a series of experiments made at the Carpenter Steel Works.

While the heat treatments and various tests described in his paper were conducted in a thoroughly scientific manner, Mr. Sargent failed to show the value of his investigations on the *life* of metal-cutting tools.

Fully appreciating the value of specialists for the various tests required to complete this work, the writer has been fortunate in being associated with, and assisted by, professional experts during the entire experimenting period, each one carrying on his special part of the investigation.

The writer would particularly mention Messrs. W. C. Post, A. D. de Pierrefeu and J. H. Critchett, of the Chicago Metallurgical Laboratory, in connection with the metallurgical examination by photomicrographs, Mr. James Lowrie, Ph.D., with the hardness test, and Mr. W. V. Young, of the Hoskins Mfg. Co. He would also acknowledge his indebtedness to the Hoskins Mfg. Co. for enabling him to carry on the heat treatments at their Chicago demonstrating

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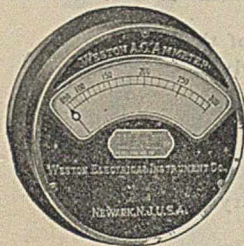
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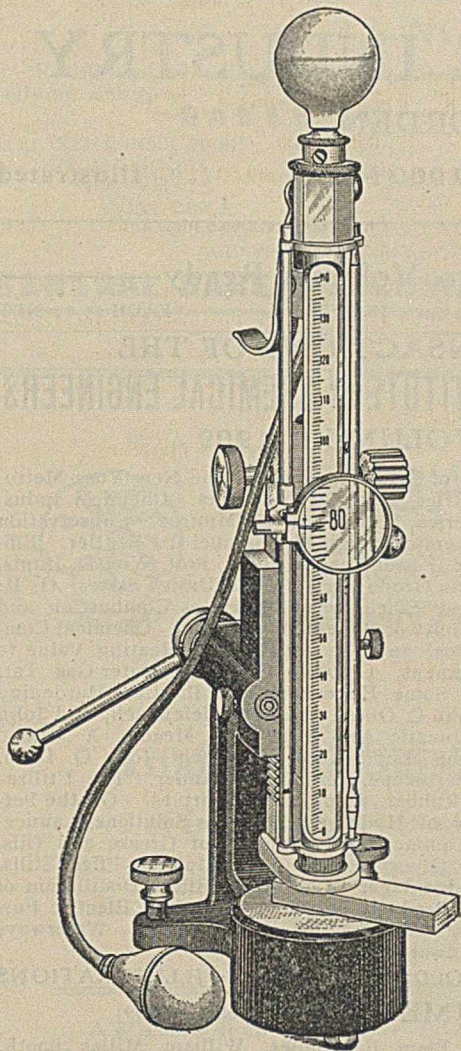
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### Van Nostrand's Chemical Annual

A Handbook of Useful Data for Analytical, Manufacturing, and Investigating Chemists, and Chemical Students. Based on Biedermann's "Chemiker Kalender."

EDITED BY

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plant, and the Link-Belt Company, at which shops the cutting tests were performed.

To recapitulate: The writer's work may be said to consist of:

A. Establishing a guide as to how rapidly the steel should be heated under the high heat treatment by a heat absorption test.

B. Determining at which degree of temperature in the heat treatment, the maximum cutting efficiency occurs for a steel of a certain chemical composition.

C. Giving reasons for the relations found by these tests by metallurgical examinations and to illustrate the same by photomicrographs.

*Steels Used in Test.*—Four prominent high-speed steels were selected to be experimented upon. These steels were marked A, B, C, and D, and these marks will be retained in referring to the four series of specimens undergoing the various tests.

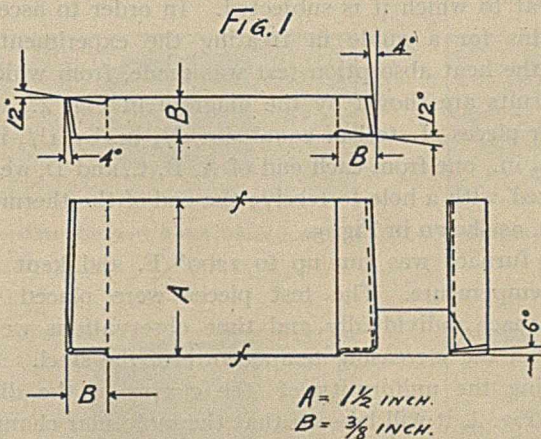
The chemical analyses of these steels are as shown in Table I:

TABLE I.—CHEMICAL COMPOSITION OF STEELS.  
Figures are percentages.

	A.	B.	C.	D.
Carbon, C.....	0.70	0.56	0.74	0.67
Silicon, Si.....	0.211	0.248	0.262	0.278
Sulphur, S.....	0.016	0.035	0.016	0.010
Phosphorus, P.....	0.010	0.012	0.016	0.015
Manganese, Mn.....	0.27	0.20	0.21	0.22
Chromium, Cr.....	4.76	5.54	5.80	3.30
Tungsten, W.....	15.15	8.45	10.94	15.37
Nitrogen, N.....	0.005	0.005	0.004	0.015

*Tools Used in Test.*—In order to eliminate the effect of forging upon the steels to be tested, straight tools for boring or inside turning, ground to shape and to standard angles in a grinder, were decided upon.

Steel bars of  $\frac{3}{8}$  by  $1\frac{1}{2}$  in. size were cut off from the four previously mentioned steels, to be made into tools for roughing cuts in boring cylinders to  $4\frac{1}{2}$  in. diameter. The tools were treated and ground with a cutting edge on both ends and to cutting angles as shown in the accompanying sketch (Fig. 1).



Boring tool used in tests.

exceptionally hard castings were provided for this test.

In order to insure equality, the greatest care was taken in preparing the molds for these castings, and all were poured from the same heat.

In view of the fact that the life of a tool decreases with the increase of combined carbon in the castings on which it is used, and again that the amount of combined carbon is dependent upon the rapidity with which the cast-iron is cooled after pouring it into the mold, it became necessary to find some method by which these castings could be cooled in the same length of time.

The molds were therefore specially arranged for this purpose, and eight minutes after the iron was poured the cores were removed and the castings cooled in water. This gave the castings as nearly as possible the same amount of combined carbon.

Dimensions of the cylinders were as follows: Outside diameter, 8 inches; length, 8 inches; and diameter of core, 4 inches; leaving  $\frac{1}{2}$  inch of metal to be removed by the double end tools to be tested, or, in other words, providing for  $\frac{1}{4}$ -inch depth of cut for each end of the tool.

The thickness of metal or walls of the cylinders being 2 inches, the castings were inspected for soundness and then considered if of the quality for the test or condemned.

*Heat Treatment of the Tools.*—The temperatures used in the heat treatment of tools have heretofore generally been measured in practice by the terms: cherry-red, bright yellow, white, etc. These measurements of heat were probably as correct as any other in connection with the old-time method of tempering tools in the blacksmith forge, where no accurate control of the heat could be obtained.

Admitting that there are experts in this line, who are able to guess temperatures very closely by the color of the heated steel, the writer has heard differences of opinions, when the limit line was to be drawn between white and bright yellow, etc.

With the modern electric furnace, its perfect control, evenly distributed heat, reducing atmosphere preventing burning of the steel, and the thermoelectric pyrometer for measuring temperatures, the science of treating metal-cutting tools has taken a long step forward.

The instruments as used for the experimental tools are shown in the accompanying illustration (Fig. 2) from a photograph. To the left can be seen the muffle furnace used for preheating the steel slowly up to 1400° F., prior to transferring it to the tube furnace, seen to the right in the picture, there to be subjected to the high heat treatment.

The muffle furnace, to the left, is of the wire resistance type constructed for temperatures up to 1800° F. The tube chamber design of furnace, to the right,

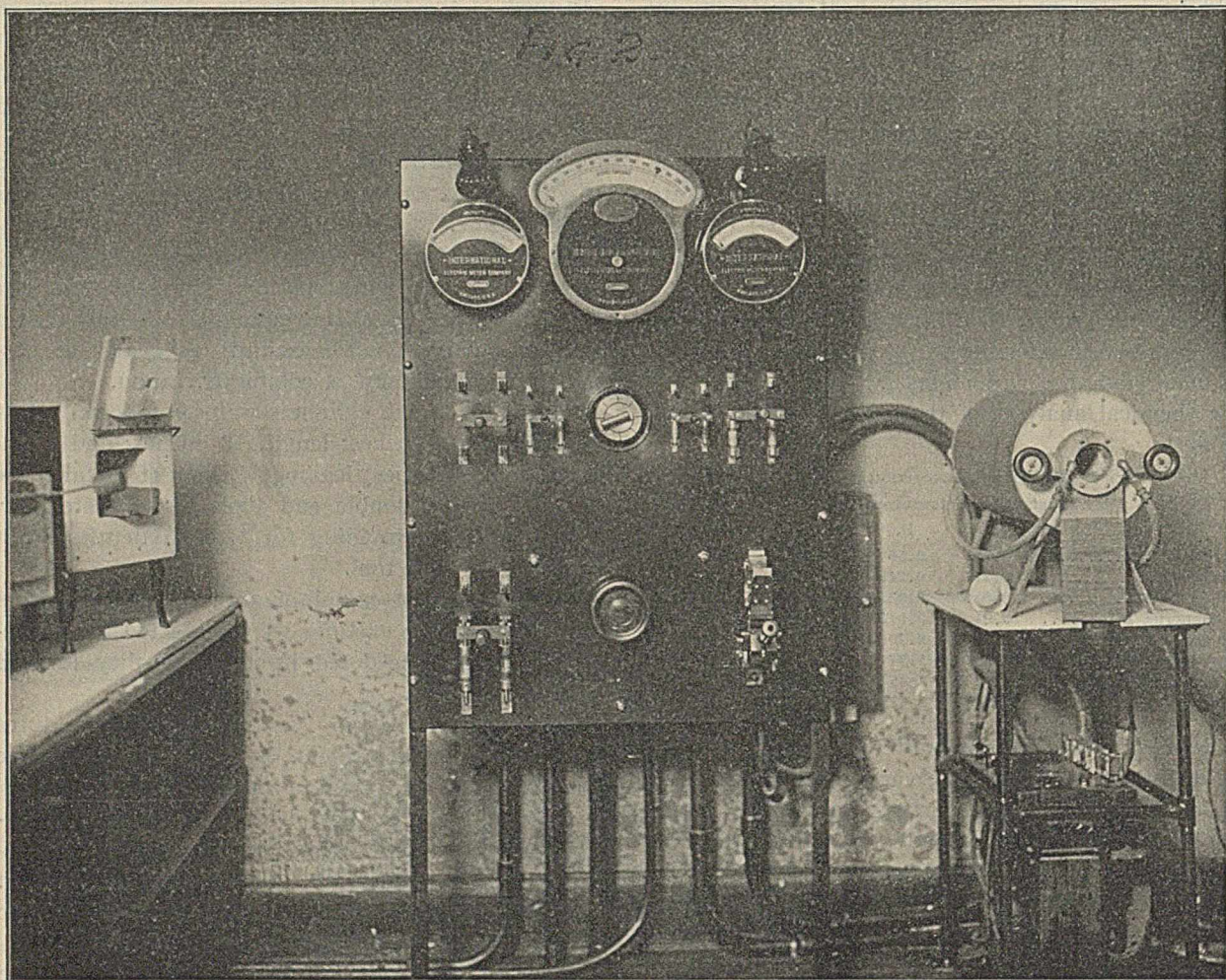
*Specimens Used for Physical Tests.*—Cylinders made from cast-iron of a chemical composition producing

where the experimental tools were subjected to the high-heat treatment, is constructed for temperatures up to 2600° F.

The current for both of these furnaces is controlled on the switchboard shown in the center of Fig. 2.

allowed for the heat to penetrate thoroughly to the center of the tool, which otherwise would be in danger of cracking.

To do this it is necessary to know the length of time required by the tool under treatment to absorb



Electric heating furnaces and switchboard.

The switchboard also carries the thermoelectric pyrometer, which is connected with the thermo-couples by the switch in the center of the board, this rendering possible the reading of temperatures in several furnaces on this one instrument by turning the switch, the contact points of the switch being numbered to avoid confusion. A wiring diagram of the pyrometer and selective switch is shown in Fig. 3.

To insure accuracy the thermo-couples used were calibrated before and after the readings made on the temperatures of the test specimens. The calibrating consisted in taking a reading on water at the boiling point (212° F.), on aluminum at the melting point (1215° F.), and on copper at the melting point (1949° F.).

In giving high-speed tools the high-heat treatment, the temperature should be raised rapidly to the desired degree for quenching, but enough time should be

the heat to which it is subjected. In order to ascertain this for a guide in treating the experimental tools, the heat absorption test was made, from which the results are shown by the diagram in Fig. 4.

Four pieces of steel of equal size,  $\frac{3}{8}$  in. by  $1\frac{1}{2}$  in. by  $1\frac{1}{2}$  in., one from each end of A, B, C, and D, were prepared with a hole to receive the end of the thermo-couple, as shown in Fig. 5.

The furnace was run up to 2200° F. and kept at this temperature. The test pieces were placed in the furnace individually and time observations were taken on the increasing temperature of the steel.

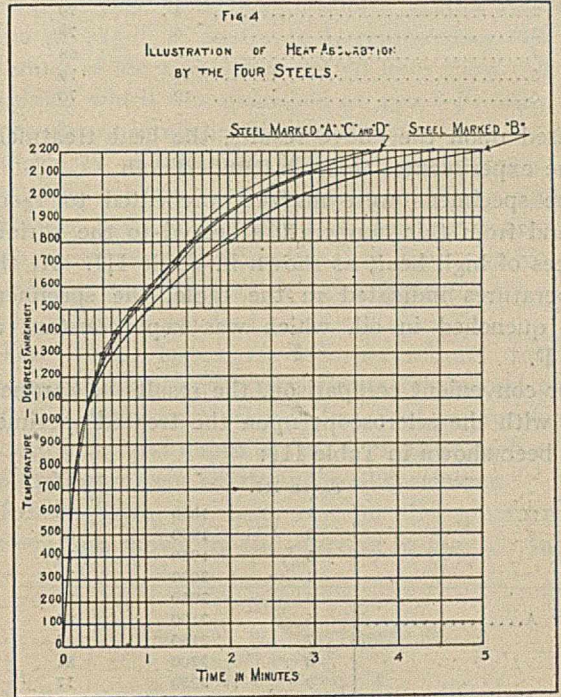
Noting the uniformity of the curves in the diagram, Fig. 4, it will be seen that the molecular change in the steel up to 2200° F. did not at any point disturb the evenly increasing temperature of the specimen. As will appear later, it was found that some of these steels are treated with the best results at

2150° F. The molecular change evidently is not violent enough and quick enough to stop the increase of temperature in the steel, at least it could not be observed by the instruments used.

From other tests made on heat absorption with various sizes of steel, it appears that the time for the absorption of heat increases very nearly in proportion to the thickness of the steel. Thus, a piece of steel 3/4 in. thick requires twice as long a time as is shown by the diagram in Fig. 4, which would be 6.6 minutes for a temperature of 2150° F., for any one of the A, B, C and D steels.

Plate I shows fractures of specimens from Series A, which have been heated to 2150° F. but which were

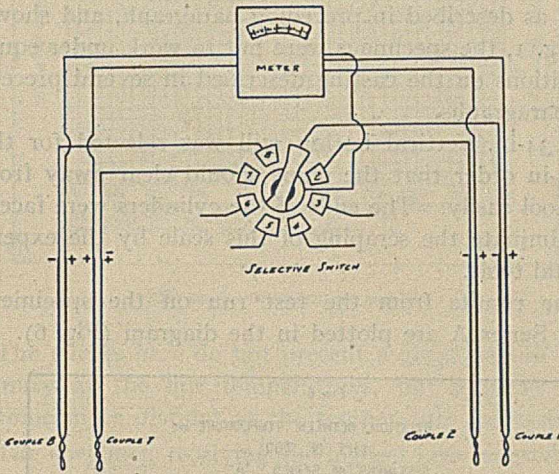
the necessity of careful observation in the matter of time for the tool to remain in the furnace to become thoroughly and uniformly heated.



The heat absorption of steels.

A hardness test of these specimens performed with a scleroscope gave the results shown in the following table:

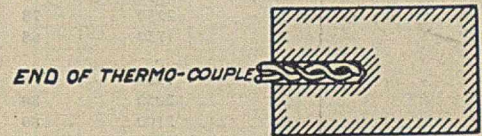
FIG. 3.



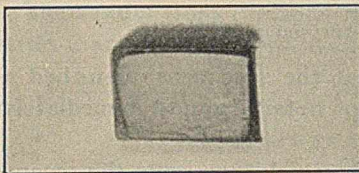
Electric pyrometer.

left in the furnace a certain length of time after reaching this temperature before quenching in oil at 100° F. Comparing these fractures with the ones from the experimental tools and the results from the physical tests of the latter, they strongly indicate

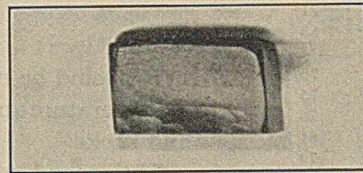
FIG. 5



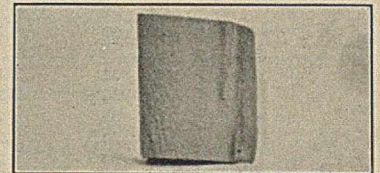
Fractures from specimens of Series A heated to 2150° Fahr. and the length of time for the specimens to remain in the furnace varied. Specimens quenched in oil at 100° Fahr.



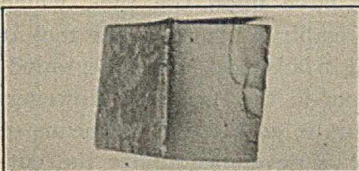
1—Left in furnace 2 min. before quenching.



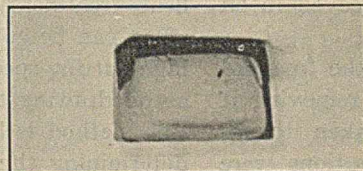
2—Left in furnace 4 min. before quenching.



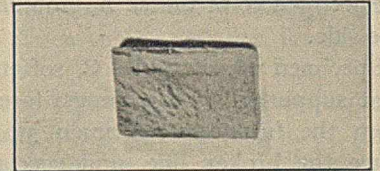
3—Left in furnace 6 min. before quenching.



4—Left in furnace 8 min. before quenching.



5—Left in furnace 10 min. before quenching.



6—Left in furnace 12 min. before quenching.

TABLE II.

Specimen.	Length of time left in furnace. Hardness by	
	Minutes.	scleroscope.
1.....	2	80
2.....	4	79
3.....	6	78
4.....	8	68
5.....	10	79
6.....	12	70

Based upon the above results, the heat treatment of the experimental tools was undertaken.

The specimens were marked, preheated to 1400° F., and from this temperature heated to the various degrees of high heat, as shown in Table III. At the temperatures indicated in the table, the specimens were quenched in oil, which was kept constant at 100° F.

For convenient comparison, the results of hardness tests with the scleroscope upon the treated specimen have been shown in Table III:

TABLE III.

A.....	1	1850	78
	2	1900	81
	3	1950	76
	4	2000	78
	5	2050	81
	6	2100	82
	7	2150	83
	8	2200	81
	9	2250	77
	10	2250	77
B.....	0	2300	74
	11	1850	78
	12	1900	74
	13	1950	75
	14	2000	77
	15	2050	83
	16	2100	83
	17	2150	82
	18	2200	79
	19	2250	78
C.....	20	1750	68
	21	1950	78
	22	2050	80
	23	2100	80
	24	2150	83
	25	2200	80
	26	2250	75
	27	2300	73
	28	2350	..
	29	2325	71
D.....	30	2350	68
	31	1950	70
	32	2050	75
	33	2100	76
	34	2150	81
	35	2200	79
	36	2250	83
	37	2300	86
	38	2350	86
	39	2300	86
40	2400	84	

Specimen 0, of Series A, softened and caved in on one side.

Specimen 28, of Series C, softened so the free end (not supported by the tongs) tore off in removing it from the furnace. Specimen 30 was taken to replace the broken one, and special precautions were made for its removal from the furnace, and it was quenched without mishaps.

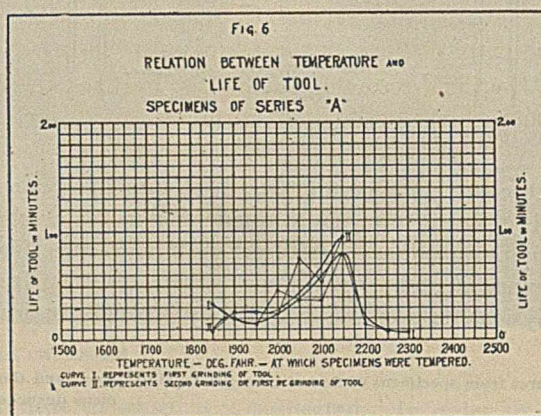
The specimens receiving the maximum heat all fused at the ends without exception, and some were, as previously stated, considerably softened.

In order to get the reading of temperature of the steel itself, a wire loop (wire  $\frac{3}{64}$  in. diam.) was put around one end of two specimens, which were to receive an equal amount of heat. The loop was made loose enough to permit the moving apart of the two free ends of the specimens. A wedge-formed space was obtained between them, in which the end of the thermo-couple was held firmly, yet from which it could be easily removed.

*Physical Tests.*—The life or durability of these tools, treated in the previously described manner, appears to vary a good deal. Being ground into tools as described in preceding paragraph, and shown in Fig. 1, the specimens were put to work under equal conditions on the casting described in several preceding paragraphs.

A 34-in. vertical boring mill was selected for the test, in order that the chips should clear away from the tool easily. The ends of the cylinders were faced, to eliminate the scraping of this scale by the experimental tools.

The results from the test run on the specimens from Series A are plotted in the diagram (Fig. 6).



"A" steels—temperature and life.

It should be noted that the specimens quenched a temperature above 2150° F. failed almost immediately and broke.

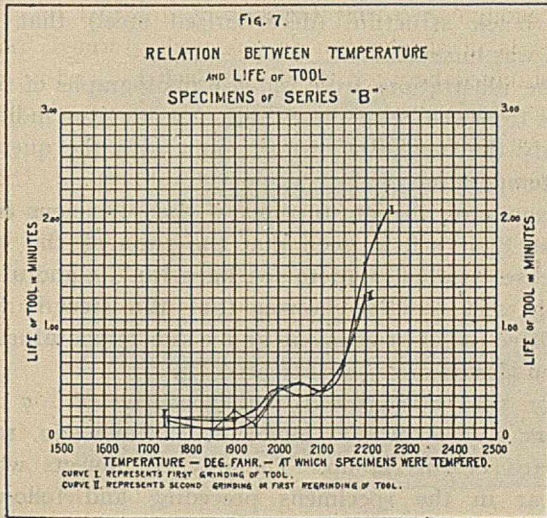
The second curve (II), which represents the second grinding of the tool, shows a slight increase in durability. This indicates the effect a second heat treatment (drawing the temper of the tool after the high-heat treatment) would have upon the tool, which effect can be gotten as readily by running the tool at high-cutting speeds until it fails, and have it reground, as by drawing the temper in the furnace. However, this method is less accurate, as there is no means of determining the heat thus developed under the cutting action, at the present time.

The cutting speed, 80 feet per minute, the thickness



of the shaving or feed per revolution, 0.0339 inch, and depth of cut,  $\frac{1}{4}$  inch at each end of the tool, were kept constant for all specimens and for both grindings.

Results from the test run on the specimens of series B are plotted in diagram (Fig. 7).



"B" steels—temperature and life.

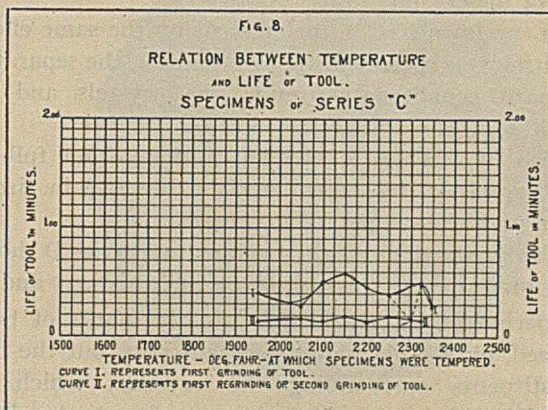
The curves here do not present a great deal of uniformity at the low temperatures, but improve and become more distinct as the temperature increases.

The specimen receiving the highest heat showed the maximum durability, but it failed very suddenly and broke into several pieces. The fractures gave evidence of brittleness.

Practically no difference in durability appears between the first and second grinding of the tool.

The cutting speed, 80 feet per minute, the thickness of the shaving or feed per revolution, 0.0339 inch, and depth of cut,  $\frac{1}{4}$  inch at each end of the tool, were kept constant for all specimens and for both grindings.

The results from the tests run on the specimens of series C are found plotted in the diagram (Fig. 8).



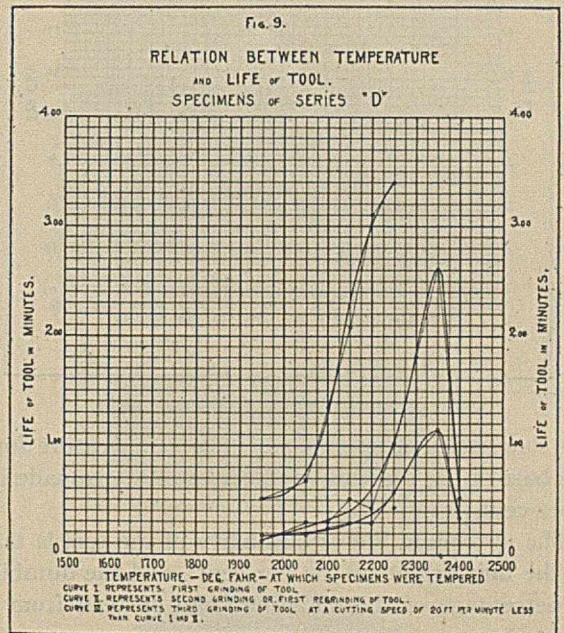
"C" steels—temperature and life.

The cutting speeds were evidently too high for this grade of steel. The durability being very low at all points, the variations are not distinct. However, it will be seen that the durability attains its maximum at 2150° F. in Curve I, representing the first grinding of the tool. The dotted lines show that the specimen which was quenched at 2300° F. failed and broke almost immediately after starting.

Curve II, representing the second grinding of the tool, does not show any variations whatever, and the difference between this and first grinding is negative. Both these occurrences are directly due to an increase in cutting speed of 20 feet per minute for the specimens on second grinding.

The cutting speed, 80 feet per minute for first grinding, and 100 feet per minute for second grinding, the thickness of shaving or feed per revolution, 0.0339 inch, and depth of cut,  $\frac{1}{4}$  inch at each end of the tool, were kept constant for all specimens.

Results from the tests run on the specimens of Series D are shown by the diagram in Fig. 9. In this



"D" steels—temperature and life.

diagram it may be noted that part of the specimens were subjected to a test also after being ground a third time.

All three curves (I, II, and III) show the variations very distinctly, and of exceptionally high durability, with the attained maximum at the quenching temperature of 2350° F. for both the first and the second grinding.

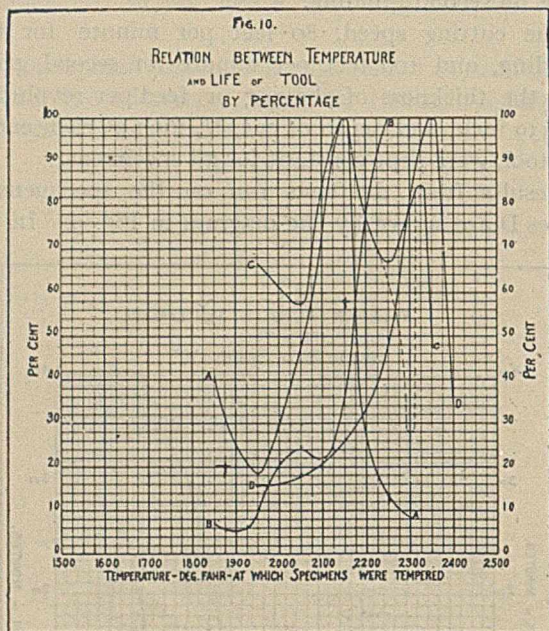
The specimen quenched at 2400° F. broke on the second grinding after failing in the length of time (0.52 minute) as shown in the diagram.

Only part of the specimens were run on the third grinding, simply for the reason that the time for

boring one cylinder would not be sufficient for the tool to fail at a cutting speed of 80 feet per minute. Cutting on more than one cylinder with the same tool would cool the cutting edge of the tool while changing and the result could not be considered.

The cutting speed, 100 feet per minute for first and second grinding, and 80 feet per minute for third grinding, the thickness of shaving or feed per revolution, 0.0339 inch, and the depth of cut,  $\frac{1}{4}$  inch at each end of the tool, were kept constant for all specimens.

In Fig. 10 is shown a diagram giving by percentage the relation between temperature and life of tool, of



The varying life of tools from temperatures.

the four series of specimens. The temperature forms the base of the diagram, and the ordinate is made into a per cent. scale.

The maximum life or durability of the tool is taken as the unit or put at 100 per cent., and the durability in percentage of the maximum can be read from the curves for any temperature used.

#### *Metallurgical Examination by Photomicrographs.*—

In examining the photographs of the specimens from Series A, it can be seen that the size of the grain increases with the temperature at which the specimen was quenched.

Specimen No. 7, because of its size of grain, absolute freedom from separation of the constituents of the steel, and the absence of the physical defects, which appear in the specimens preceding and following this one, is the one which will be able to best withstand the vibration and rough treatment of high-speed cutting.

In specimen No. 0 the hard constituents can be seen to have separated out, forming a network around the steel crystals.

The crystals of the steel under work are forced to move around, rubbing against each other like a ball and socket joint, and this hard constituent surrounding the crystals acts in the same manner as emery in a ball and socket joint, increasing the friction and generating heat, which will rapidly destroy the tool. This specimen also shows by its physical defects and black structure (decarburized steel) that the steel was burned.

The illustrations from full-size photographs of fractures from the specimens in this series also indicate clearly the increasing size of grain with the quenching temperature of the specimen.

Examining the illustrations of the specimens from Series B, it will be seen that the grain of the steel increases gradually up to specimen No. 16, and afterwards very rapidly, showing that the steel is very sensitive to heat treatment above the temperature at which this specimen was treated.

For the same reason that specimen No. 7 was chosen as the best of Series A, specimen No. 16 is selected of this group. The physical defects which appear in the specimens preceding and following specimen No. 16 are entirely absent here.

Comparing this result with the results of the physical test shown in the diagram (Fig. 7) it appears that the two do not agree for this steel. The diagram shows the maximum durability of the Series B is attained by specimen No. 19. This occurrence can hardly be accounted for unless it is due to a minimum of separated hard constituents around the steel crystals, even at the higher temperatures.

The illustrations from full-size photographs of the fracture show the increasing grain with the quenching temperature like the steel in Series A.

The illustrations of the specimens of Series C show that the size of crystal grains in this group increase gradually up to the point where the steel becomes burned, as shown in specimen No. 30.

For the series No. 24 is chosen as the best specimen, because of its clean structure, the absence of any separation of the constituents, and the uniform size of the crystal grains.

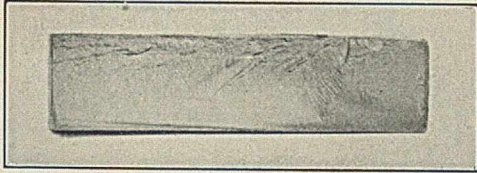
In specimen No. 30 the steel shows the same effects of burning as specimen No. 0 of Series A, the separation of hard constituents around the crystals and the black decarburized spots.

Also in this series the illustrations from full-size photographs of fractures show the increase in size of grain with the temperature.

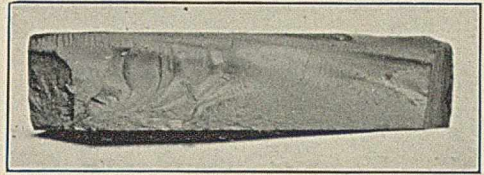
The illustrations of the specimens of Series D show a very uniform structure up to specimens No. 38 and 40.

Specimen No. 40 shows distinctly marks of being burned, by the black decarburized spots, but the hard constituents surrounding the crystals, which are found in other burned specimens, are entirely absent here.

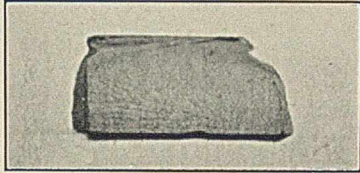
Fractures from specimens of Series A.



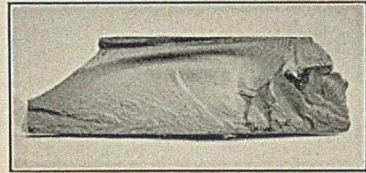
1—Quenched at 1850° Fahr.



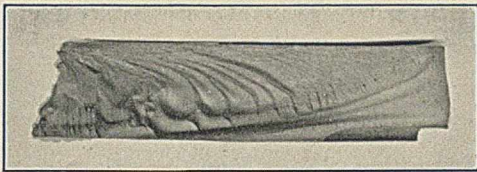
2—Quenched at 1900° Fahr.



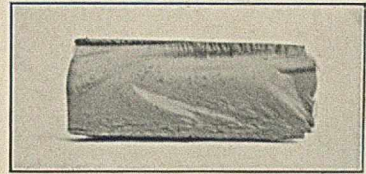
3—Quenched at 1950° Fahr.



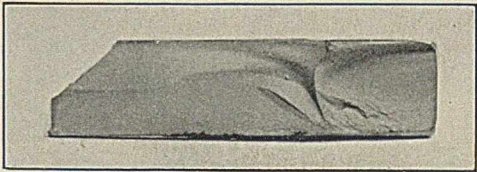
4—Quenched at 2000° Fahr.



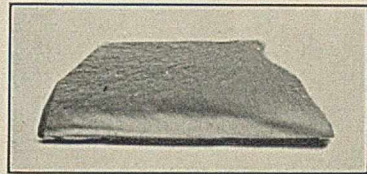
5—Quenched at 2050° Fahr.



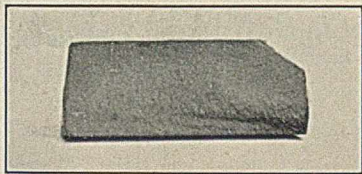
6—Quenched at 2100° Fahr.



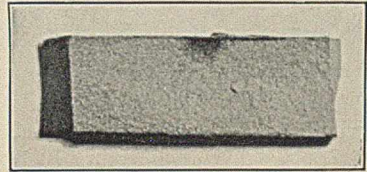
7—Quenched at 2150° Fahr.



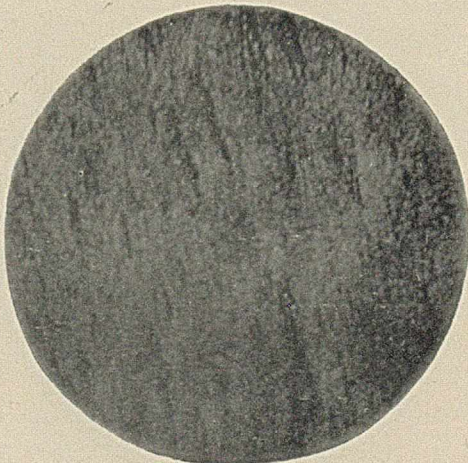
8—Quenched at 2200° Fahr.



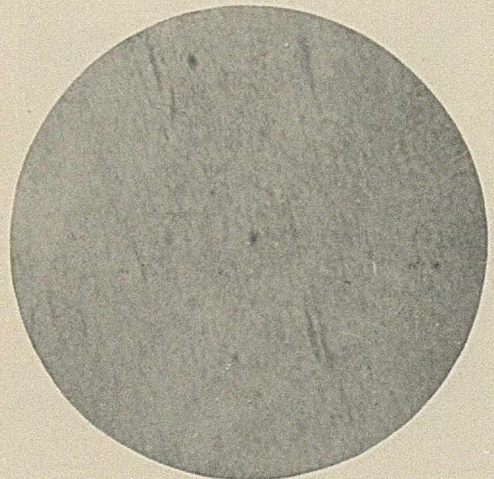
9—Quenched at 2250° Fahr.



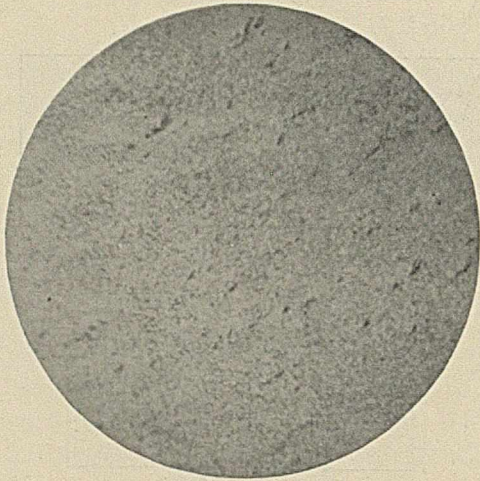
10—Quenched at 2250° Fahr.



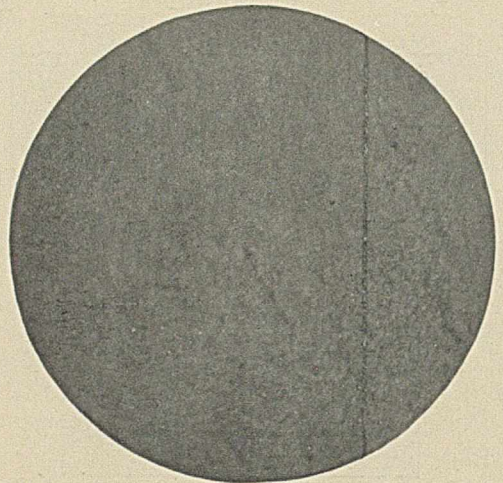
No. 1.



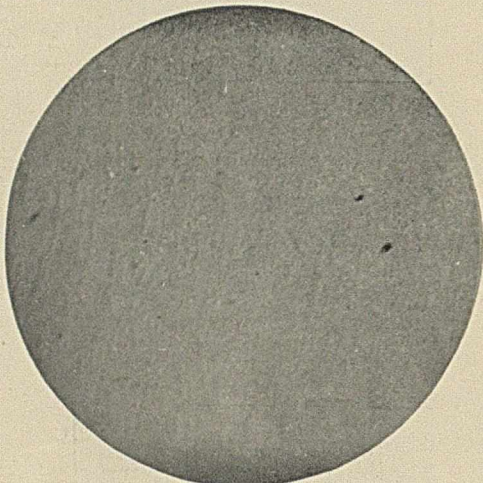
No. 4.



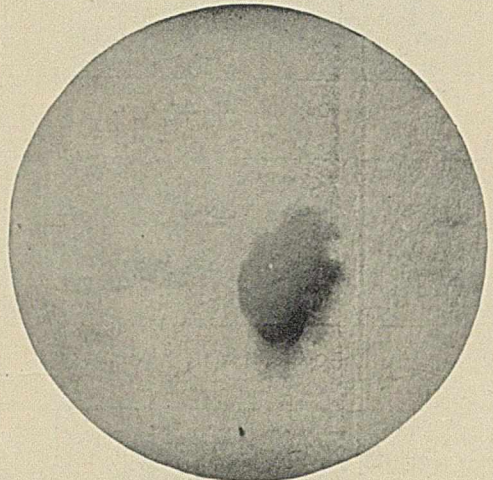
No. 5.



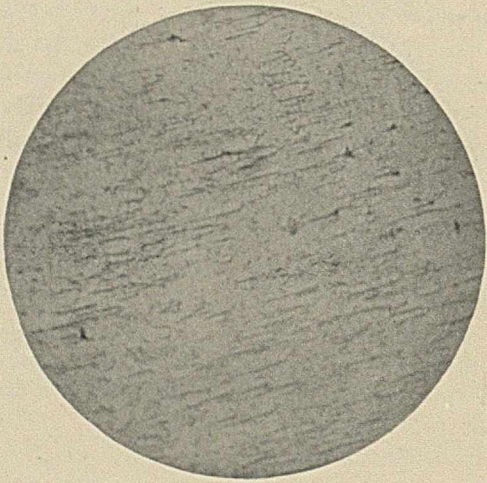
No. 7.



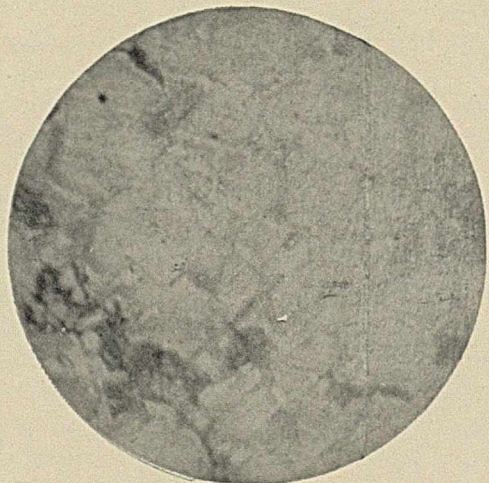
No. 8.



No. 8.

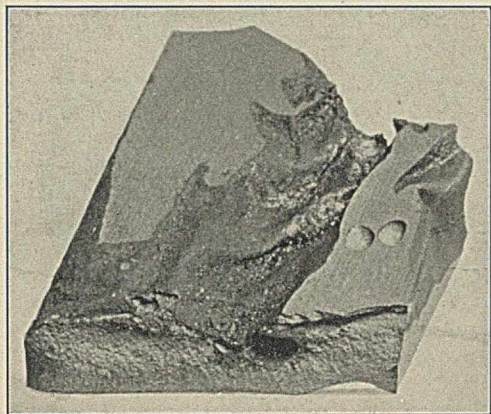


No. 9.

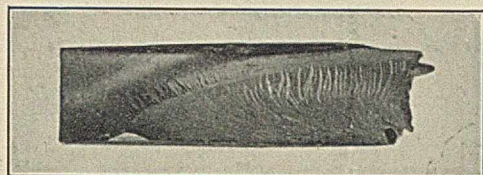


No. 0.

Fractures of Specimens. Series B.



Series A. No. 0.



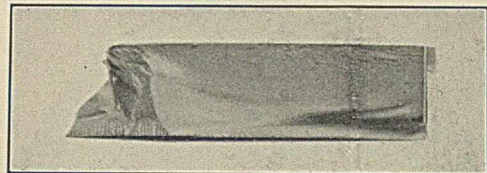
11—Quenched at 1850° Fahr.



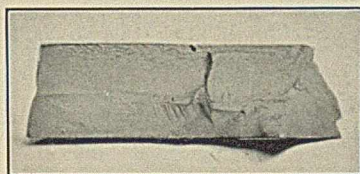
12—Quenched at 1900° Fahr.



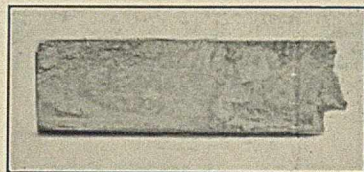
13—Quenched at 1950° Fahr.



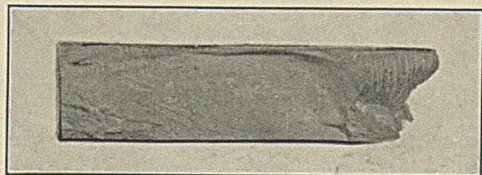
14—Quenched at 2000° Fahr.



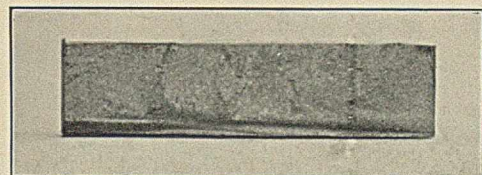
15—Quenched at 2050° Fahr.



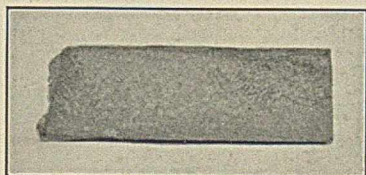
16—Quenched at 2100° Fahr.



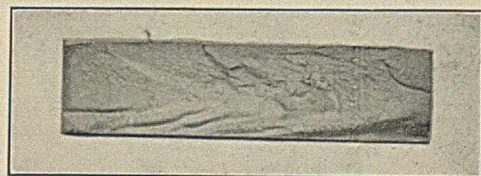
17—Quenched at 2150° Fahr.



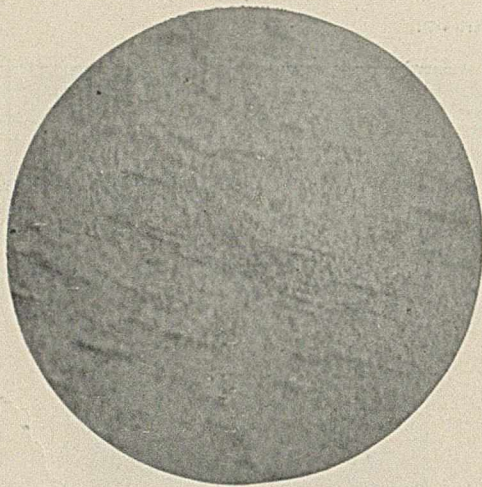
18—Quenched at 2200° Fahr.



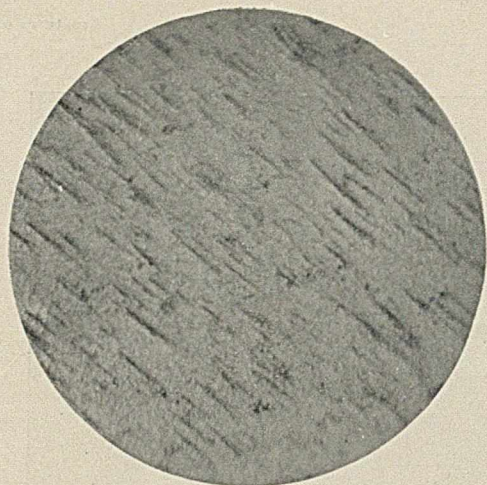
19—Quenched at 2250° Fahr.



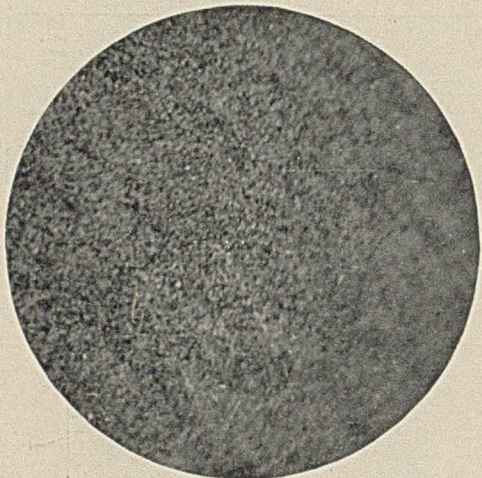
20—Quenched at 1750° Fahr.



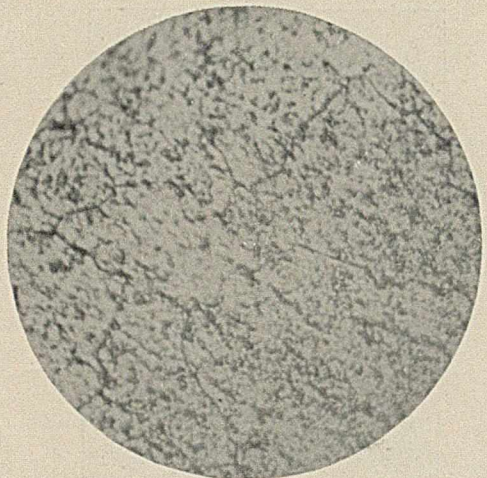
No. 11.



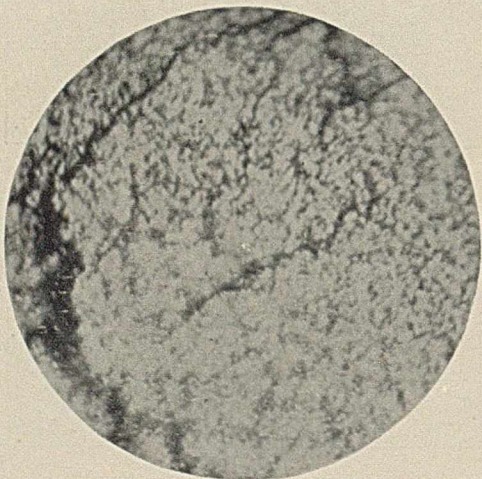
No. 14.



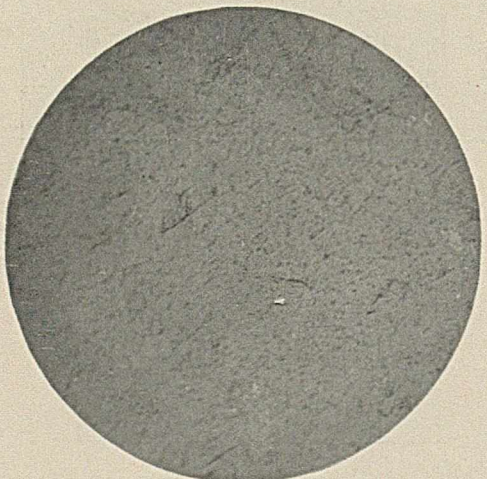
No. 16.



No. 18.

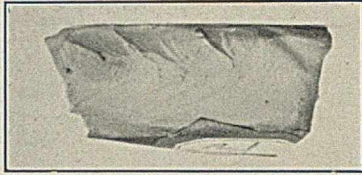


No. 18.

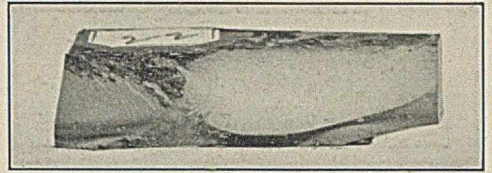


No. 19.

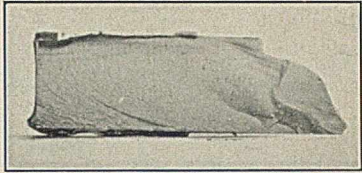
Fractures of specimens. Series C.



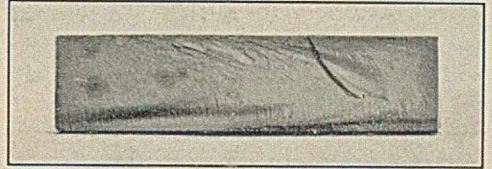
21—Quenched at 1950° Fahr.



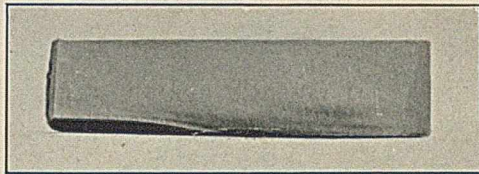
22—Quenched at 2050° Fahr.



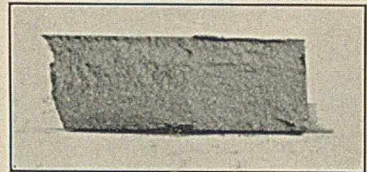
23—Quenched at 2100° Fahr.



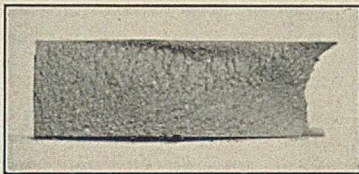
24—Quenched at 2150° Fahr.



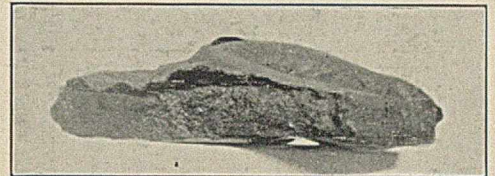
25—Quenched at 2200° Fahr.



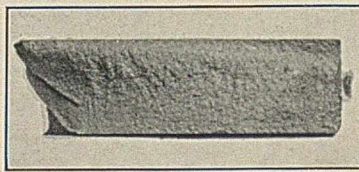
26—Quenched at 2250° Fahr.



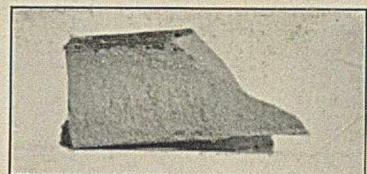
27—Quenched at 2300° Fahr.



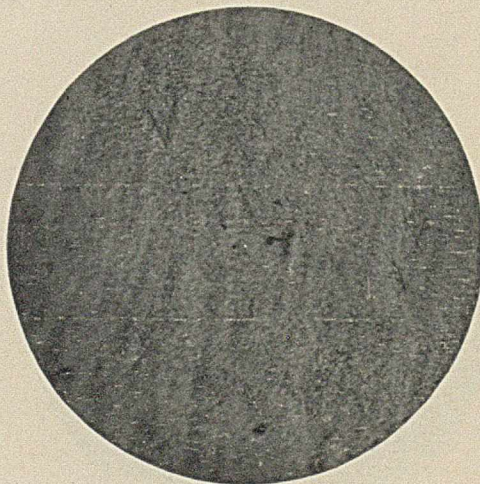
28—Quenched at 2350° Fahr.



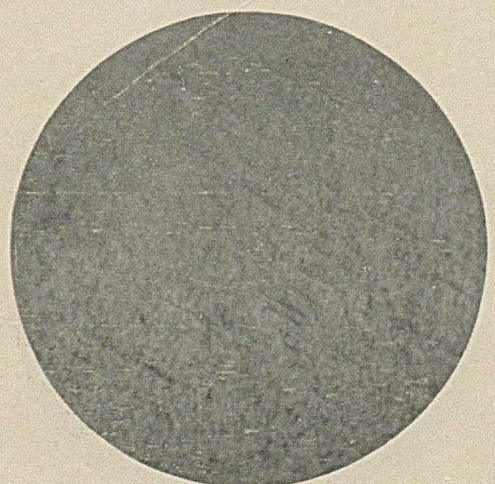
29—Quenched at 2325° Fahr.



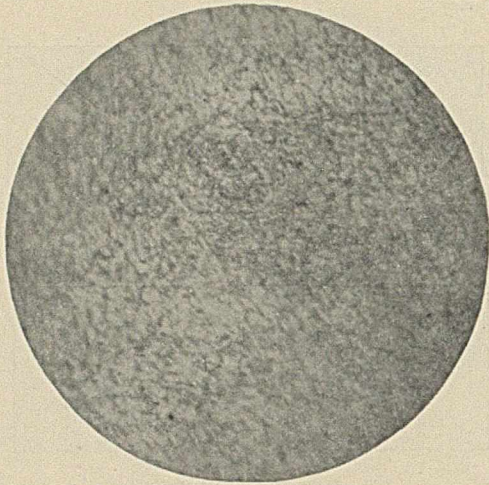
30—Quenched at 2350° Fahr.



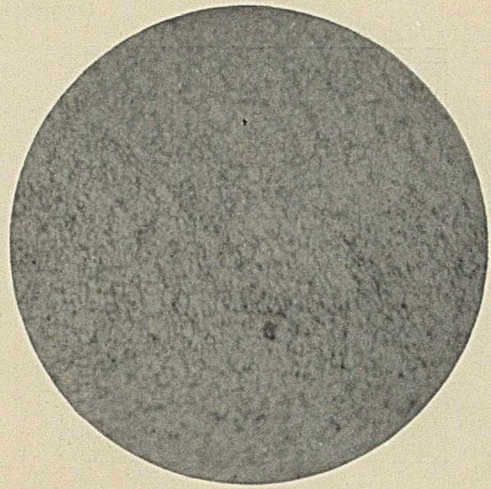
Series B. No. 20.



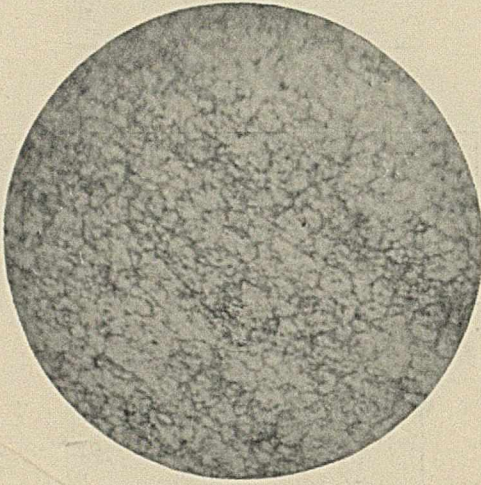
No. 21.



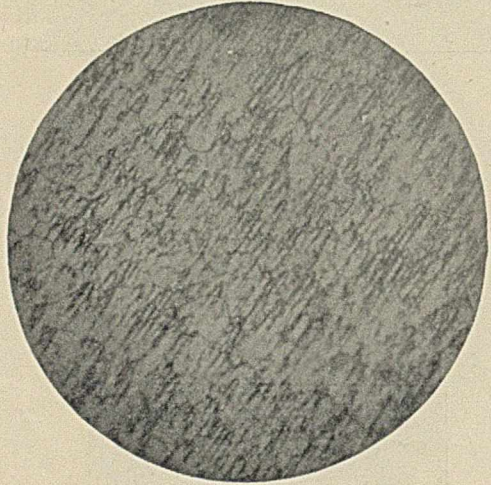
No. 23.



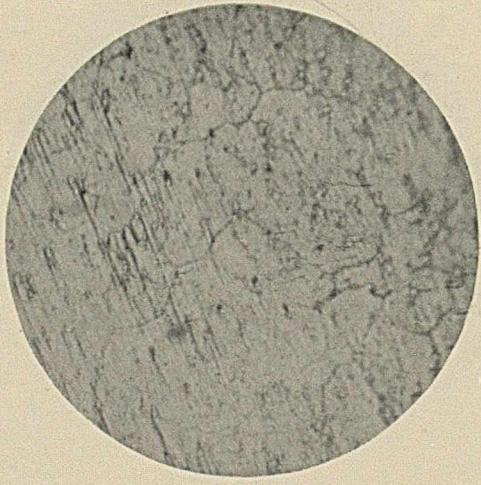
No. 24.



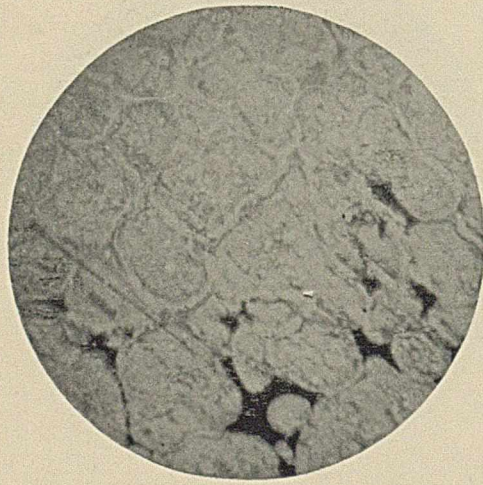
No. 26.



No. 27.



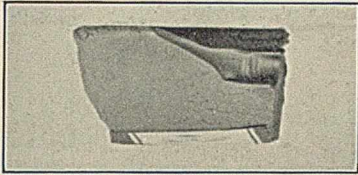
No. 29.



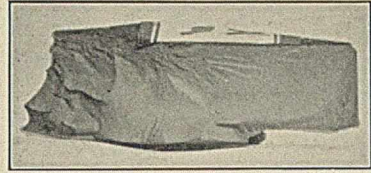
No. 30.



Fractures from specimens of Series D.



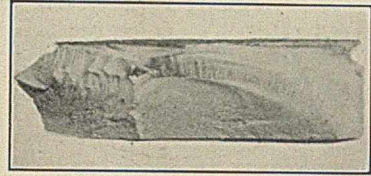
31—Quenched at 1950° Fahr.



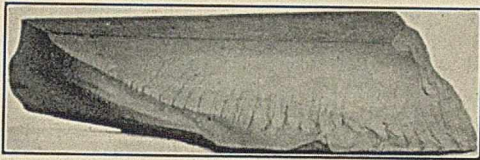
32—Quenched at 2050° Fahr.



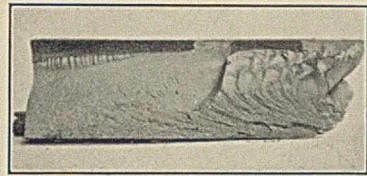
33—Quenched at 2100° Fahr.



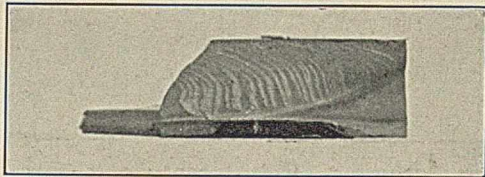
34—Quenched at 2150° Fahr.



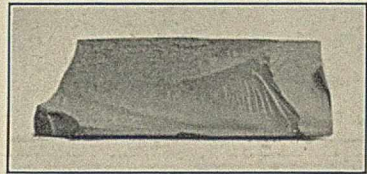
35—Quenched at 2200° Fahr.



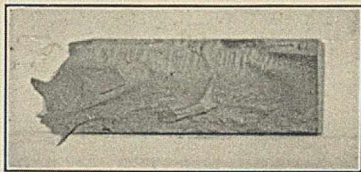
36—Quenched at 2250° Fahr.



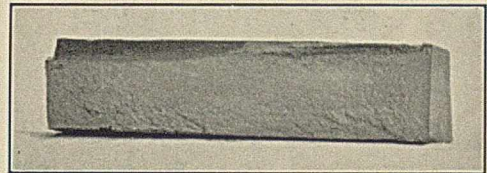
37—Quenched at 2300° Fahr.



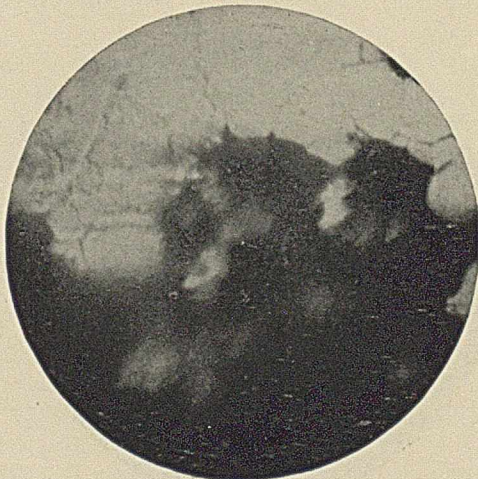
38—Quenched at 2350° Fahr.



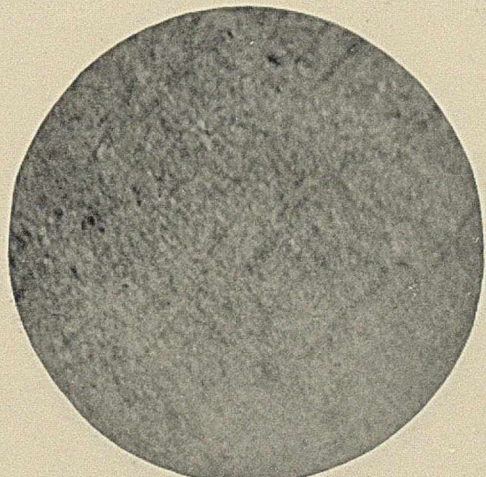
39—Quenched at 2300° Fahr.



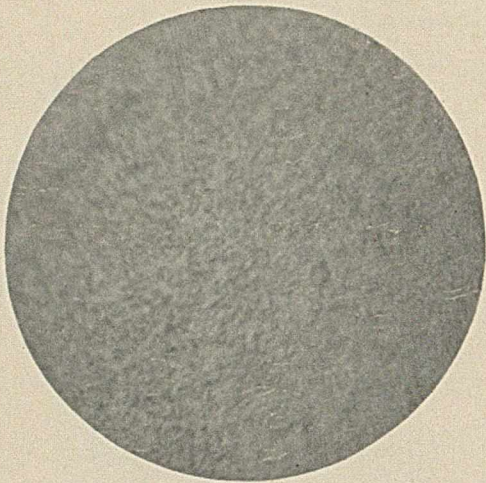
40—Quenched at 2400° Fahr.



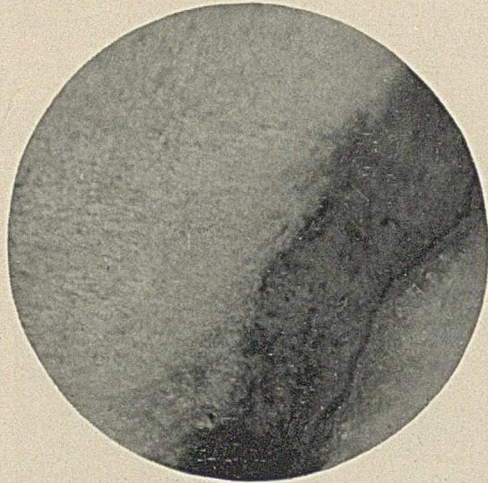
Series C. No. 30.



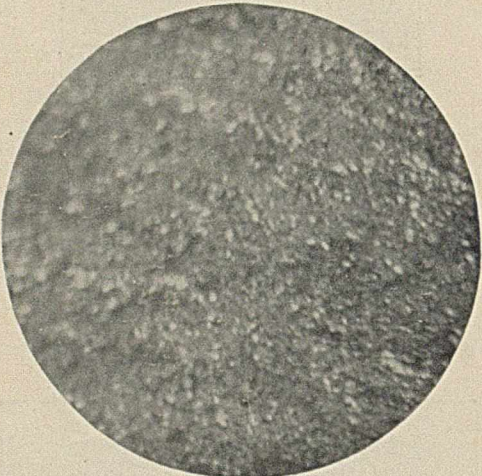
No. 31.



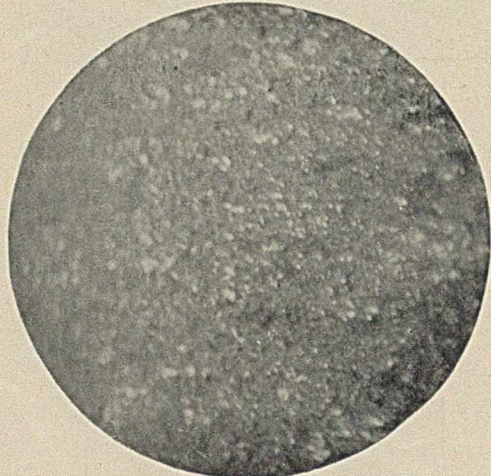
No. 33.



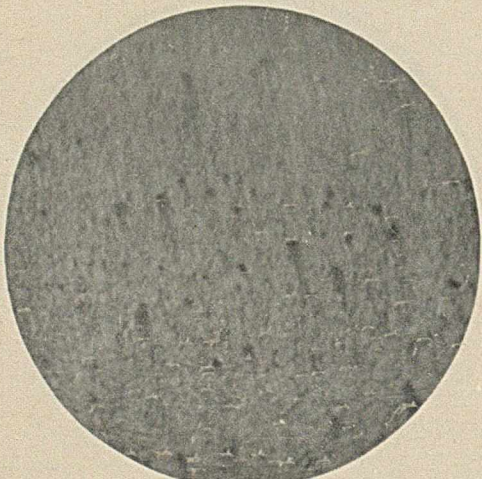
No. 33.



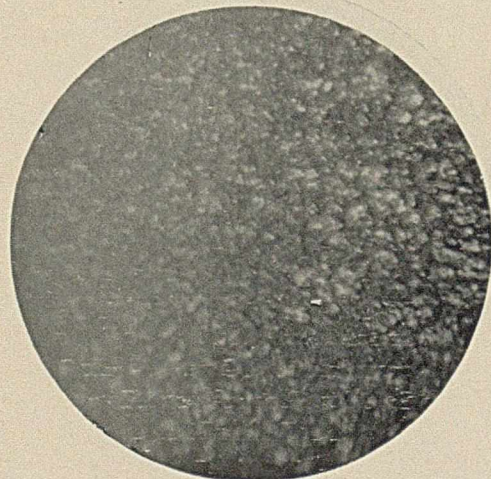
No. 35.



No. 35.



No. 36.

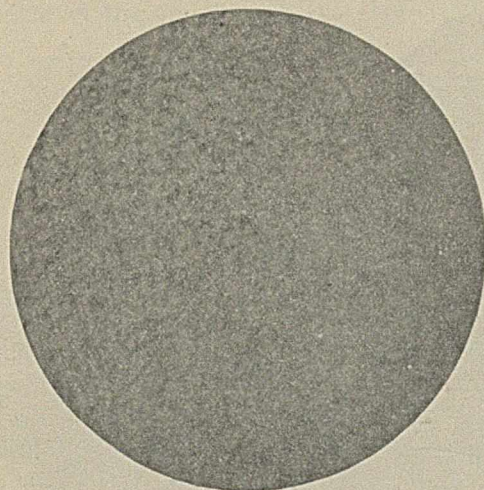


No. 37.

Specimen No. 38 shows a distinct difference from the ones just preceding and following, indicating that this steel has a narrow range of temperature in which it can be treated with the best results. This specimen shows the clearest and cleanest structure and is microscopically the best specimen of the group.

In the reproduction of one of the photographs from specimen No. 33 is shown a case referred to in paragraph No. 24. It illustrates the cracking of a specimen which has been heated too rapidly, and quenched before the heat had been allowed to uniformly penetrate to the center of it. However, it does appear remarkable that this specimen did not break under the physical test.

The illustrations from photographs of the fractures show the increase in size of grain as in the preceding series.



No. 38.

*Red Hardness as Affected by the Structure of the Steel.*—The property named *red hardness* in a high-speed tool steel, and which enables it to cut metal when the cutting edge and near portions are heated to a dull red, should, to a certain extent, be related to the structure of the steel according to the above statements.

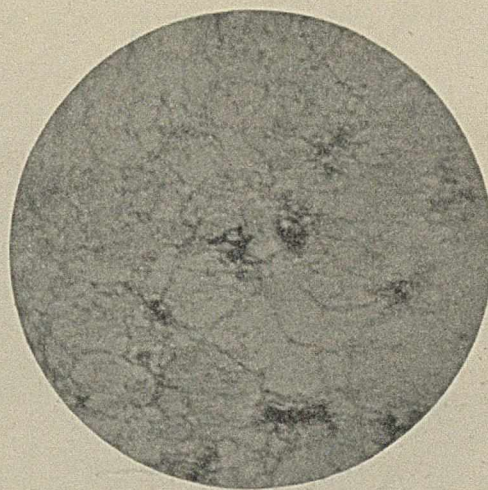
The heat which is generated by friction between the steel crystals (these being caused to move by vibration) does not destroy the tool as rapidly as the grinding on the crystals by the separated hard constituents, which are present at some temperatures. As the structure of the steel in this case generally consists of crystals of an uneven size, the smaller ones of these are ground to pieces in a comparatively short time, and the cutting edge of the tool is ruined.

Therefore, a uniform size of crystals without separated hard constituents between them in the structure of the tool steel will give a large amount of *red hardness* or high durability, considering the structure of the steel only and apart from the various effects of the chip upon the tool in cutting metals.

To find the element, or combination of elements, in the steel responsible for the highest durability, requires the most elaborate experimenting, in the making of the steel, the heat treatments, and the physical tests, and is beyond the object of the experiments described in this paper. However, it is seen that two slightly different chemical compositions of the steel, subjected to the same heat treatment, show a great difference in durability.

Taking the results of these experiments as a whole, the general shop rule for treating a high-speed tool—"Heat it to a white heat and quench it"—does have its shortcomings, because a variation of 50° F. cannot be determined by the eye.

What are the results of a poorly treated tool? It decreases the shop production for the manufacturer, who allows it inside his establishment.



No. 40.

It increases the bill of the customer, who pays for the tool and the work spent on it.

When the works manager comes through the shop and inquires about the tools, the workman naturally testifies the tool steel to be of inferior quality, which, as we have seen, may not be the case, but this tool steel maker has to find a new market for his stock of steel.

In short, it is waste of energy and waste of capital.

## APPLICATION OF ELECTROSTATIC SEPARATION TO ORE DRESSING.<sup>1</sup>

By F. S. MACGREGOR.

The possibility of utilizing the differences in the electrical conductivity of various minerals by giving a part or all of the particles of ore an electrostatic charge has for several years been recognized as a means of separation, and a large amount of experimenting has been done along this line. The com-

<sup>1</sup> A paper presented at the Eighteenth General Meeting of the American Electrochemical Society, in Chicago, October 13-15, 1910.

mercial application of the art of electrostatic separation has been tried a number of times within the last decade, but until only within about three years has success attended the efforts.

Two factors contributed to this want of success—a lack of the proper means of continuous electrification and a practical machine and system of treatment designed to meet the rigorous requirements of mill operation. Recognizing these conditions, the Huff Electrostatic Separator Company, of Boston, has perfected several types of separators and a means of electrification which have been a commercial success from their first installation, and at present the entire concentrating and separating machinery of two plants consists of Huff separators—one located at Platte-

ville, Wis., and the other at Midvale, Utah. The ore is fed across the first electrode, and it passes by gravity to each succeeding one. The mineral particles receive their charge while passing through a concentrated static field formed by two electrodes—one a grounded rotated shaft, and the other an insulated metal rod. The electrostatic charging of the electrodes is accomplished by a special electrical apparatus (using commercial dynamos and transformers), which, with no more than the usual oiling, gives either a continuous and steady potential of several thousand volts, or an intermittent or pulsating charge of great regularity. The potential, or strength of the field, can be altered at will, according to the conductivities of various ores treated. The figure shows the scheme of separation, the dotted lines

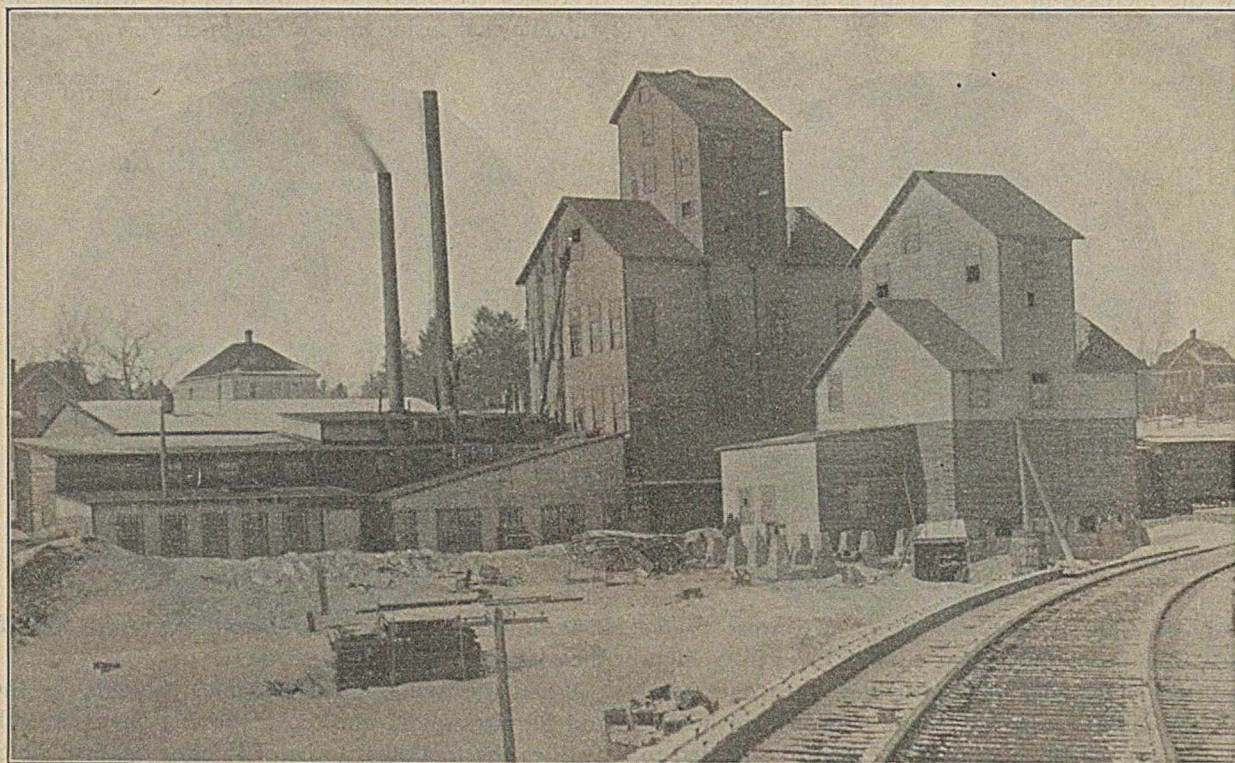


Fig. 1.—Electrostatic separating plant, American Zinc Ore Separating Co., Platteville, Wis.

ville, Wisconsin, owned by the American Zinc, Lead and Smelting Company, and the other at Midvale, Utah, owned by the United States Smelting, Refining and Mining Company. Also a plant is being installed in Nevada.

The type of machine is shown in the accompanying illustration, and consists of a series of separating electrodes placed one above the other. The frame is cast-iron, built in sections, with two electrodes to each section, which facilitates easy shipment and also flexibility in the number of treatments which can be given the ore, and which is dependent on its requirements. A three-section machine (the usual type) is six feet high, six feet six inches long, and eighteen inches wide. A feed hopper on the top distributes

indicating *in general* the path of the conductors and non-conductors.

The separating plant at Platteville was started in March, 1908, and was the first plant to be equipped with Huff separators. Although originally built as an experimental plant, it has been in practically continuous operation since then, and used to separate, without roasting, the iron pyrite from the zinc blende, which occur together in varying proportions in southwestern Wisconsin. The ores are milled in ordinary jigs and the lead and lime rock removed. Owing to the nearness in specific gravity of the blende and pyrite, they are recovered in the jigs as a middlings, containing from 10 to 45 per cent. zinc, according to the grade of the crude ore, the remaining percentage be-

ing iron and the sulphur in combination. Iron above a few per cent. interferes with the smelting of the blende, and the function of this plant is to remove this pyrite, making the low-grade ores into high-grade smelting ores.

The plant consists of a wooden, frame building, 9 x 12 meters (30 x 40 feet), and three stories high. On the first floor are the bins for collecting the finished products as they are delivered from the separators. The second and third floors are separator floors, and in the tower is located the screening system. A spur railroad track runs on either side of the mill, one for cars of raw ore, allowing them to be unloaded either directly into the mill or into storage bins across the track. The other track, which is below the mill level, permits at the same time the loading of empty cars with finished products.

The course of the ore through the plant is shown

There are four, giving an oversize and four other sizes, called A, B, C and D. In general, the sizes are as follows:

A size.....	6 x 5 mesh (7.00 x 8.00 mm.)
B size.....	10 x 7 mesh (4.00 x 6.00 mm.)
C size.....	24 x 20 mesh (0.16 x 0.20 mm.)
D size.....	50 x 50 mesh (0.08 x 0.08 mm.)

The oversize passes through a short trommel to remove any foreign materials, and is spouted to the first floor to a set of rolls, which crush it and deliver it to the boot of the elevator carrying the original feed.

The location of the screens in a tower permits the different sizes to flow by gravity through iron pipe 5 cm. (2 inches) in diameter to the top machine floor. On this floor are located the rougher machines, where the ore is given a rough split, that is, two products are made, one a product higher in zinc than the original feed, and the other higher in iron. Thus, no matter what the grade of the feed to the mill may

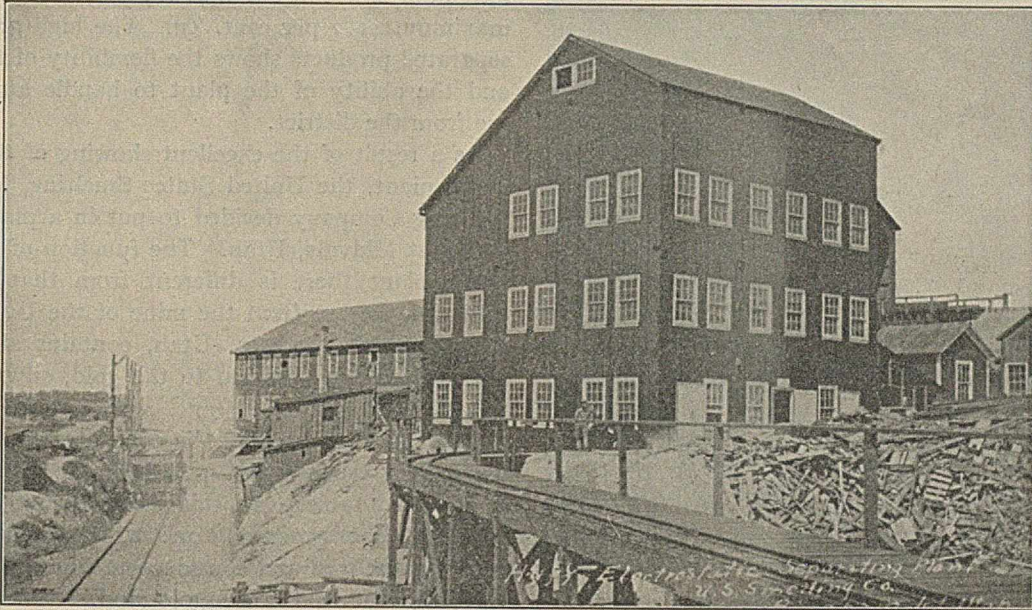


Fig. 2.—Electrostatic separating plant, showing loading trestle, U. S. Smelting Co., Midvale, Utah.

in the flow sheet, and may be described in detail as follows: It is shoveled into a wheelbarrow in the freight car, wheeled to scales and weighed, then dumped into the feed hopper of the drier. The top of this hopper is on a level with the car floors to facilitate easy handling of the ore, and at the bottom of this hopper is an adjustable plunger feeder. The drier is of the cylindrical type, and the shell is 5 meters (16 feet) long and 0.75 meter (30 inches) in diameter, rotating about  $4\frac{1}{2}$  r. p. m. Being set at a slight pitch, the ore travels gradually to the discharge end, where it emerges bone-dry. As the separation depends on the difference in conductivity of the minerals, it is necessary that all moisture be removed. A short drag conveyor carries the dried ore to the foot of a bucket elevator, which raises it to the top of the tower and discharges it into a set of screens.

be (and it varies within wide limits), a fairly uniform mixture is sent to the finishing machines on the floor below.

These finishing machines give the final cleaning to the ore, one set giving a finished iron product and the other a finished zinc product. The middlings from these cleaners return by gravity to the boot of the elevator and mix with the fresh ore, so that no ore leaves the system that is not separated into its proper grades of product.

The finished zinc product and finished iron product fall into separate bins on the first floor. These bins are V-bottomed, and constructed of two thicknesses of wood flooring with heavy building paper between. They are elevated from the floor so that they may conveniently be drawn off into a 730 kg. (1,600 lb.) capacity push car for loading.

The car is then wheeled to a small elevator and dumped into a hopper on the floor level. This feeds the ore into the boot of a small elevator, which discharges either into a freight car by means of a goose-neck spout, or may be allowed to discharge to a second

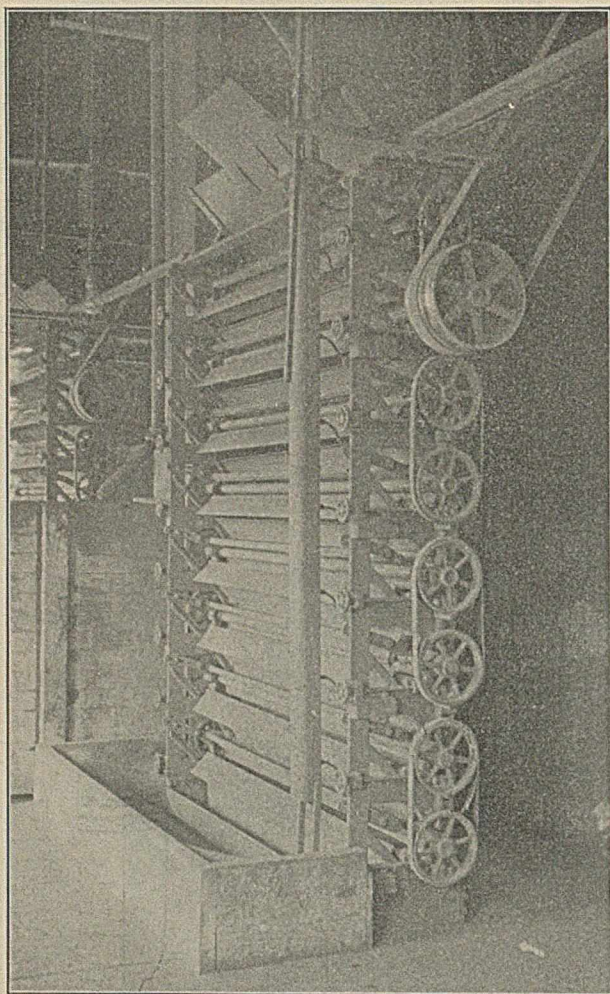


Fig. 3.—Huff electrostatic separator.

elevator in the storage bins. From these bins a car may be loaded whenever convenient.

The plant generates its own power, and the engine and boiler rooms are located in an adjoining building. The fire boxes of the boiler and drier are side by side, enabling the engineer to look after both fires as well as the engine room. Power is supplied by a Corliss engine, connected to the mill by a clutch.

The plant operates continuously three shifts per day. The labor required per twenty-four hours is as follows:

- 3 shift bosses (8 hours each).
- 3 machine helpers (8 hours each).
- 3 drier feeders (8 hours each).
- 2 loaders (10 hours each).
- 2 engineers (13 and 11 hours each).

There is also a superintendent, master mechanic, assayer, one buyer and bookkeeper, although the buyer and, to a large extent, the assayer devote their time to obtaining custom work.

Two products of marketable value are obtained: The iron pyrite, hitherto valueless in these Wisconsin ores, is sold for its sulphur content, and by reason of its free-burning qualities, makes a very desirable product for the acid manufacturer; and a zinc product, which is, of course, sold for spelter. The pyrite is sold by contract, but the blende is sold to the smelters on the open market. With a penalty for excess of iron or lead, one may see it is necessary for such a plant to turn out consistently high-grade products in order to command a satisfactory market price.

The results taken from the "Record of Shipments" for a month show an average zinc product of 55.2 per cent. Zn and 3.4 per cent. Fe, and a pyrite product of 3.7 per cent. Zn and 44.7 per cent. S. The average zinc content of the ore bought and separated into the above products was 24.1 per cent. Zn, and the average iron content was 25.4 per cent. Fe. The minimum zinc content was 6.7 per cent. Zn, and the maximum 41.2 per cent. Zn. The high grade of the separated products shows the flexibility of the process and the ability of the plant to handle any grade of ore from the district.

As a result of the excellent showing of this electrostatic plant, the United States Smelting, Mining and Refining Company decided to put in a plant at their works at Midvale, Utah. The function of an electrostatic plant there is different from that in Platteville, for the ore from the mine of the United States Company, at Bingham, Utah, contains about 9 per cent. of zinc in addition to the gold, silver and lead values.

This ore is shipped to the concentrator at Midvale, where it is crushed and milled by the usual methods of jigs and tables. In this concentration there were formerly two products, one a lead-pyrite product carrying the iron and considerable zinc, and a tailings carrying zinc and some gold and silver values, the object being to keep the zinc as low as possible in the

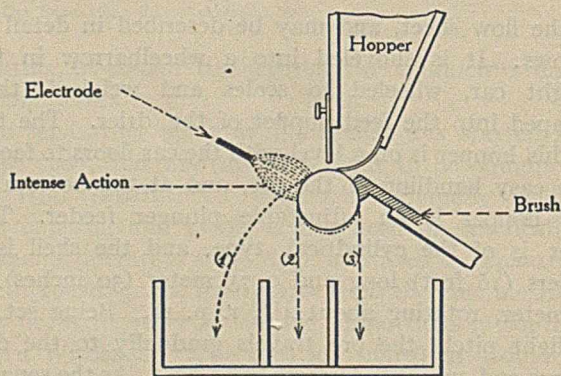


Fig. 4.—Section of electrostatic separator, showing principle of operation.

lead concentrate, and yet at the same time make the maximum recovery of the gold, silver, lead and copper values. The zinc added materially to the

difficulty and cost of smelting the lead concentrates, and, at the same time, was a total loss. In order to recover this zinc, three products were made in the concentrator, a lead-pyrite carrying practically no

separated, and the products drawn from the bins on the first floor into tramcars. These are run out of the mill to the loading trestle and dumped into freight cars. The pyrite product is smelted in the United States smelter near-by, and the zinc product shipped to the Kansas zinc smelters.

The plant is electric-driven by a 20 h. p. motor, the 15 Huff separators requiring about  $\frac{1}{3}$  h. p. each. The generating apparatus for the electrostatic field is located in a small room on the finishing floor. A 3 h. p. motor is direct coupled to a generator, and the strength of field is controlled from a small switch-board. The plant is operated in conjunction with the concentrator, and the superintendence, assaying and bookkeeping are taken care of by the smelter staff.

The average assays of the feed and products are as follows:

	Oz. per ton.							
	Au.	Ag.	Cu.	Pb.	SiO <sub>2</sub> .	Fe.	Zn.	CaO.
Crude ore to concentrator.....	0.08	3.8	0.41	8.4	28.8	14.3	9.0	6.0
Middlings to electrostatic plant.....	0.05	2.8	1.11	3.3	4.6	24.3	21.6	1.9
Finished pyrite.....	0.14	4.8	2.24	6.6	...	26.0	9.0	...
Finished blende.....	0.02	1.5	0.61	2.0	...	3.6	52.9	...

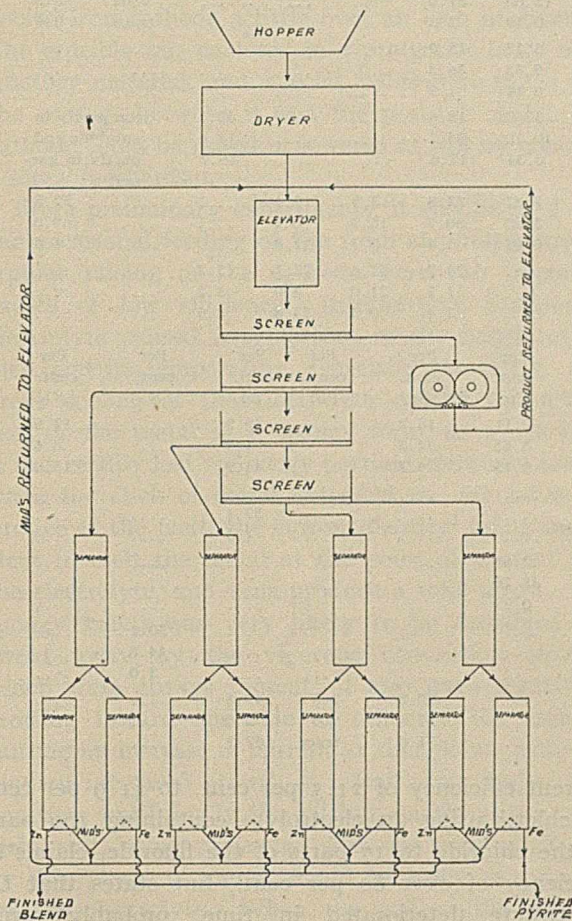


Fig. 5.—Flow-sheet, showing course of ore through the mill.

zinc, tailings free from zinc, and middlings containing about 22 per cent. zinc, the balance pyrite and some copper, lead, gold and silver.

To treat these middlings, an electrostatic plant was built near the concentrator as shown. It is a wooden frame building 12 x 12 meters (40 x 40 feet) and covered with corrugated sheet-iron. In general plan it is the same as the Platteville plant—finished ore bins on the ground floors, and two floors of separators. The method of handling the ore is somewhat different. The middlings are shoveled from the table hutches in the wet concentrator into tramcars, which are pushed by hand to the platform elevator at the electrostatic plant. The cars are raised to the third floor level, and, after weighing, are dumped into a 40-ton hopper. This is built over the drier, and feeds automatically. After drying, the ore is screened as follows, making A size 12 on 24, B size 24 on 50, C size through 50-mesh.

The oversize is small in amount and very low in zinc, so instead of recrushing, it is put directly into the finished pyrite. The three sizes, A, B and C, are

This electrostatic plant not only removes the objectionable zinc from the lead-pyrite concentrate, but makes of it a marketable product, and, instead of being a total loss, it is made to produce a profit. The electrostatic process in these two plants demonstrates two applications in ore dressing, one the custom plant making low-grade ores profitable, and the other as an adjunct to a wet concentrator for the recovery of zinc.

Besides these plants, there is being installed in Nevada a plant working on crude silver ores, wherein the ore goes through no concentrating machinery prior to its electrostatic treatment. The process has been proved applicable to many special problems such as the concentration of copper and lead-silver ores in

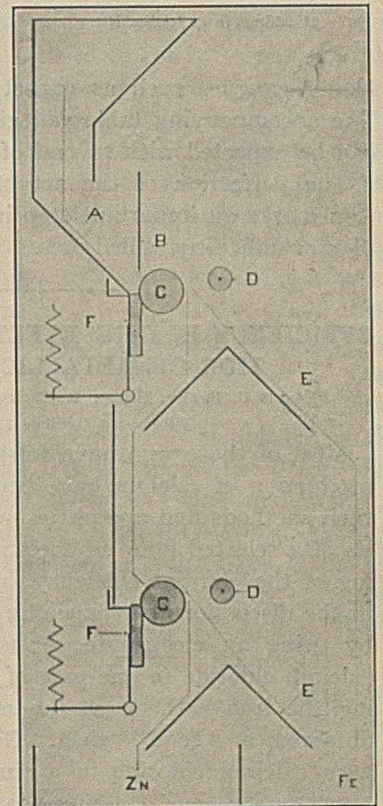


Fig. 6.

- A—Hopper.
- B—Feed gate.
- C—Grounded electrode.
- D—Charged electrode.
- E—Adjustable divider.
- F—Brush.

TABLE OF ELECTROSTATIC SEPARATIONS.

Material.	Product.	Per	Per	Per	Per	Per	Oz.	Oz.
		cent.	cent.	cent.	cent.	cent.	Au.	Ag.
		Cu.	Fe.	Pb.	Zn.	SiO <sub>2</sub> .		
Low-grade chalcopyrite in quartz	Original	2.56	17.8	.....	.....	.....	0.01	2.6
	Concentrates	5.63	37.0	.....	.....	.....	0.02	5.5
	Tails	0.10	2.0	.....	.....	.....	trace	0.4
Pyrite and chalcopyrite in various gangues	Original	6.37	25.0	.....	.....	.....	.....	.....
	Concentrates	9.33	36.3	.....	.....	.....	.....	.....
	Tails	0.14	1.9	.....	.....	.....	.....	.....
Chalcopyrite and bornite in garnet	Original	3.60	18.6	.....	.....	32.3	(iron partly in sulphide and partly in garnet)	
	Concentrates	19.10	25.7	.....	.....	14.4		
	Tails	0.34	17.6	.....	.....	36.7		
Zinc, iron and silver ore	Original	2.61	23.8	13.9	19.4	.....	.....	52.8
	Concentrates	3.33	30.7	16.4	6.4	.....	.....	69.0
	Tails	0.91	3.4	2.7	51.8	.....	.....	4.6
Zinc, lead, and iron middlings	Original	.....	20.2	12.6	23.1	5.2	.....	.....
	Concentrates	.....	31.2	21.0	4.0	3.2	.....	.....
	Tails	.....	2.4	0.5	53.8	8.5	.....	.....

Material.	Product.	Per	Per	Per	Per	Per	Per
		cent.	cent.	cent.	cent.	cent.	cent.
		Cu.	Fe.	Pb.	Zn.	S.	SiO <sub>2</sub> .
New Mexico concentrates	Original	2.11	16.2	.....	29.9	.....	12.9
	Concentrates	5.65	37.2	.....	4.9	.....	6.6
	Tails	0.13	4.2	.....	44.9	.....	15.9
Zinc from above tailings	Original	.....	.....	.....	.....	.....	.....
	Concentrates	.....	.....	.....	57.1	.....	.....
	Tails	.....	.....	.....	1.3	.....	.....
Native copper in sandstone	Original	2.68	.....	.....	.....	.....	.....
	Concentrates	38.70	.....	.....	.....	.....	.....
	Tails	0.27	.....	.....	.....	.....	.....
Pyrite concentration for sulphur	Original	.....	.....	.....	.....	30.1	.....
	Concentrates	.....	.....	.....	.....	44.8	.....
	Tails	.....	.....	.....	.....	3.0	.....
Middlings from Joplin, Mo.	Original	.....	10.8	2.5	49.5	.....	.....
	Concentrates	.....	37.4	9.9	2.9	.....	.....
	Tails	.....	1.6	trace	62.3	.....	.....

heavy gangues such as garnet, barite, epidote, etc. The accompanying table will give some idea of what can be expected with several of these problems.

The perfection of the art of electrostatic separation marks an important step in the dressing of complex or difficultly milled ores.

### EFFICIENCY IN THE ELECTROLYTIC PRODUCTION OF METALLIC CALCIUM.<sup>1</sup>

By FRANCIS C. FRARY, HENRY R. BICKNELL AND CARL A. TRONSON.

Received October 12, 1910.

Most of those who have worked on the electrolytic production of calcium have been content to describe their methods and apparatus, with perhaps an analysis of a selected lump of their product, but say nothing of the current efficiency obtained. Muthmann,<sup>2</sup> in the discussion of a paper by Rathenau, states that by using an electrolyte consisting of two parts of calcium chloride to one part of the fluoride, and raising the iron cathode as the metal accumulated, he obtained a "good" yield. Goodwin,<sup>3</sup> electrolyzing pure calcium chloride in a similar way, obtained a

<sup>1</sup> A paper presented at the Eighteenth General Meeting of the American Electrochemical Society, in Chicago, October 13-15, 1910. The work described in this paper is a continuation of that published by Frary and Badger (*Trans. Am. Electrochem. Soc.*, 16, 185) where a summary and discussion of previous work on the electrolytic production of calcium will be found.

<sup>2</sup> *Z. Elektrochem.*, 10, 508 (1904).

<sup>3</sup> *J. Am. Chem. Soc.*, 27, 1403 (1905).

current efficiency of 21.5 per cent. to 41.9 per cent. Woehler,<sup>1</sup> using an electrolyte containing 100 parts of the chloride to 17 parts of the fluoride, claims an efficiency of over 80 per cent., but states that the electrolyte deteriorated in time, probably owing to the formation of the hydrated oxychloride, and that hydrogen (!) is then liberated at the cathode, and the yield decreases. He used a current of 40 amperes at 33 to 38 volts, but does not say how often or for how long a time this efficiency could be obtained. Tucker and Whitney<sup>2</sup> improved the apparatus of Goodwin, and claim an efficiency of 60 per cent., using the pure chloride as electrolyte, but give no data to support the claim. As far as we are able to ascertain, no one else has published any results on the efficiency of the various processes which have been proposed.

During previous work in this laboratory,<sup>3</sup> efficiencies as high as 46 per cent. were obtained, but, unfortunately, the only runs in which the necessary data were taken were made under unfavorable conditions. As it was certain that better results could be obtained and had been obtained in some of the runs for which no data were at hand, these were not published at the time, and the work was continued by the present authors.

<sup>1</sup> *Z. Elektrochem.*, 11, 612 (1905).

<sup>2</sup> *J. Am. Chem. Soc.*, 28, 84 (1906).

<sup>3</sup> Frary and Badger, *Loc. cit.*



The apparatus used was the same as that described by Frary and Badger,<sup>1</sup> and consisted essentially of a large crucible of Acheson graphite having a water-cooled bottom and serving as anode, and a water-cooled iron cathode a little over an inch in diameter. The crucible was enclosed in a protective layer of refractory material, and special pains were taken with the contact between it and the positive cable. The cathode could be raised or lowered at will by means of a screw mechanism.

From preliminary experiments, it was decided that the occasional feeding of the fresh electrolyte and irregular raising of the cathode were two important causes of low efficiency. Intermittent addition of electrolyte caused irregularities in the height of the melt and its temperature, especially the latter. Too great cooling of the electrolyte caused the deposition of the metal in a spongy form, in which state it was readily lost. Spongy portions were also formed when the stick of metal extended too far below the surface of the melt, the current density<sup>2</sup> being insufficient to melt the metal at the point of contact with the electrolyte, and thus produce a solid stick. This spongy metal was very likely to be dislodged and swept away by the vigorous convection currents which were always present; it also gave trouble by growing toward one side or other of the crucible, causing an increase of current at that point, with consequent increased growth of metal and a higher temperature, until finally the calcium on the edges would melt, and, being connected with the main stick only by thin pieces of metal, would be easily swept away by the electrolyte. When the end of the stick of metal was kept just below the surface of the electrolyte, the spongy metal at first formed melted almost at once, and its surface tension drew it into a compact globule which was almost immediately frozen by the cooling effect of the rest of the stick and the water-cooled cathode. Thus a solid stick was easily obtained. To get the best results, it was found necessary for one person to devote all his attention to the raising of the cathode and the addition of the electrolyte, making both operations practically continuous.

The chloride used was some of Merck's C. P. granulated, which had previously been used in desiccators. It was dried in an iron crucible over a four-post Bunsen burner, and preserved in a stoppered bottle.

In starting up a run, the cold fused chloride remaining in the crucible from a previous run was heated until dry by directing the flame of a blast lamp upon it. Then a small portion of it was fused by drawing an arc from the side of the crucible with the aid of a graphite rod. A small current was used until contact was made with the cathode, when more cur-

rent was put on and the graphite rod removed. As soon as good contact was assured, the direct current was shut off and an alternating e. m. f. of about 30 volts applied. The current usually rose rapidly to about 200 amperes, being regulated by raising or lowering the cathode, and the upper part of the crucible was soon filled with the molten chloride. A sufficient supply of electrolyte was added at the time to fill up the crucible, and when all was ready the alternating current was thrown off and the direct current thrown on. Readings of the time, voltage and amperage were taken at once. The voltameter and ammeter were read every five minutes during the run, and the average of these readings considered to be the average voltage and amperage for the run. The current varied very little during each run, as it was taken from the 110-volt lighting circuit through a constant resistance. There was no trouble with the so-called "anode effect," except when the electrolysis was started before a sufficient amount of the electrolyte had been melted down by the alternating current.<sup>1</sup>

The formation of the metal under the cathode was watched very carefully, great care being necessary to get a good start. We aimed to withdraw the cathode and metal as rapidly as it was possible to do so without striking an arc. It will be noticed in the table of results that practice in doing this increased the yield obtained. When the electrolysis is going on properly, and the stick of metal is at the right depth, the electrolyte seems to flow rather rapidly across the surface in a fixed direction, and is hottest at the cathode. The operator must be guided by the appearance of the electrolyte at the cathode. There should be a rosette-like spot with radial markings here; if the stick of metal is pulled out too fast, this spot becomes almost white hot, and if the metal is not at once lowered, an arc forms, and part of the metal is melted off and lost. If the stick is not raised fast enough, the spot becomes less noticeable, and spongy metal deposits below the surface, causing losses. When the electrolysis was well under way, new electrolyte was added in small portions, taking care to make these additions as continuous as possible, and in such a spot that the convection currents carried the cold chloride away from the metal. The following table shows the efficiency obtained.

The sticks of metal were cleaned by hammering off the crust on the outside, and then placing them in absolute alcohol for 24 hours to remove the rest of the chloride. When taken out of the alcohol, the sticks were always clean, though covered by a thin coat of oxide. They were dried by burning off the

<sup>1</sup> A sample of the electrolyte was taken at such a time, when the "anode effect" had been more than usually troublesome, and the per cent. of silica present determined. Only 0.056 per cent. was found, confirming the results obtained in the previous paper, and indicating that current density rather than impurities should be blamed for this "effect."

<sup>1</sup> *Loc. cit.*

<sup>2</sup> In most cases a rod of about 1 cm. diameter was obtained, so the cathode area was about 1 to 1.5 sq. cm.

alcohol, and weighed. The current was, of course, not absolutely constant, so there is a possible error of one or two per cent. in the efficiency as calculated, but the results are sufficiently accurate for practical purposes.

TABLE I.

Run No.	Time. Min.	Amperes.	Volts.	Weight. Grams.	Efficiency. Per cent.
1	60	74.45	18.3	30.8	55.3
2	60	73.9	21.4	25.0	45.2
3	60	74.2	21.0	43.5	78.4
4	38	73.2	26.0	27.0	77.8
5	32	73.1	24.4	26.5	90.7
6	30	71.5	25.5	24.0	89.8
7	27	70.4	33.0	21.5	90.5
8	30	69.66	28.0	26.0	100.0
9	34	52.54	34.0	21.6	97.0
10	36	68.75	31.0	31.0	100.5

Since Ruff and Plato,<sup>1</sup> Muthmann,<sup>2</sup> and Woehler<sup>3</sup> have recommended the use of a mixture of the chloride and fluoride as the electrolyte, we decided to try it and see if it offered any advantages. The fluor-spar partially purified by treatment with concentrated hydrochloric acid to remove iron. It was mixed with the chloride in the proportion of 16.5 parts to 100, as recommended by Ruff and Plato. A new crucible was made for use with this electrolyte, having the same size as the other, but a different arrangement of the water-cooling. The bottom of the crucible was turned out on the lathe so as to fit loosely over the hollow brass cooling cylinder of the Borchers's<sup>4</sup> furnace for the electrolysis of fused salts. The crucible was then turned upside down, this space filled with a strong copper sulphate solution, and copper deposited until the cylinder would not enter the space. The copper was now turned out on the lathe to fit the cylinder, and the whole of the outside of the crucible and cylinder protected from the air by a coat of Portland cement and carborundum fire-sand, held in place, as before, by a tin form. The contact, being made through the water-cooling cylinder, was kept cool and did not burn away, as the other crucible did in the course of time. A more complete protection of the outside of the crucible was also possible.

With this crucible and the above-mentioned electrolyte a new series of runs was made. Considerable trouble was found in making smooth, solid sticks of metal with the electrolyte. The particular advantage of this mixture is supposed to be its low melting point (660°). This appears to us to be a disadvantage, as the bath must be worked at a temperature of nearly 750° in order to get a solid stick of metal, and the bath is so fluid at the working temperature that convection currents are more violent and more likely to sweep away the metal from the end of the stick, forming an arc. We had a great deal of trouble

from this cause. Reduction of the current did not bring the desired result, as the efficiency decreased markedly (Run No. 6, Table II). The following results were obtained:

TABLE II.

Run No.	Time. Min.	Amperes.	Volts.	Weight. Grams.	Efficiency. Per cent.
1	30.0	42.0	...	15.0	95.5
2	32.5	41.5	31.0	15.0	89.2
3	42.0	53.9	37.0	27.0	95.7
4	35.0	45.6	31.3	12.8	64.4
5	9.0	54.9	26.0	8.0	81.2
6	41.0	31.9	30.0	5.0	30.6
7	45.0	52.1	29.5	18.0	61.6
8	45.0	53.5	30.7	26.0	86.6
9	46.0	69.3	31.4	29.4	74.0
10	40.0	52.7	34.0	22.6	86.0
11	35.0	53.5	30.8	20.0	85.5

During the runs with this electrolyte only the chloride was added, it being assumed that the fluoride would not be decomposed. However, at the close of these experiments, a sample from the top of the melt showed only 2.21 per cent. of insoluble matter, so, evidently, much of the fluoride had been lost. This loss was probably largely mechanical and due to the violent spattering of the electrolyte; it was noticed that a great deal more of the fine dust from the electrolyte collected on the crucible and its surroundings with this than with the simple chloride electrolyte.

We also took samples from the electrolyte in the lower part of the crucible, which had been kept frozen during the electrolysis by the cooling coil, and so, presumably, retained its original composition, and attempted to isolate the fluochloride of calcium described by Poulenc<sup>1</sup> and Defacqs,<sup>2</sup> but found none of it.

From our experience with both electrolytes we believe that the plain chloride is a little more satisfactory than the mixture of the chloride and fluoride in point of efficiency, and decidedly easier to manipulate. We have shown that satisfactorily high efficiencies can be obtained with it, and that efficiency is more largely a matter of careful regulation of conditions than anything else.

UNIVERSITY OF MINNESOTA,  
September 9, 1910.

## SOME IMPERFECT PAVING BRICKS.

By JAMES C. LAWRENCE AND CHARLES J. BONER.

Received October 1, 1910.

It was noticed by the authors that a paving-brick manufacturing company near this city was making quite a large number of imperfect bricks, along with their good ones. These bricks were imperfect in that they were distorted and contained a dark gray scoriaceous core (see figure). These bricks were of course worthless for paving or construction work, for even if they were not swollen out of shape, the scoriaceous core weakens them to a considerable extent, as shown

<sup>1</sup> *Ann. chim. phys.*, [7] 2, 5 (1894).

<sup>2</sup> *Ibid.*, [8] 1, 337 (1904); *Compt. rend.*, 137, 1251 (1903); *J. Chem. Soc.*, 86, ii, 123 (1904).

<sup>1</sup> *Ber.*, 35, 3612 (1902); 36, 491 (1903); D. R. P. 153,731 (*Chem. Centr.*, 1904, II, 802).

<sup>2</sup> *Z. Elektrochem.*, 10, 508 (1904).

<sup>3</sup> *Ibid.*, 11, 612 (1905).

<sup>4</sup> Borchers, "Die Elektrische Oefen," 1907 ed., pp. 35 and 36.

by some standard tests. The perfect bricks stood a cross-breaking test of from 6,000 to 9,000 pounds, while the swollen ones showed only about 2,500 pounds on the Olsen machine. At the time of making our preliminary tests we also found that the company was discarding a layer of shale at the pit, about ten feet thick and one hundred feet along the face, simply because they *thought* it wouldn't make good bricks, it being a little darker in color than the other strata of shales. We decided to look into that shale also, to see what bearing it could have on the bricks made if used.

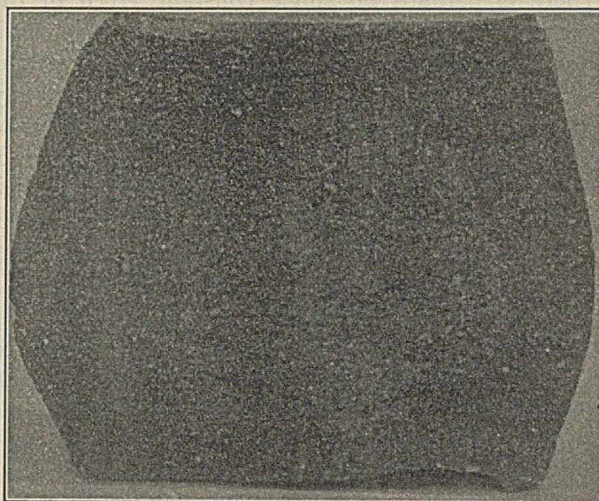
Samples of all the shales used in making the bricks were obtained from the pit, beginning at the top, and calling it Sample No. 1, and obtaining three other samples each ten feet lower down the face of the pit than the immediately preceding sample, taking three samples in each stratum.

The imperfect and good bricks were selected at random from a pile in the yard. All the samples were ground to pass an 80-mesh sieve, then kept in glass-stoppered bottles until used. Duplicate analyses of each shale and brick were made, the results of which are shown in the table, expressed as the mean values of the analyses:

	Imperfect bricks.					
	Shale 1. Per cent.	Shale 2. Per cent.	Shale 3. Per cent.	Shale 4. Per cent.	Shell Per cent.	Core. Per cent.
SiO <sub>2</sub> .....	63.33	66.67	64.85	55.79	58.99	60.01
Fe <sub>2</sub> O <sub>3</sub> .....	6.29	6.77	1.16	1.22	19.06	5.64
FeO.....	1.46	5.06	7.36	9.56	1.23	12.27
Al <sub>2</sub> O <sub>3</sub> .....	14.51	9.81	14.66	17.65	12.87	12.68
CaO.....	0.71	1.15	1.56	0.40	1.33	1.25
MgO.....	1.46	0.16	0.17	1.96	2.03	2.17
Moisture <sup>1</sup> .....	3.04	0.95	0.94	1.42	trace	0.05
Loss <sup>2</sup> .....	4.55	4.52	4.90	6.64	none	0.39
K <sub>2</sub> O.....	1.12	1.11	0.82	2.95	1.95	1.79
Na <sub>2</sub> O.....	2.75	3.23	4.27	1.54	2.86	2.62
H <sub>2</sub> O <sup>3</sup> .....	...	...	...	...	none	0.36
S <sup>4</sup> .....	0.13	trace	trace	1.71	0.30	1.46

Proceeding with the first question: that of the fitness of the shale No. 1 for making bricks, we see by comparing with the others in the table that it shows practically the same values, merely being a little higher in ferric iron. The state of the iron in this sample is due to its being more exposed to the weather, since it was taken from near the surface. It will be noted that the ferrous iron content increased as we obtained the samples farther down the face of the pit, and since the bricks were being made of the dark shale at the bottom of the pit, their ferrous iron content was high until oxidized in the burning. In as far as the ultimate chemical analysis of a shale can show its adaptability for brick-making, this shale (No. 1) is as good as any of the others, and perhaps better than No. 4, for the manufacture of paving-brick,

for No. 4 has too high a sulphur content. This sulphur, as pyrites, in a shale is very objectionable, for it forms a ferrous silicate that is very hard to oxi-



dize in the burning of the brick,<sup>1</sup> and will remain as a very brittle black slag, making a poor brick for paving purposes.

In the distorted bricks referred to at the beginning of the article, the question arises as to what causes the distortion and the black core. From the table it can be seen that there are only three main differences in composition of the outer shell and the inner core of the bad bricks. These are in ferrous iron, in sulphur, and in combined water content. The question then arises as to which of these causes the swelling and the difference in color and texture. Going back to the analyses we see that all the shales are rather high in the so-called "fluxing oxides" (those of Mg, Ca, Fe, Na and K). Therefore, if heated rapidly to a high temperature fusion begins, and naturally the outside of the brick fuses first. We have shown that the inner core of the brick contains some combined water, while the outer shell does not. Hence, the vitrification on the outside having taken place before the interior of the brick was completely dry, the water was set free as steam, and, having no outlet through the vitrified shell, exerted a great pressure within, thus causing the distortion and the scoriaceous appearance of the inner core. This fact, the incomplete burning of the inner part of the brick, is further proved by the fact that the sulphur, which is present as pyrite, is almost completely burned off in the outside shell, while the amount in the inside is practically the same as shown in the shale itself. The dark color of the interior is attributed to the ferrous iron, which the analyses show to be much higher in the interior of the brick.

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<sup>1</sup> Purdie, *Bull.* 9, Ill. Geol. Survey.

<sup>1</sup> Water at 100° C.

<sup>2</sup> Includes "combined water."

<sup>3</sup> Combined water as found with special apparatus.

<sup>4</sup> Present as pyrites.

THE NORMAL WEIGHT OF DEXTROSE.<sup>1</sup>

By C. A. BROWNE.

Received August 1, 1910.

There is perhaps no single constant given in the literature upon sugar analysis which shows such a variation in value as that given for the normal weight of dextrose. The range extends from 32.5 to nearly 33 grams. Landolt<sup>2</sup> gives as the normal weight of dextrose for true cc. 32.65 grams and for Mohr cc. 32.73 grams; Sidersky,<sup>3</sup> in his latest work, gives the figures 32.82 grams for true cc. and 32.765 for Mohr cc.; Tucker<sup>4</sup> and König<sup>5</sup> each give the value 32.68 grams, and this figure is the most common perhaps of any value given in the literature.

The reason for the considerable variation given to this constant is due largely to the fact that each authority has taken a different specific rotation of dextrose as a basis of calculation. There is no other sugar which shows such a difference in specific rotation for variations in concentration as dextrose; the values for specific rotation of dextrose, according to the formula of Tollens,  $[\alpha]_D^{20} = 52.50 + 0.018796p + 0.00051683p^2$ , range from 52.52 for a 1 per cent. solution to 54.73 for a 50 per cent. solution, which is about the limit of saturation at 20° C.

Landolt<sup>1</sup> gives as the normal weight of dextrose for a 5 per cent. solution 32.91 grams, for a 15 per cent. solution 32.75 grams, and for a 25 per cent. solution 32.50 grams, in which connection he states that in weighing out the dextrose-containing material for polarization, the chemist must select his normal weight according to the amount of dextrose present. This of course involves a preliminary assay of the material under examination, which means practically doubling the work of analysis.

In the case of dextrose, as of all sugars, the author believes that one fixed value should be given to the normal weight, the value to be selected (as in the case of sucrose) being that weight of c. p. sugar which dissolved to 100 true cc. and polarized at 20° C. in a 200 mm. tube will give a constant reading of exactly 100 upon the saccharimeter. If in the use of such a normal weight with impure products readings of less than 100 are obtained, the latter are corrected by a table giving the true percentage equivalent of each division of the saccharimeter scale. The principle is the same as that employed in the well-known table of Schmitz for sucrose.

The author has converted the formula of Tollens for the specific rotation of dextrose from a percentage to a concentration basis, the latter form being more easily applied in the calculation of normal weights.

<sup>1</sup> Paper read before the San Francisco meeting of the Amer. Chem. Soc., July, 1910.

<sup>2</sup> Landolt, "Das Optische Drehungsvermögen" (1898), p. 448.

<sup>3</sup> Sidersky, "Polarization et Saccharimetrie" (1908), p. 100.

<sup>4</sup> Manual of Sugar Analysis (1905), p. 292.

<sup>5</sup> König, "Untersuchung landwirtsch. u. gewerb. wichtig. Stoffe,"

The formula is thus recalculated as  $[\alpha]_D^{20} = 52.50 + 0.0227c + 0.00022c^2$ . According to this formula the specific rotation of a dextrose solution containing 32.5 grams to 100 cc. (the preliminary value taken for the normal weight) is 53.47. Calling the specific rotation of sucrose 66.5 and its normal weight, as under the present metric cc. standard, 26.00 grams, we obtain by means of the proportion 53.47:66.5::26:x, a value of 32.336 grams as the amount of c. p. dextrose necessary to dissolve to 100 true cc. in order to obtain a constant reading of 100 upon a saccharimeter standardized according to the requirements of the modern Ventzke scale.

The value just calculated is not absolutely correct, however, since it is based upon the assumption that the equivalent of 1° Ventzke upon the circular scale is the same for dextrose as for sucrose. That there is a slight difference in the rotation dispersion of these two sugars as compared with quartz has long been recognized. According to Landolt, the value of 1° Ventzke in circular degrees for dextrose is 0.3448. Brown, Morris and Miller give for a 10 per cent. solution of dextrose the value 0.3442 and for a 5 per cent. solution the value 0.3454, the mean figure being 0.3448, the same as that of Landolt. The value of the 100° point of the Ventzke scale for dextrose may be taken, therefore, as 34.48 circular degrees. The specific rotation of a dextrose solution of 32.34 grams concentration (the value for the normal weight just calculated), according to the preceding formula, is 53.46. Substituting these values in the general concentration formula for specific rotation  $[\alpha]_D^{20} = \frac{\alpha \cdot 100}{l \cdot c}$ , in which  $\alpha$  is the reading in circular degrees,  $l$  the dcm. length of the observation tube, and  $c$  the grams of sugar dissolved to 100 cc., we obtain for a 2 dcm. observation tube the value  $c = \frac{34.48 \times 100}{2 \times 53.46}$

32.248 grams, or rounding off to the even hundredths of a gram, which can be done without a sensible error, 32.25 as the correct normal weight for dextrose.

The extent of the corrections necessary to be applied to the scale reading of a saccharimeter, when using the above normal weight, is shown by the following table, which gives the scale division, the cor-

Scale division.	Concentration. Grams dextrose 100 true cc. 20° C.	Specific rotation dextrose $[\alpha]_D^{20}$ .	Actual dextrose value of scale division.	Correction to be added.
100	32.250	53.46	100.00	0.00
90	29.025	53.34	90.20	0.20
80	25.800	53.23	80.35	0.35
70	22.575	53.12	70.45	0.45
60	19.350	53.02	60.50	0.50
50	16.125	52.92	50.51	0.51
40	12.900	52.83	40.48	0.48
30	9.675	52.74	30.41	0.41
20	6.450	52.66	20.30	0.30
10	3.225	52.58	10.17	0.17
1	0.323	52.51	1.02	0.02

responding percentage value of the normal weight, the specific rotation of dextrose corresponding to this weight of sugar in 100 true cc. and the actual dextrose value of the scale division.

The correction necessary to be added to any reading ( $s$ ) of the saccharimeter scale, as formulated from the above table, is equal very closely to  $+0.02s - 0.002s^2$ . The percentage of dextrose ( $D$ ) corresponding to any scale reading( $s$ ) of the saccharimeter is therefore expressed by the formula

$$D = s + 0.02s - 0.002s^2$$

The advantages of using a fixed value for the normal weight of dextrose as defined are very evident. The percentage of dextrose is found at one operation without the necessity of making a preliminary assay of the material in order to determine the exact quantity necessary to be weighed out. The method is also much more accurate than any of the processes using the variable normal weights prescribed in sugar literature.

The method described for dextrose is one which can be applied to all other sugars. By defining the normal weight for each of the sugars in the manner outlined in this paper, giving it a fixed value as in the case of sucrose, much of the confusion and inaccuracy attending the use of saccharimetric methods in sugar analysis can be avoided.

### MACHINE FOR MILLING SAMPLES OF WHEAT.

By GEO. A. OLSON.

Received October 1, 1910.

A milling outfit which will mill small samples of wheat (50 to 500 grams) as efficiently as the \$550.00 Allis-Chalmers experimental mill can be installed for a sum not exceeding \$10.00. With this outfit it is possible to test the milling qualities of flour, determine the various constituents contained therein, and determine the value of a wheat from a nutritive standpoint as well as the baking qualities.

This inexpensive outfit has been used by the writer in his research work and as a result has proven useful in a number of instances, among which may be mentioned, first, the modifying and remilling of flour; second, the germinating of wheat and its effect on the quality of the flour therefrom; third, determining the milling qualities of Washington wheats and new hybrids; fourth, determining the amount of flour contained in oats, barley, corn, etc.; fifth, the mixing of wheats to determine which combination of wheat makes the best blend for flour; sixth, assisting the State Grain\* Inspection Department in several instances; and seventh, determining the milling qualities of hybrid wheats from centgener plots. The possibilities for extending the use of this outfit in commercial, as well as experiment station, laboratories, flour mills, grain inspection departments,

commission houses, and among the farmers seem promising from the many ways that it may be used satisfactorily.

In addition to the usefulness of this outfit in work similar to that done by the writer, it may also prove valuable in feeding-stuff work, *e. g.*, for the detection of adulterations in ground feed, which are claimed to be made up of whole grains, when, as a matter of fact, oat hulls, corn cobs, etc., have been admixed. Such adulterations can readily be detected by making a milling determination. In cases of this kind flour determinations will tell more in regard to the nature of the feed than crude fiber determinations. By changing the bolting-cloths for sieves of any desired size, mechanical analysis of soil, the reduction of coal and ore can readily be accomplished.

In the following paragraphs a description of the mill, bolting machine, and the methods of operating the same, are given, together with results showing the efficiency of this inexpensive milling outfit.

*Mill.*—It is needless to state that the success of milling small samples of wheat depends as much upon the efficiency of the mill as it does upon the bolting machine. With the coöperation of the manufacturer of the mill used in this work, the writer finally succeeded in getting one of their standard mills modified in such a way that it will reduce wheat into flour as satisfactorily as if the wheat had passed between rollers. The mill has been thoroughly tested on both hard and soft wheats. It has been found, however, that it takes a little longer to reduce hard wheats than soft ones. In addition it requires some judgment to mill the same and different varieties of wheat. The mill (Laboratory Special) is manufactured by the Gray Iron Casting Co., Springfield, Ohio.

*Bolting Machine.*—The accompanying drawing shows the construction of the bolting machine used by us. The gearing from an old-style Babcock tester was used, leaving one of the arms on the horizontal wheel long enough so as to allow a three-inch reciprocal motion. Other forms of shaking devices will answer the same purpose. A modified soap box with a platform built about one-third the distance from the bottom to hold a removable drawer, beveled flanged pieces inside the box to permit the flour to drop toward the center of the drawer, and two strips of wood to hold the grooved sliding board (having an opening large enough to hold the bolting frames), which is connected by means of a shaft to the arm on the horizontal wheel, completes the machine. A tin box would be preferable to a wooden box owing to the fact that the smooth surface would tend to remove the danger of loss of flour in sifting and make it easier to collect same.

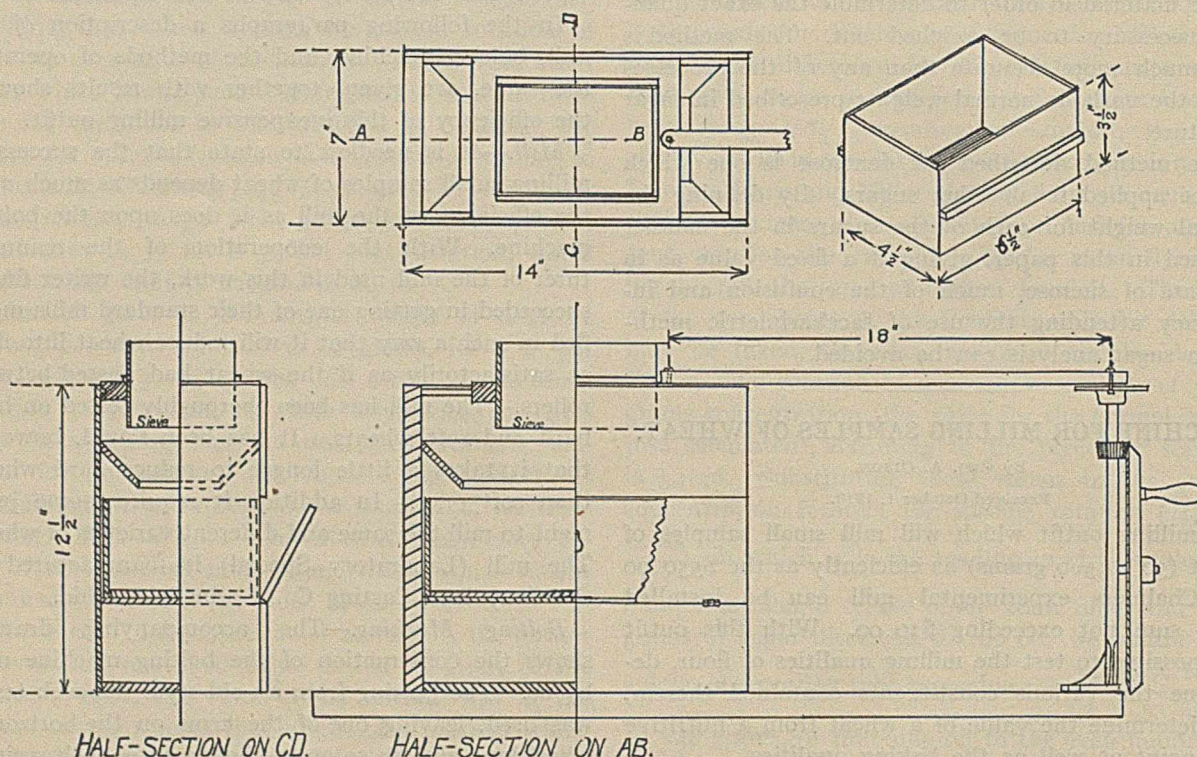
*Bolting Frames.*—The bolting frames were made out of crayon boxes with the bottoms sawed off. Besides a 20-mesh wire gauze, a No. 30 GG, No. 50

GG, No. 70 GG, and No. 10 XX bolting-cloths were either tacked or glued to the boxes. The frames were reinforced on the sides with two strips of wood so as to prevent them from falling through.

*Milling Process, First Method.*—One hundred grams of cleaned wheat are tempered with approximately a thimbleful of water and allowed to stand for about thirty minutes or so, depending upon the variety of wheat to be milled. When the outer coating (epidermis) feels soft to the touch the sample is ready for grinding. The first grinding should be done with the mill loosely set. The larger particles of bran are then separated from the smaller ones by bolting through the 20-mesh sieve. This process is repeated three times, which will usually be sufficient. The

paper and work as much of unbolted material as will first pass through the 70 GG and finally the 10 XX bolting-cloths, using a coin or iron washer to aid in removing the last traces of flour. The residue remaining on the 10 XX bolting-cloth and including everything to 30 GG is weighed as shorts. The flour is then gathered and weighed and the amount of loss or gain calculated from the difference between the sum total of bran, shorts and flour from one hundred. By rebolting the flour through the 70 GG sieve a couple of times, the sample mixes uniformly and is then ready for carrying out the gluten and baking tests.

*Milling Process, Second Method.*—If the grain of the flour is considered of minor importance, the mill-



BOLTING MACHINE

unbolted material is then ground again with the mill set tighter together and bolted through the 30 GG bolting-cloth, which leaves the germ, fragments of bran and some particles of flour on the bolting-cloth. It will be necessary to grind the unbolted material left on the 30 GG sieve several times in order to reduce the germ and flour particles. The material not passing through the 30 GG and 20-mesh sieves is weighed as bran. Next gather the siftings in the drawer and bolt through the 50 GG bolting-cloth. The unbolted material left on this sieve is then ground again with the mill set tight and the operation of grinding and bolting through the 50 GG sieve continued from two to three times, depending upon the variety of wheat used. Collect the flour on a smooth

ing operation can be simplified by bolting first through 30 GG bolting-cloth to remove bran and then follow by using 10 XX bolting-cloth exclusively. This process consists of tempering the wheat as previously described and alternating the milling and bolting operations. This method of procedure is in every respect as good as the former to determine the yield and quality of the gluten, blending, grading, and determining the composition of the wheat and its products. It should prove as valuable for determining the amount of flour in barley, corn, oats, and supposedly whole grains. In addition, this process saves time and where small quantities of grain are milled more samples can be tested, and as a result more work will be accomplished than is possible for

accurate results with a larger type of mill and bolting machine. The writer, single-handed, has succeeded in milling twice the number that is possible with the Allis-Chalmers outfit with two men. The time required in either case, however, will depend upon the nature of the wheat (hard or soft) and to a large extent upon the condition of maturity of the grain to be tested.

*Suggestions.*—A few words of advice in regard to operating the mill may be of some value to others who may contemplate using this small outfit. Grain should never be crowded nor forced through the mill, rather feed slowly and grind oftener. Set the mill loosely at first and after the bran has been removed the mill should be tightened up to reduce the more flinty part of the wheat. If the wheat is too moist after tempering there is a tendency for the wheat to pack the mill; this is especially noticeable when the wheat is fed in too large quantities. On the other hand, if the wheat is moist and fed a few kernels at a time no packing has been observed to take place. In addition there is a tendency for the mill to heat when grinding and care should be exercised to avoid this as it may alter the quality of the flour.

*Efficiency of Outfit.*—Using samples of the same wheat which the cerealist used in his milling operations on the Allis-Chalmers experimental mill showed that accurate work could be done with the outfit herein described. Since no data were taken by the cerealist in regard to the loss or gain in the milling, the writer had to limit his comparisons to the amount of bran and shorts obtained by the two methods. The largest variation observed was in case of a blue-stem wheat where the writer obtained 2.6 per cent. less bran and shorts than did the cerealist. In the other fourteen cases the results were within a narrow range of each other.

*Other Milling Tests.*—A total of 119 samples of wheat representing different varieties grown in the State of Washington have been milled and bolted and the results for average, maximum, and minimum have been summarized in the following table:

RESULTS OF MILLING TESTS.

	Per cent. bran and shorts.	Per cent. flour.	Per cent. loss. <sup>1</sup>	Per cent. gain. <sup>2</sup>
Average.....	27.37	72.77	1.21	1.01
Maximum.....	38.80	82.00	5.10	3.30
Minimum.....	15.95	60.55	0.03	0.05

The results summarized in the above table show that some wheats when milled lose in weight, while others gain. The gains may be attributed to water absorption, whereas the losses may be due to either unavoidable loss or to the lowering of the moisture content, or both. Out of a total of 119 samples milled, 64 had an average gain of 1.01 per cent., and in one case a gain of 3.30 per cent. Fifty-seven

out of the 64 samples milled did not exceed 1.50 per cent. over the theoretical amount. Fifty-five samples milled had losses, one of which (a New Mexico hard wheat) resulted in a loss of 5.10 per cent. Forty-five out of the 55 did not exceed 1.50 per cent. loss.

The wide variations in the yield of bran and shorts and flour, as is evidenced from the maximum and minimum figures, show the importance of milling samples of wheat in order to determine the relative value of different wheats which are sold.

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## THE REACTION OF LIME AND GYPSUM ON SOME OREGON SOILS.

By C. E. BRADLEY.

Received July 11, 1910.

It is a well-known fact that the soils of Western Oregon respond very readily to even small applications of gypsum. Many instances are recorded where the yield of a clover or vetch crop has been practically doubled by a treatment with plaster at the rate of fifty or sixty pounds to the acre, and this fertilizer has also been used with success by a number of market gardeners on general truck crops.

The reactions which take place in the soil when gypsum is applied have been studied by many investigators. Boussingault compared the analyses of clover on which gypsum had been used with the same plant grown on untreated plats and noted that the plastered clover contained more potash. Storer<sup>1</sup> referring to this action states:

"It is found that the lime of the gypsum is fixed in the soil while a corresponding quantity of sulfate of potash goes into solution. Thus it happens that gypsum not only sets potash free for the use of the crop but it causes potash to be transferred from the upper to the lower layers of the soil, so that the roots can everywhere find a store of it."

R. Warrington<sup>2</sup> and P. Richard<sup>3</sup> show that gypsum has also a favorable action in promoting nitrification in the soil.

According to Stockhardt, "the action of gypsum perhaps, more than any other manure, depends upon the kind of soil and crop, upon climate and other conditions, and is subject to manifold limitations." In this connection it is of interest to note that in a number of recent experiments with this fertilizer, reports unfavorable to its use are given. L. L. Harter<sup>4</sup> reports: "In all our experiments gypsum has proven decidedly injurious to Norfolk soils and its use is not recommended." Morse and Curry<sup>5</sup> have made extensive studies on the effects of lime and gypsum

<sup>1</sup> "Storer's Agriculture," 1-207.

<sup>2</sup> *Trans. Chem. Soc.*, 47, 758.

<sup>3</sup> *Ann. de Chim. et de Phys.*, 25, 271.

<sup>4</sup> *Bull.* 1, Virginia Truck Exp. Sta.

<sup>5</sup> *N. H. Bull.* 142.

<sup>1</sup> 55 samples.

<sup>2</sup> 64 samples.

on some of the New Hampshire soils as well as upon samples of feldspar (apophyllite). They note little chemical effect in liberation of potash from the soils by either the lime or gypsum. From the feldspar the lime dissolved appreciable amounts of potash and about three times that released by the gypsum. They state it is because of the fixing action of the clay that the lime does not apparently increase the water-soluble potash in these soils.

In connection with some soil studies which have been carried out recently in this laboratory, the comparative reactions of lime and gypsum on a few typical soils have been investigated as regards the liberation of soluble potash by these fertilizers. The soils of this region are in general clay loams of basaltic origin and usually contain a good stock of potash. Soil No. 1, referred to in the following table, is a clay loam from the college farm and is typical of the southern portion of the Willamette Valley. Soil No. 2 is a bench land sample commonly characterized as "red hill" or "shot" soil and is a high-grade fruit soil. Soil No. 3 is a mildly alkaline silt loam from the branch experiment farm at Union. The composition of these soils with respect to potash is as follows:

TABLE I.—COMPOSITION OF SOILS IN POTASH.

	1.		2.
	Per cent.	Per cent.	Per cent.
Total.....	2.77	1.09	1.18
Sol. HCl 1.115.....	0.30	0.23	0.64
Sol. HNO <sub>3</sub> N/5.....	0.035	0.038	0.145

In the first series of tests large glass percolators having a capacity of about twenty-five pounds of soil were filled with the soils which had been moistened to a good working condition with water (20–25 per cent.). The fertilizers were then applied and thoroughly mixed with the soil, the outlet of percolator closed with a cork, and the top of the soil covered with a layer of paraffine to prevent evaporation. After standing six weeks the corks were removed and the percolator leached with distilled water until approximately 500 cc. of percolate were obtained. The potash was then determined in these solutions by the method of Cameron and Failyer<sup>1</sup> and the colors read in a Schreiner colorimeter. Results of these tests are recorded in the following table:

TABLE II.—POTASH IN PARTS PER MILLION OF SOLUTION.

	Blank.	1 Per	1 Per
		cent.	cent.
		CaO.	CaSO <sub>4</sub> .
Soil No. 1.....	2.7	4.7	7.2
Soil No. 2.....	3.1	4.0	7.2
Soil No. 3.....	53.5	69.2	88.0

It is seen that both lime and gypsum increased the amount of water-soluble potash in these soils though the action of the lime is in some cases very slight.

Very little action was exerted by either agent on the water-soluble phosphates.

In the following tests the lime and gypsum used were specially purified potash-free in order that no soluble potash could be introduced in these reagents. Fifty grams of soil were treated in each case with 500 cc. of distilled water and one gram of lime and gypsum, respectively. The material was placed in stoppered bottles and shaken occasionally for twenty-four hours at room temperature. After filtration through a Pasteur-Chamberland filter an aliquot was analyzed as above, a blank with distilled water being run in each instance.

TABLE III.—POTASH IN PARTS PER MILLION OF DRY SOIL.

	Time.	Blank.	1 gram	1 gram
	Hours.		CaO.	CaSO <sub>4</sub> .
Soil No. 1.....	24	7.7	5.0	31.3
	96	....	5.6	....
Soil No. 2.....	24	14.0	9.2	37.4
Feldspar (pegmatite) .	24	32.3	22.5	51.7

In the above table it is seen that gypsum was pronounced in its action in each instance on the soil as well as the feldspar, while lime reduced slightly the amount of soluble potash. It is evident that gypsum acts as an indirect potash fertilizer on these soils while lime does not.

In some localities where plaster has been used for a long period of years it is claimed that the soil does not respond to its application as readily as formerly. One particular field, a sandy loam used for market gardening, has come to our notice, however, which has had applications of plaster for 25 years at the rate of 200 pounds per acre and still responds readily to this treatment. An examination of this soil together with the same soil in an adjoining field not treated with gypsum gave the following interesting results, tests being made of the surface nine inches of the soil in each instance:

TABLE IV.—PER CENT. OF POTASH.

	Unplastered soil.	Plastered soil.
Potash sol. in HCl, 1.115.....	0.202	0.268
Potash sol. in HNO <sub>3</sub> , N/5.....	0.050	0.069

These results indicate that considerably larger amounts of available potash are present in the soil which has been for a long period treated with gypsum.

## SUMMARY.

The soils of Western Oregon respond readily to applications of gypsum. Tests on a number of these soils with lime and gypsum under different conditions indicate that gypsum here acts as an indirect potash fertilizer while lime does not. Neither of these fertilizers affects the amount of water soluble phosphates in the soil.

<sup>1</sup> Bur. Soils, Bull. 31.



## THE CHEMICAL COMPOSITION OF KAFIR CORN.

(FIRST PAPER.)

By R. O. BAIRD AND C. K. FRANCIS.

Kafir corn, *Andropogon sorghum vulgaris*, comes under the general classification of sorghums, and is supposed to have originated from a single species native to tropical Africa. It takes its name from the well-known Kafir tribe.

The value of Kafir corn as a drought-resistant crop has been clearly proved.<sup>1</sup> It can be depended upon for good yields under conditions distinctly unfavorable to Indian corn. Its value in the semi-arid regions of the United States cannot be overestimated as it is better able to withstand the drought and hot winds than any other crop. The hot winds may cause this species of plant to wither, but if favorable conditions follow a period of drought it resumes growth, and produces good yields. During the past few years a large acreage has been devoted to this



Well developed Kafir corn.

crop and almost entirely for the purpose of producing roughage for live stock. The value of the grain as a food for stock and man is not fully appreciated,

though its milling qualities are given more consideration to-day than ever before.

*Scope of the Investigation.*—In order to determine the value of the Kafir corn kernel as a food and as a raw product in manufacture the experiments herein reported were planned as outlined below:

1. A study of the chemical compounds which make up the proximate constituents of the Kafir kernel for a comparison with Indian corn.
2. The relation between the inorganic plant constituents of Kafir corn and Indian corn, and the approximate amount of plant foods removed from the soil by each.
3. A study of the Kafir corn fat and methods of extracting it from the seed.

## ANALYTICAL METHODS.

The samples of Kafir corn kernels were obtained from local dealers and from the Oklahoma Experiment Station fields. Sample No. 4764 was taken from a "no treatment" field while sample No. 4765 was taken from a plat which had been well manured. About one bushel of each sample was freed from hulls, thoroughly mixed and ground to a fine meal. The meal was quartered down to about 1 kilo and then placed in air-tight jars until analyzed.

*Moisture.*—The moisture was determined by drying five grams of the sample for 12 hours at 100°.

*Ash.*—The ash was determined by incinerating five grams of the sample until no loss of weight was noticed on further heating. The time required was about eight hours.

*Crude Fiber.*—This determination was made by the official method.<sup>1</sup>

*Ether Extract.*—The indirect method was used.

*Nitrogen.*—The Gunning method was used in this determination.

*Nitrogen-free Extract.*—Was determined by subtracting from 100 the sum of the percentages of moisture, ash, crude fiber, ether extract, and protein.

*Starch.*—This determination was accomplished by the direct acid-hydrolysis (modified Sachsse method). The diastase method for the determination of starch was tried several times, but the results did not agree, and were never high enough in starch.

Reducing sugars, sucrose, galactans, and pentosans were determined by the official methods.

*Specific Gravity.*—A 25 cc. gravity bottle was used in this determination. The weighings were made at 15.5°.

*Melting Point of the Fat.*—This determination was carried out according to the method proposed by Wiley. A flat disc, made by dropping the melted fat on ice, was heated in a mixture of alcohol and water. The temperature at which the disc rolled into a sphere was considered the melting point.

<sup>1</sup> U. S. Department Bureau of Chemistry, *Bulletin 107* (Revised), was used as a guide in all determinations unless stated otherwise.

<sup>1</sup> Oklahoma Agricultural Experiment Station, *Bulletin 87*, 1910.

*Solidifying Point—Titer Test.*—The method of Dali-can was used for this determination.<sup>1</sup>

*Iodin Absorption Value.*—Hübl's method for the absorption of iodine was used according to the official methods.

*Saponification Number.*—The method used in this determination was that of Koettstorfer.

*Acetyl Value.*—This determination was made according to Lewkowitsch.<sup>2</sup>

Soluble and insoluble acids, Reichert-Meissl number, free fatty acids, Maumené number and inorganic plant constituents were determined according to the well-known standard methods.

1. *Proximate Constituents of the Kafir Kernel.*—In order to show the relative value of the proximate constituents of the Kafir corn kernel, some standard must be chosen for comparison. As Indian corn, in conditions of growth and nature of environment, is somewhat similar to Kafir corn, it will be used for comparison.

TABLE I.—COMPOSITION OF KAFIR CORN.

Sample.	Mois- ture.	Ash.	Pro- tein.	Nitro- gen-free		Nitro- gen.
				Fiber.	extract.	
3302 Kafir meal...	12.43	1.13	11.25	1.89	71.09	2.21 1.800
3804 Kafir meal...	12.63	1.28	11.47	...	71.83	2.79 1.834
3308 Kafir meal...	13.50	1.25	11.47	1.79	69.47	2.52 1.834
3367 Kafir meal...	13.46	1.23	10.60	1.86	70.80	2.05 1.697
3383 Kafir meal...	13.31	1.27	10.95	1.85	71.31	1.32 1.751
4122 Kafir meal...	12.02	1.26	10.06	...	73.72	2.94 1.610
4123 Kafir meal...	12.06	1.23	9.89	...	73.87	2.95 1.582
4720 Kafir grain ..	10.08	1.40	9.19	2.15	74.31	2.87 1.477

TABLE II.—COMPOSITION OF INDIAN CORN.

Sample.	Mois- ture.	Ash.	Pro- tein.	Nitro- gen-free		Nitro- gen.
				Fiber.	extract.	
3301 Cornmeal ...	11.59	1.38	9.70	2.16	71.64	3.53 1.551
3803 Shelled corn .	12.56	1.23	9.63	...	72.96	3.62 1.540
3804 Cornmeal ...	12.54	1.35	9.27	...	72.91	3.93 1.484
3307 Cornmeal ...	14.58	1.28	9.71	2.03	71.40	1.00 1.553
3366 Cornmeal ...	13.81	1.35	9.30	2.13	72.26	1.11 1.487
3382 Cornmeal ...	13.03	1.47	9.74	2.13	72.30	1.33 1.558
4121 Cornmeal ...	11.26	1.29	8.84	...	74.25	4.26 1.414
4706 Corn chops ..	10.89	1.02	8.57	1.99	74.27	3.26 1.372
4716 Corn chops ..	9.74	1.27	10.06	2.65	72.29	3.99 1.610
4717 Corn chops ..	9.70	1.22	10.06	2.54	72.12	4.36 1.610

From the preceding analyses of Kafir corn and Indian corn obtained from different parts of Oklahoma, the conclusion can be reasonably drawn that Kafir corn is similar in composition to Indian corn and is therefore a valuable food. The analyses presented by Tables I and II show that the protein and carbohydrates in Kafir corn are slightly higher and the fat somewhat lower in per cent. than in Indian corn.

Samples Nos. 4764 and 4765 were taken from unmanured and manured fields, respectively. The effect of the fertilizer is apparent in every determination, and illustrates a remarkable response to the application of fertilizing material.

<sup>1</sup> Food Inspection. Leach, p. 403.

<sup>2</sup> Jour. Soc. Chem. Ind., 503, 1897. Chemical Technology, Lewkowitsch, 1, 268 (1904).

<sup>3</sup> The results in all tables are expressed in per cent. unless otherwise indicated.

TABLE III.—ANALYSES OF KAFIR CORN.

Sample.	Moisture.	Ash.	Crude		Protein.	Nitrogen- free extract.
			fiber.	Fat.		
4760.....	13.471	1.453	2.648	3.416	12.85	66.162
4762.....	12.250	1.196	2.470	3.541	12.97	67.573
4763.....	11.474	1.277	3.319	3.570	11.92	68.440
4764.....	12.805	1.599	2.957	3.517	11.06	68.061
4765.....	13.105	1.700	2.890	3.896	11.99	66.419
Maximum.....	13.448	1.668	2.900	3.800	12.85	70.826
Minimum.....	11.264	1.196	1.880	3.464	11.37	65.334
Mean.....	12.356	1.432	2.390	3.632	12.11	68.080

Table III shows that the proximate constituents of Kafir corn are fairly uniform, for the samples were obtained from various places.

In the following tables the results of a number of analyses have been averaged and calculated to moisture-free basis. The data for Indian corn is that reported by Dr. C. G. Hopkins.<sup>1</sup>

TABLE IV.—COMPARISON OF INDIAN CORN AND KAFIR CORN. MOISTURE-FREE BASIS.

	Indian corn.		Kafir corn.	
	Maximum.	Minimum.	Maximum.	Minimum.
Ash.....	1.74	1.09	1.93	1.35
Protein.....	13.88	8.35	14.85	12.81
Fat.....	6.02	3.95	4.39	3.90
Carbohydrates.....	85.78	78.92	84.33	76.44

The following table will show more clearly the comparison of the food constituents of Indian corn and Kafir corn:

TABLE V.—FOOD VALUES COMPARED.

	Kafir corn.	Indian corn.
Average yield per acre.....	30 bu.	35 bu.
Feeding value, considering corn 100.	90	100
Pounds of protein per acre, considering 11.3 per cent. of Kafir corn and 10.5 per cent. Indian corn...	219.84	205.80
Pounds of fat per acre, considering Kafir corn 3 per cent. and Indian corn 3.5 per cent.....	50.4	68.6
Pounds of nitrogen-free extract per acre, considering Kafir corn 70 per cent., Indian corn 72.5 per cent.....	1176.0	1421.0
Value per acre, considering corn worth 37.5 cents and Kafir corn worth 30 cents per bu.....	\$9.00	\$13.125

*Nitrogen-free Extract.*—Under this head is included the starch, glucose or dextrose, sucrose, galactans and pentosans. The determination of these compounds show more completely the value of the nitrogen-free extract.

The following table contains the results of the analysis of nitrogen-free extract:

TABLE VI.—COMPOSITION OF NITROGEN-FREE EXTRACT.

Sample.	Nitrogen- free extract.	Starch.	Pento- sans.	Galactans.	Glucose.	Sucrose.
4762.....	67.573	60.713	3.79	0.150	1.362	0.406
4763.....	68.440	59.031	4.41	0.136	1.360	0.493
4764.....	68.061	57.125	4.53	0.119	1.440	0.669
4765.....	66.419	57.956	5.04	0.104	1.345	0.795

From the preceding table the following conclusions can be reasonably drawn:

That Kafir corn kernel has as much sucrose, reducing sugars and pentose bodies as Indian corn. The analyses also show that 90 per cent. or more of the nitrogen-free extract can be utilized as a food.

The following table has been computed from Table VI, and shows the value of Kafir corn for the production of alcohol as compared with Indian corn:

TABLE VII.—PRODUCTION OF ALCOHOL.

	Kafir corn.	Indian corn.
Pounds of fermentable material (starch and sugars) in one bushel.....	38.0	39.2
Approximate pounds of alcohol per bushel.....	18.0	19.0
Gallons of alcohol in one bushel.....	2.56	2.7
Cost of grain <sup>1</sup> to produce one gallon of alcohol.....	12 c.	14 c.

### 2. Determination of the Inorganic Plant Constituents.

—The ground meal was ignited in a muffle furnace and the charred material extracted with a 10 per cent. solution of acetic acid. The acid was washed out with hot water and the combined filtrates evaporated and burned to a white ash. The residue was also burned to a white ash, and the two thoroughly mixed and placed in ground-glass stoppered bottles until used for analysis.

In Table VIII complete analyses of the ash of Kafir corn are reported. The composition of the ash of Indian corn is shown in Table IX.:

TABLE VIII.—ASH OF KAFIR CORN.

Sample number.	3898.	3958.	3230.	3231.	Average.
Sand.....	4.30	3.33	5.73	2.88	4.06
Soluble silica.....	0.96	1.28	2.25	4.15	2.16
Carbon.....	0.24	0.31	0.28	0.17	0.25
Sulphur trioxid.....	0.19	0.17	1.22	0.51	0.52
Chlorin.....	0.45	0.48	0.58	0.44	0.49
Sodium oxid.....	0.94	0.96	2.42	2.39	1.18
Phosphorus pentoxid.....	43.76	44.21	37.47	46.72	43.04
Iron and aluminum oxids.....	1.19	1.18	2.08	1.84	1.57
Calcium oxid.....	1.95	2.15	1.64	1.46	1.80
Magnesium oxid.....	18.86	18.56	16.67	15.25	17.34
Potassium oxid.....	27.11	26.99	29.78	24.82	27.17

TABLE IX.—ASH OF INDIAN CORN.

	By Wolff <sup>2</sup>	By Ford <sup>3</sup>
Potassium oxid.....	29.80	29.15
Sodium oxid.....	1.10	1.76
Calcium oxid.....	2.20	1.60
Iron and aluminum oxids.....	0.80 <sup>4</sup>	1.64
Phosphorus pentoxid.....	45.60	49.58
Magnesium oxid.....	15.50	13.29
Sulfur trioxid.....	0.80	0.54
Silica.....	2.10	2.45
Chlorin.....	0.90	0.66

From the above analyses it will be seen that 87.55 per cent. of the Kafir ash and 92.29 per cent. of the corn ash is in the form of potassium and magnesium phosphates. The average per cent. of ash in Kafir corn kernel is 1.433 while that of corn is 1.372.

The following table shows the approximate amount of potassium oxid, phosphorus pentoxid, and nitrogen, which is removed from the soil by an average crop of Kafir corn and Indian corn:

TABLE X.—PLANT FOOD REMOVED FROM SOIL.

	Kafir corn.	Indian corn.
Average yield in bushels per acre.....	30.000	35.000
Pounds per bushel of potassium oxid.....	0.218	0.227
Pounds per acre of potassium oxid.....	6.540	7.945
Pounds per bushel of phosphorus pentoxid.....	0.345	0.366
Pounds per acre of phosphorus pentoxid.....	10.362	12.810
Pounds per bushel of nitrogen.....	1.089	1.023
Pounds per acre of nitrogen.....	32.940	35.798

As shown by the above table, corn takes up from the soil a larger quantity of the three important plant foods than Kafir. This knowledge is of special value when allowance is made for the fact that corn has been shown by analysis, to be very little, if any, better than Kafir corn as a feed for stock and poultry.

3. *Kafir Corn Fat*.—Equal quantities of five samples of Kafir corn kernel were well mixed, ground to a very fine meal and the fat extracted with gasoline. Large bottles were used in the extraction, and the mixture of meal and gasoline was shaken thoroughly every few hours. After standing for 24 hours the gasoline and the extracted fat were put into another bottle with a new charge of meal, and this process continued for five days, each charge of meal being extracted five times. The liquid was then filtered, evaporated, and purified.

In the evaporation of the mixture most of the gasoline was removed by the aid of heat and a suction, pump. The liquid was placed in 500 cc. Jena flasks attached to a suction pump, and the flasks placed in a bucket of water. The water was heated from 55° to 60° C., the suction started, and the process continued for 36 hours.

The golden liquid obtained from the gasoline extraction was poured into a flask (1000 cc.) and heated in a water oven kept at 100°. While the liquid was being heated carbon dioxid, which had previously been dried by means of calcium chlorid and sulphuric acid, was drawn through it. After 40–50 hours this treatment usually removed all of the water and any traces of gasoline.

The fat on cooling, became solid, not unlike vaseline, though somewhat harder. It had a yellow color with a greenish hue, a pleasant though not marked odor, and a pleasant vegetable oily taste.

TABLE XI.—CONSTANTS OF KAFIR CORN FAT AND CORN OIL.

	Kafir fat.		Corn oil. <sup>1</sup>	
	1.	2.	1.	2.
Specific gravity.....	0.9398	0.9397	0.9274	0.9213
Melting point.....	44.4°	44.0°	18.0°	20.0°
Titer test.....	34.1°	33.8°	14.0°	16.0°
Iodin value.....	109.98	109.43	111.0	180.0
Soluble acids.....	0.64	0.68	...	...
Insoluble acids.....	93.04	93.41	82.2	95.7
Saponification value.....	249.7	248.5	188.0	193.0
Richert-Meissl No.....	6.14	6.07	4.2	9.9
Liquid acids.....	86.44	85.52	...	...
Solid acids.....	7.40	7.55	...	...
Free fatty acids.....	26.93	27.10	...	...
Acetyl value.....	42.22	42.24	7.8	8.75
Maumené number.....	68.2°	68.0°	5.6°	8.6°
Unsaponifiable res.....	1.72	1.71	...	...

<sup>1</sup> Chemical Technology, Lewkowitsch, II, 515, 1904.<sup>1</sup> Corn, 37.5 c.; Kafir, 30 c. per bushel.<sup>2</sup> Wolff's Aschen Analysen, 1880. See also Thorp's Dictionary of Applied Chemistry, Vol. I, page 497, 1890.<sup>3</sup> Oklahoma Experiment Station.<sup>4</sup> Wolff reported iron oxid only.

In Table XI the chemical and physical constants of two samples of Kafir fat are compared with those of two samples of corn oil.

The melting point of Kafir corn fat is 44.2, and that of corn oil is 18° to 20° C. This and the higher Titer test of the Kafir fat shows that the latter contains more of the solid fatty acids than corn oil. The indications are that Kafir fat could be utilized much more satisfactorily than corn oil for soap-making. An experiment demonstrated that the fat could not be used as a lubricant owing to the high percentage of acids. The fat might, however, be used with other oils especially the edible fats and oils, as it has an agreeable taste and odor. Owing to its high melting point it might be used with such fats as lard, oleomargarine and butterine. The fat was found to be practically non-drying.

The fat is soluble in gasoline, ether, chloroform, carbon bisulphide, and to some extent in absolute alcohol. This property is receiving attention with more detailed consideration of the investigation.

#### SUMMARY AND CONCLUSIONS.

The proximate analysis shows the Kafir kernel to compare favorably with corn.

a. Kafir corn is more uniform than corn in composition.

b. It is a cheap food.

Alcohol and glucose can be produced cheaper from Kafir corn than from corn if the cost of the raw material is alone considered.

Kafir corn removes a smaller quantity of the important plant foods from the soil than corn. This fact has been shown by analyses of the ash of both grains which were grown under similar conditions.

The fat from the Kafir kernel is a solid which melts at 44.2°.

c. It should be valuable in the manufacture of soaps and fatty acid products.

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#### ADDRESSES.

##### PRESENT STATUS OF OZONE, WITH REFERENCE TO AIR PURIFICATION.<sup>1</sup>

By RALPH D. SMALL.

The development of ozone for industrial uses, water purification and ventilation, has progressed rapidly since 1903, which seems to be the median line between inaccuracy and accuracy so far as determination, concentration, economical operation, properties and uses of ozone are concerned. In 1890, the French Academy appointed a commission to report on the status of ozone in Europe. After a lengthy investigation their report submitted proved absolutely inconclusive. The members were almost divided as to what they recognized had been scientifically proven. From 1895 to the present date the whole subject has

<sup>1</sup> Read before the 18th general meeting of the American Electrochemical Society, October 14, 1910, at Chicago, Ill.

been largely taken out of the laboratory and put on a commercial plane, and this has been chiefly dependent upon the progress and developments that have taken place in the electrical industry.

As this paper is to be largely devoted to the uses of ozonized air as an adjunct or supplement to ventilation, very little reference will be made to the largest commercial use to which ozone has at present been put, namely—that of water purification, except to state that water purification by ozone has in many places in Europe supplanted every other method of filtration and sterilization that is known. In the United States, owing probably to imperfectly developed methods, a like success cannot be claimed. Schneller, De Fries, W. Siemens, Vosmaer, Becquerel, Otto, Ehlwein, Gerard, Berthelot, Koch, Ohlmüller have all been largely responsible for the progress that has been made along this line. To-day there are over 40 cities and towns in France that are purifying all or part of their water supply with ozone apparatus. In Germany also this method is being rapidly adopted. Some idea may be gained of the efficiency of this method when, as is stated,<sup>1</sup> "ozone treatment reduced the bacterial count in water from 12 million to 40 with a total consumption of 18 grams of ozone per cubic meter." To-day there are over 150 patents in the United States Patent Office, and this department is rapidly becoming one of the "busy" departments, thus indicating the amount of interest that is now being taken in the latest development of the electro-chemical field. One of the former heads of the Westinghouse interest has been credited with the remark that "not only was ozone the coming thing in electricity, but was destined to be in the course of time one of the largest fields with which electricity would be identified, barring the use of light and power."

There are various ways of producing ozone, such as the oxidation of phosphorus, or the action of ultraviolet rays upon air, these rays being produced by a mercury vapor lamp in a quartz receptacle, or by heat, according to Nernst and Clement, by which they produce 3 grams per kilowatt hour. It should be stated here that concentration is the percentage of ozone usually measured in grams contained in a cubic meter (about 35 cubic feet) of air. All these processes, however, are not economical for commercial purposes. Ozone is produced in nature by evaporating water, when acted upon by the ultraviolet rays of either sunlight or electrical discharge. It is also produced from green plant life, in what is known as the process of photo synthesis. In this process carbon dioxide is absorbed and unites with water to form carbohydrates. In this chemical reaction the atoms of oxygen are liberated and appear in a nascent state. This affords a logical origin for the presence of ozone in the vicinity of forests or where much plant life is found. Its presence in mountainous regions and higher air strata is largely accounted for, first—by the lack of organic impurities to use it up, and, second, because the sun's ultraviolet rays having less atmosphere to pass through are more slowly absorbed. This is investigated quite extensively by Ladenburg and Lehmann, as was noticed in the *Scientific American* of August 6th, and their works are now the basis of a series of investigations on the part of the United States Weather Bureau. The spectroscope is used to determine the presence of ozone in such investigations.

It is generally conceded now since the research of Henriot and Bouysey, and also Steinmetz, that ozone is created by the action of ultraviolet rays upon oxygen; that it is an endothermic process; heat is absorbed. In nature this usually takes place and is more observable when there is much electricity in the air, or when water evaporates quickly as on the beach of the seashore, where it is in a finely divided state, and on account of which these rays have a better opportunity for their peculiar action.

<sup>1</sup> *Engineering News*, April 28, p. 497.

For air-conditioning purposes ozone is now being made with generators, which first change the direct current to an alternating current, preferably with cycles not less than 60, and then step-up the voltage to 5,000–30,000, although it is now thought that to obtain the best economies a voltage under 8,000 is poor practice. The discharge is made by electrodes on either side of a dielectric, such as glass, micanite, mica, or some high insulating material, there being an air gap between the dielectric and the electrodes. The electric glow, which has no sparks such as is exhibited in the voltaic arc and which is comparatively heatless, is a brush discharge, purple in color, and fairly quiet in its action. Various types of condensers and electrodes have been used from 1859 down to date. The consensus of modern opinion is that point electrodes such as employed by Andreoli and others have disadvantages, first, because they quickly lose their pointed character and round off, or, second, because a minute particle of dust can do a great amount of destructive work on a small point, in generating heat and interrupting the flow of electricity. Third, because the necessary cleaning of an infinitely large number of points require too much attention. Leon Gerard, one of the leading electrical engineers of Belgium, states: "The aigrette or point electrodes apparatus has only 55 per cent. efficiency of those where the glow discharge is used." Other types of electrodes are either plates or cylinders on either side of a dielectric material, and these appear in various forms—flat, serrated, gridded or perforated. Another type is the covered electrodes, with no metal exposed, which is very commendable. A fourth is the use of a rotating fan electrode, such as is shown in the Vohr type, which has the advantage of quickly forcing the air through the generating field, and ozonizing it at the same time, thus giving a high purity of product. It is generally regarded as axiomatic that the briefer the period of ozonization the purer the resultant gas, purity meaning practically an absence of oxides of nitrogen, which are principally produced by heat, sparking, or the presence of dirt.

The amount of nitrous oxide generated by any properly made type of air ozonizer, however, is so infinitely small that it can be totally disregarded. This statement, however, does not apply to all ozonizers, as will be later explained.

It may be stated: The more modern machines consume in operation 40–250 watts per hour.

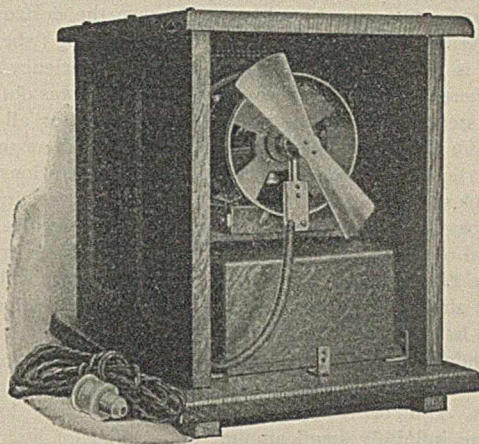
Normal air has as its constituents, according to recent tables, giving volumes per 1,000 and not using the decimals beyond the 4th place:

Nitrogen .....	769.0
Oxygen .....	206.0
Aqueous vapor .....	14.0
Argon .....	9.0
Carbon dioxide .....	0.33
Hydrogen .....	0.19
Ammonia .....	0.008
Ozone .....	0.0015
Nitric acid .....	0.0005

This is for normal air. It does not apply to air where all the ozone has been used up in oxidizing such various substances as the exhalations and emanations from millions of human beings, horses, automobiles, smoke from factories, trains, boats, gases and dust from manufacturing processes, volatile substances from rendering plants, packing houses and decomposing garbage and refuse in the street.

Authorities differ as to the amount of ozone in the air. It has been given all the way from one part in one million by volume up to one part in 20 millions. Perhaps a figure from 1 in 1,000,000 to 1 in 5,000,000 would represent what most have agreed upon as correct for those places where the presence of ozone is easily detected, so that the best constructed ozonizers of later years have been in alignment with, or very little in excess of, the concentration which nature provides in localities remarkable for their invigorating air. German scientists have

stated: "1/10 of a mg. to 1 mg. as the ideal concentration for continuous breathing." The limits as recommended by recent investigators is somewhere between 1/10th of a mg. up to 2 mg. If a density of much over a centigram is used, another factor must be relied upon to dilute the ozone to a point where it is agreeable to breathe, that is, the rest of the air in the room. This is unscientific, because you are dealing with a factor out-



Vohr ozonizer.

side of your own control, and the air currents of any room differ from those of every other. The machine that delivers the ozone with a continuous uniform concentration and with a controllable yield is built along sane, scientific lines.

*Properties of Ozone.*—Ozone can be condensed to a liquid state of a bluish color, with a specific gravity of 1.46. In this state it boils at about 120° C. Its density is 1<sup>6</sup>/<sub>10</sub> as compared with oxygen, and 1<sup>66</sup>/<sub>100</sub> as compared to ordinary atmosphere. It is slightly soluble in water and more soluble in certain oils. It reverts to oxygen at 270° C. It is unstable and rapidly disintegrates on standing. The loosely attached third atom is constantly tending to fly off and combine with other atoms, as it has a remarkable affinity for all carbon or compounds of carbon, which so far as ventilation is concerned will be hereafter referred to as organic matter. Its value as an oxidizing agent is due to ease of application and because nothing but oxygen is used in reaction. In the lighter concentrations its odor faintly resembles that of freshly bleached linen and is crisp, refreshing and exhilarating. It can be detected by the nose when present in one part to 10 millions of air. In the higher concentrations its odor is pungent, heavy and disagreeable. Many of the properties of ozone are discussed in the works of Pescheux, Gerard, Le Coux, Warburg, Mendeléef, Berthelot, Ehrlewin and Dr. Fischer of Germany. Heat and humidity are unfavorable conditions for the generation of ozone (see L. Gerard's treatise in the August, 1909, number, of *Société of Belgian Electricians*). For this reason different methods have been employed to keep the electrodes cool. Steynis uses ammonia gas in pipes. Gerard uses oil. Others employ water jackets. The preferable method for air purification is the rapid passage of air by suction pumps or fans, such as are found in the Siemens & Halske later models in Germany, and the Vohr model in the United States. Any type of ozonizer where no mechanical means are provided for forcing the air rapidly past the electrode surface is utterly unreliable. In the first place, the air will remain for too long a period in the heat zone and thus produce an unsafe amount of nitrous oxide. Furthermore, this type of generator is unscientific, as there are no means of obtaining either concentration or yield, since there is no regular air flow to measure by. You must guess at what is being made and how much of it. The amount of ozone generated is in direct proportion to the wattage of discharge per unit of air ozonized. Some element of heat is present in the so-called

"cold" discharge, and this tends to destroy a portion of the ozone generated and also destroys the theoretical accuracy of the above statement. Heat increases as the square of the current of discharge. It is therefore desirable to use a high voltage and low amperage, and it has been found that from 8,000-12,000 volts produce ozone with commendable economy.

Very high concentrations are needed for such purposes as water purification, the bleaching of fabrics, the destroying of disease germs, treating of petroleum oils, cyaniding (where with ozone it is now possible to get 94 per cent. efficiency off the plates where in many instances only 60 per cent. was obtainable before), sterilizing infected rooms, ships, etc. For all of the above from 1 up to 12 grams is required. As high as 30 grams concentration has been obtained. High concentrations necessitate high wattage of electrical discharge per unit of air. Here the air passage must be slow, which of course results in low volume of ozonized air. The converse of course holds true that the more rapid the air flow the higher will be the volume of ozonized air but the lower the density or concentration. For all these large concentrations it is better to dry the air by the use of quicklime or other means, but for ventilating purposes it is not necessary to resort to this in the more recent types of ozonizers. One of the objections to extraordinary humidity is that an infinitely small amount of peroxide of hydrogen is liable to be formed.

*Method of Measuring Ozone.*—The determination of the quantity of ozone generated is frequently obtained by using iodide of potassium solution. The iodine is freed by ozone, is acidified, then titrated by sodium thiosulphite and starch.

*Air Purification.*—Of all known subjects which are intimately connected with our health and working efficiency, the least understood, the least attended to, with the most widely varying opinions in regard to it, is the subject of air purification and the chemistry of the air we breathe. 20 years ago we would have complacently taken any kind of water from any spigot or hydrant without much thought. To-day you don't take that chance because you know it is a chance that may produce harm. We now have spring water in bottles in our offices, or we use boiled or filtered water at home. 20 years ago we took any kind of food in tin cans that was handed us at the grocery store, but to-day the laws of the United States protect us. Pure Food laws have materially cut down the ptomaine poisoning, dysentery, and various complaints arising from diseased or adulterated food. At present, however, although we eat but three times a day and drink water 7 or 8 times, we are breathing continuously both night and day and are thoughtlessly taking into our system any kind of air that we happen to find.

What is the harmful part of bad air? The consensus of modern chemists, physicists and scientists on this subject is absolutely conclusive, it permits of no debate. Experiments have been tried, tests have been made, and the old bugaboo—carbon dioxide—has been effectually exposed. Many persons used to entertain an idea which is rapidly becoming obsolete—that is, that the carbon dioxide in the air is the particular thing that creates the harm. Carbon dioxide is harmful *only* in that it *reduces the oxygen* supply by displacing it. As long as you can get the proper percentage of oxygen in the air that you breathe, the amount of carbon dioxide produced in any chemical laboratory can be present—according to the best scientists of the last ten years—to an amount of 20 times that which many engineers put as a figure destructive to life. Carbon dioxide is not poisonous, but when present in quantities in any air it is a danger sign that impurities exist in that air. But remember that it is a *sign board* and not the danger itself. It is the organic impurities exhaled at the same time as the carbon dioxide that are poisonous, so merely getting rid of carbon dioxide is a good deal like burning up the danger sign to get rid of the danger.

Dr. Ira Remsen, President of the Johns Hopkins University, of Baltimore, has done much to expel this carbon dioxide theory. He states: "Carbon dioxide is given off from the lungs just as it is from the fire. It is a waste product—it is not poisonous any more than water is. If, however, pure carbon dioxide is introduced into air it has been found that as much as 5 per cent. may be present without serious results to those who breathe it. The ill effects of breathing the air of a badly ventilated room occupied by a number of human beings appear to be due for most part to the presence of the small quantities of decomposing organic matters which are given off with the carbon dioxide and other gases. These act as poisons."

In "Air and Life," by Henry de Varigny, M.D., Sc.D., member of the Société de Biologie and Demonstrator of Museum of Natural History of Paris. "The atmosphere of a room may be considered vitiated as soon as it begins to smell close. This is not due to carbonic acid, which is scentless, but to organic impurities from the skin, mouth, etc."

Prof. S. H. Woodbridge, in Connecticut School Document No. 13, 1908: "The most active and dangerous impurity in the air of occupied enclosures is the matter of organic nature, thrown off by the body through its pores. That matter rapidly changes in character, passing through a fermenting and decomposing to a putrescent condition. The longer it is retained within a room the worse its odor becomes and the more morbidic its condition."

Organic impurities come from a variety of sources as has been previously mentioned. In all confined spaces, however, the chief source of air pollution is the organic matter cast off through the pores of the skin and the nose, throat and mouths of the individuals occupying that space. The longer that matter which the body has cast off remains suspended in the air the quicker it deteriorates. When it reaches a putrescent state it is unfit to be rebreathed. This is air sewage, and is just as unfit to take into the system as diseased meat would be unfit for the stomach. What our body has cast off it is safe to assume is unfit for further use. This organic impurity has recently been called "crowd poison," according to Dr. Fischer in "Ozone and Air Purification." He states: "What is known as 'crowd poison' is responsible for many of the bad air diseases. A large amount of decomposition is continually going on upon the surface of the body and in the nose, mouth and throat of every individual, so that large quantities of these 'decomposing products' are thrown out into the air. As these substances are formed more rapidly when there are a number of persons confined to the same space, they have been called 'crowd poison.' Wherever there is decay there is bound to be odor, and the unpleasant smell in confined spaces is due to this 'crowd poison.' 'Crowd poison' because of its odor also produces *shallow respiration* with the decreased oxygen supply which this occasions. It also has an effect upon the cell tissues in retarding proper oxidation. When the body cells are not properly oxidized or do not properly take the oxygen from the hemoglobin (which is that part of the blood which carries the oxygen to the tissues), we have more than enough of this hemoglobin. It is a general law of nature that what cannot be used is destroyed, so that we soon have a reduction in hemoglobin and *anemia* results. With the progress of anemia other disturbances manifest themselves. Without sufficient oxidation the fires of life begin to smolder. Food is not properly digested or assimilated. Mal-nutrition ensues and the weakened body easily falls a prey to any disease. *Prevention is better than cure*, and ozone, by destroying air poisons, does prevent the diseases which follow upon bad air."

So that it would seem that while ventilation is necessary to bring in out-of-door air to replace the oxygen which our breathing uses up, outdoor air alone is absolutely insufficient to purify the indoor air. It never did and never will *destroy* the im-

purities that constitute the danger element. Nature purifies her atmosphere with ozone. Man can purify it only with ozone. In "Atmosphere in Relation to Human Life and Health" F. R. Russell, Member of the Royal Institute of Great Britain, and Fellow of the Sanitary Institute, says: "Ozone is an important constituent of the atmosphere, greatly contributing to its purity and freshness and to the vigor of human life. Its activity is so great and its function so beneficial that its presence in normal quantities is a fair guarantee of the purity of the air and of health conditions. No ozone is found in the streets of large towns, and in most inhabited rooms, near decomposing matter, and in confined spaces generally."

Nothing has been said about ozone as a deodorizer. Its properties are remarkable in this line, and with higher concentrations almost any odor known, excepting the extraordinary perfumery from the pole-cat, can be successfully combated. In an office, factory or home the chief odors to be eliminated come from tobacco smoke, cooking, laundry, sick rooms or any overcrowded spaces.

*Therapeutics.*—It now seems to be regarded as an accepted opinion that colds and kindred diseases come from bad air, chiefly because bad air disturbs that part of the nervous system which regulates the blood circulation, and local blood congestion ensues, bringing with it an interference with certain bodily functions which destroy the bacteria constantly taken into the system. Thus infection occurs, lowering resistance to disease, and we start with colds, which are frequently the forerunner of tonsilitis, bronchitis, pneumonia, and even tuberculosis. Sir Frederick Treves, one of the four leading physicians of Europe, recently stated: "The idea that colds are caused by drafts is absurd. No cold ever had such an origin. Colds are a result not of drafts, but of stuffy rooms."

Undoubtedly ozonized air acts as a preventative of conditions which bring about many of our colds, and it is on the preventative rather than on the curative side that it has a serious claim to your consideration. There is just as much and no more magic in ozone for continuous breathing purposes as there is in pure air. Pure air will help the body to cure itself, and that is all that ozonized air in a concentration proper for breathing will do. There are so-called "doctors' machines," from which the patient is supposed to inhale ozone passed through turpentine oils for a few minutes each day. Nothing will be said about such apparatus except that it stands to reason that you cannot be sent to the Adirondacks, or Martha's Vineyard, or the Rocky Mountains and breathe that air for half an hour, and then be sent back home with any reasonable expectation that half hour's breathing will materially change your state of health. Interrupted administrations of ozone in high concentrations certainly cannot be seriously considered as beneficial as its continued use in more diluted and diffused form.

Dr. Oscar Linder said in a paper read at the Convention of American Institute of Chemical Engineers, June 24, 1910: "It is well known that this matter we have defined as air sewage is a specially attractive ground for bacteria, miasmata, and other animal and plant life of the lowest order, which thrive in cities and congested districts. In such small concentrations as ozone is employed in ventilating, the destruction of this air sewage is probably its beneficial action rather than the direct destruction of bacteria, which has sometimes been accredited to it. It has been proven that ozone, when diluted, to the extent of one part in one million parts of air, cannot act directly as a bactericide, but it is an established fact that even in such dilutions it acts as a deodorizer and destroyer of the food and favorite surroundings of the bacteria, thus depriving them of the conditions favorable to their propagation."

This is confirmed by D. Mendeléeff, in his "Principles of Chemistry, 1905," when he says: "The air of dwellings contains no ozone, the air of fields and forests always contains ozone;

that misamata, etc., are destroyed by ozonizing the atmosphere."

Abroad ozone as an air purifying agent and as a supplement to ventilation has been extensively used in factories, theatres, mines, ships, schools, hospitals, hotels, restaurants, gymnasia, offices, cold-storage houses, libraries and homes. The use of ozone in the purification of air is undoubtedly one of the most valuable of the newer achievements of electrochemistry.

## PLANT AND MACHINERY.

### THE TOOEELE SMELTER.<sup>1</sup>

By C. H. REPATH AND A. G. MCGREGOR.

The Tooele smelter is situated about four miles east of Tooele City, Tooele County, Utah, and by rail is forty-one miles from Salt Lake City. The smelter is connected by its own railroad (the Tooele Valley Railway) with the San Pedro, Los Angeles & Salt Lake railroad, the junction being about seven miles from the smelter site. The smelter is located upon a hillside, which makes it possible, to a large extent, for the level of delivery of the product of one building to be the level of charge floor of the next succeeding one.

*The Ores.*—The ores treated come principally from the mines of the Utah Consolidated Mining Company in Bingham Canyon. These mines in Bingham Canyon are connected with the smelter by an aerial tramway, four miles long, having a capacity of 125 tons per hour. Custom ores from other mines are received over the San Pedro railroad and the Tooele Valley Railroad.

*Receiving Bins.*—The receiving bins are constructed of steel and are fire-proof throughout. The receiving bins have a capacity of 10,000 tons of ore and coal. The bins are so located and arranged that they may be served either by the 50-ton electric larry cars, which deliver the ore from the tramway terminal, or by standard railroad cars.

*Sampling Mill and Crushing Plant.*—This building is of steel and concrete throughout. It is 40 ft. x 84 ft. in plan, and is five stories high. The mill is composed of two sections, and each section has a crushing and sampling department. The ore from the receiving bins is automatically fed upon belt conveyors which convey it to shaking grizzlies that discharge the coarse ore into the crushers. The ore from the crushers is elevated to the top of the building by bucket elevators. In the sampling department the ore is cut four times by Brunton automatic samplers, cutting one-fifth of the amount each time and discarding four-fifths, so that of each ton of ore crushed a sample weighing 3.2 pounds is obtained.

The sampling department of each section of the mill contains, besides a 12" x 24" Blake crusher, which is common to the crushing and sampling department:

- 1 O-A sampler.
- 1 20" x 10" crusher.
- 1 1-A sampler.
- 1 48" x 12" rolls.
- 1 2-A sampler.
- 1 26" x 15" rolls.
- 1 4-A sampler.

The discard from the sampling machines drops into screens of the crushing department, from which it is conveyed to the roaster bins. The final sample is quartered by a quartering shovel, the resulting sample is then dried on a steam drier, ground in an Englehardt sample grinder, and again ground in a Braun pulverizer, so as to pass through a 100-mesh sieve. The 100-mesh product is put up in three sample packages, one of which goes to the smelter laboratory for analysis, one to the

<sup>1</sup> Paper presented to the Utah Society of Engineers by C. H. Repath, Superintendent Construction and A. G. McGregor, Electrical and Mechanical Engineer, Sept. 16, 1910.

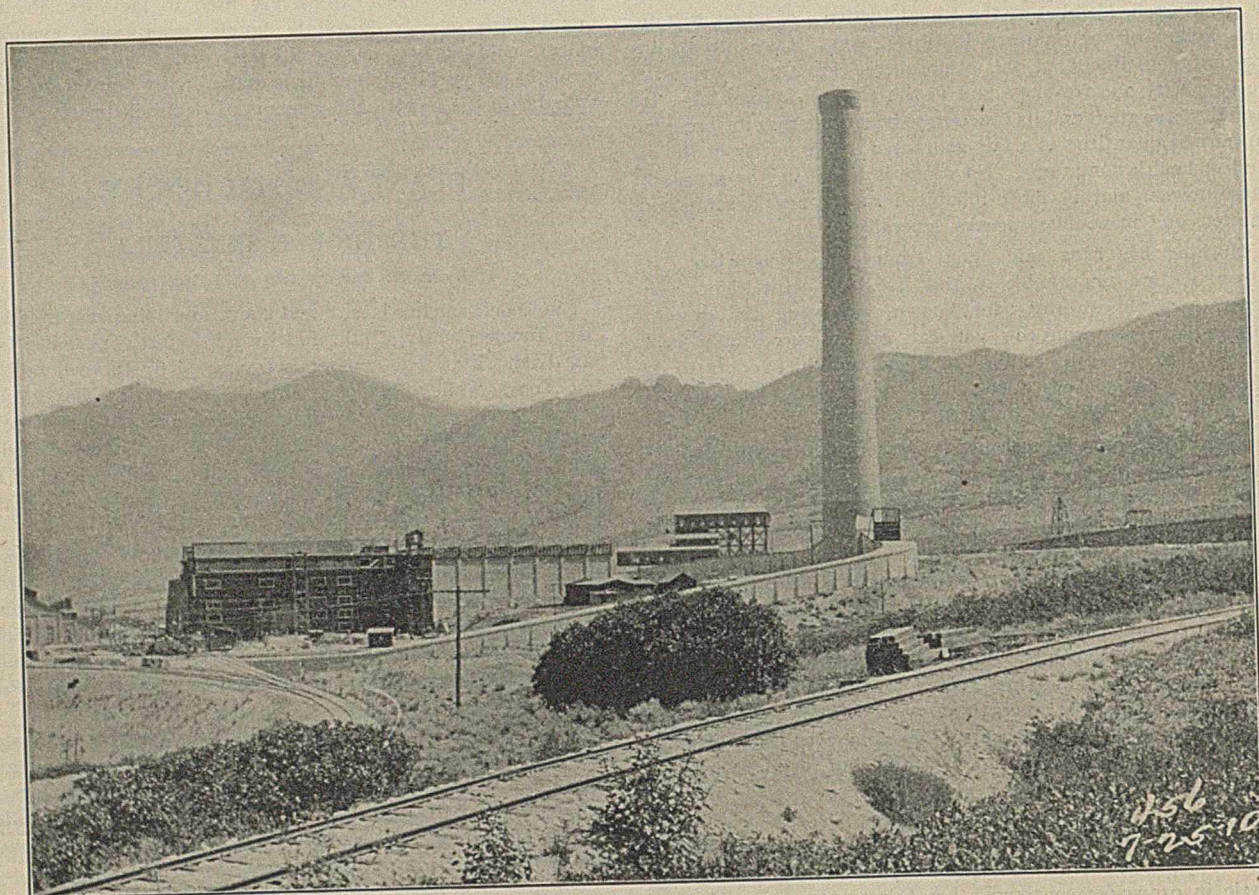


Fig. 1.—General view of plant.

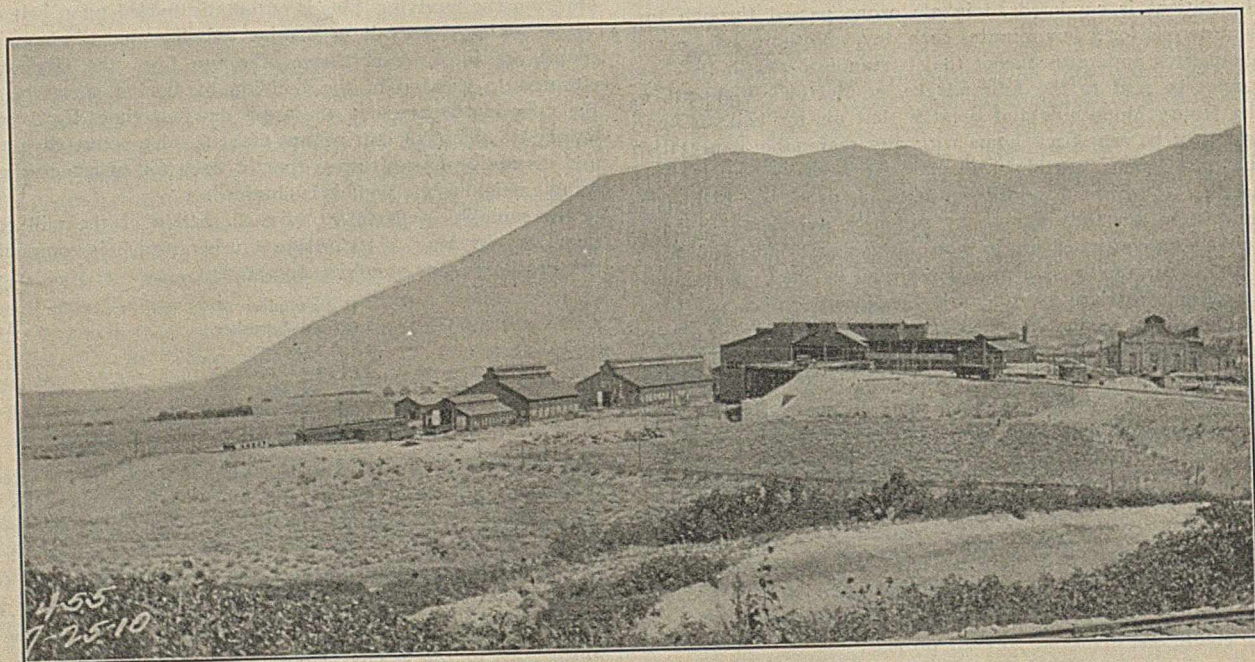


Fig. 2.—General view of plant.



owner of the ore, and one is filed away for use in case of a dispute.

The crushing department of each section of the mill contains:

- 1 12" x 24" Blake crusher.
- 2 15" x 9" crushers.
- 2 48" x 14" screens.
- 2 48" x 12" rolls.

From the crushing plant the crushed and sampled ore is conveyed by belt conveyors to the McDougal roaster steel receiving bins, which have a capacity of 5,700 tons. If it is desired, the coarse ore, after being sampled, may be conveyed to the blast furnace steel receiving bins, which have a capacity of 3,500 tons.

A blast furnace has not yet been installed, but provision has been made for it.

**Roaster Plant.**—From the roaster ore bins the ore is automatically fed upon a conveyor system which conveys it up to and discharges it directly into the McDougal furnace charge hoppers. The ore in transit from the bins to the roaster plant passes over a Blake-Denison automatic and continuous weighing and recording machine, which accurately weighs all the ore delivered to the roaster plant.

The roaster plant consists of two buildings, each 64 ft. x 162 ft. Each building contains sixteen McDougal calcining furnaces, of the Evans-Klepetko type. These furnaces have

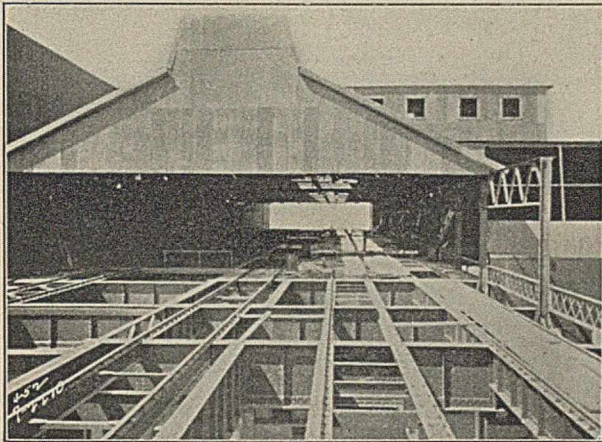


Fig. 3.—Reverberatory charge tracks.

six hearths 16 ft. in diameter and are 18 ft. high. They have revolving water-cooled shafts and arms, driven by a suitable gearing from the bottom. The rabblers are so set as to move the material from the circumference to center and *vice versa* on alternate hearths, until it finally drops into the calcine hoppers, immediately over the tracks of the electric tramping system, for transportation to the charge floor of the reverberatory building. No fuel is used other than the sulphur in the crushed ore, the burning of which furnishes sufficient heat to do the calcining. The gases are taken through flues into the large brick and steel dust chamber, which is 120 ft. x 140 ft. x 40 ft. high. This dust chamber is so arranged that the bottom forms a series of hoppers. The entire content of the dust chamber can be drawn into flue dust cars of the electric tramping system, and conveyed directly to the reverberatory furnaces for smelting. Each of the thirty-two McDougal furnaces has an approximate capacity of 45 tons in twenty-four hours.

**Reverberatory Plant.**—The reverberatory plant consists of three buildings joined together: the reverberatory charge building, containing the ore and coal hoppers over the furnaces 66 ft. x 280 ft.; the reverberatory furnace building, covering the larger portion of the furnaces, 82 ft. x 280 ft.; and the boiler house, 36 ft. x 326 ft. The latter at the present time contains four 746-horse power waste heat boilers and three 300-horse

power hand-fired boilers. The boilers are all of the Stirling water-tube type. The reverberatory plant contains five coal-fired reverberatory furnaces, the hearth dimensions of which are 19 ft. in width by 102 ft. in length, with a grate area of 7 ft. x 16 ft. These furnaces have a maximum capacity of 300 tons of calcine in twenty-four hours, on natural draft. The fuel

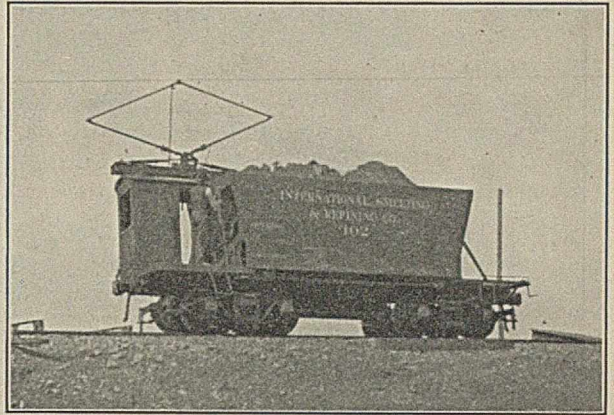


Fig. 4.—Ore car.

used is Diamondville coal, shipped from the mines in Wyoming owned by the Washoe Copper Company. The coal is dumped from large railway coal cars, or from cars of the electric tramping system, into hoppers that have five points of discharge, directly over the fire-box. The flame after leaving the furnace passes through a 746-horse power Stirling boiler, which reduces the temperature of the gases going to the main flue to about 600° F. By this means approximately 600 boiler horse power are obtained from each furnace from the waste heat. The ashes from the furnace fire-box fall into hopper cars of the electric tramping system, and are hauled away to the ash dump. The slag is skimmed from the reverberatories twice in eight hours. It is allowed to accumulate until its depth is from three to four inches above the skimming plate in the front of the furnaces, and then skimmed into slag cars having a capacity of 225 cubic feet, which are hauled to the slag dump over the electric tramping system. The matte is tapped from the side of

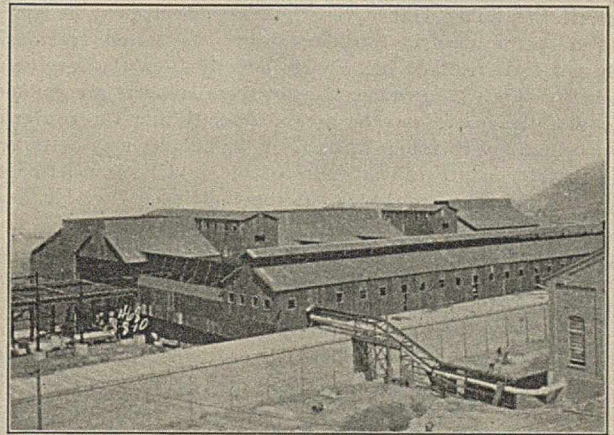


Fig. 5.—Main building.

the furnaces through a copper tap hole plate, and run through cast-iron launders directly into the converter building.

One of the waste-heat boilers referred to above has been equipped with a superheater. The superheater is just at the rear of the boiler. In case it proves satisfactory the other waste-heat boilers can each be equipped with one.

*Converter Plant.*—The main converter aisle of this plant is 65 ft. x 408 ft.; and the casting shed is 52 ft. x 255 ft. The main converter aisle contains five converter stands for 96" x 150" converters, and the converter lining department. The

ing plant. The product of the pug mill drops directly into a bin over the electric tramping system, from which it is transported in cars to the converter lining plant. The lining plant at the converter contains a 7-ft. grinding and mixing pan.

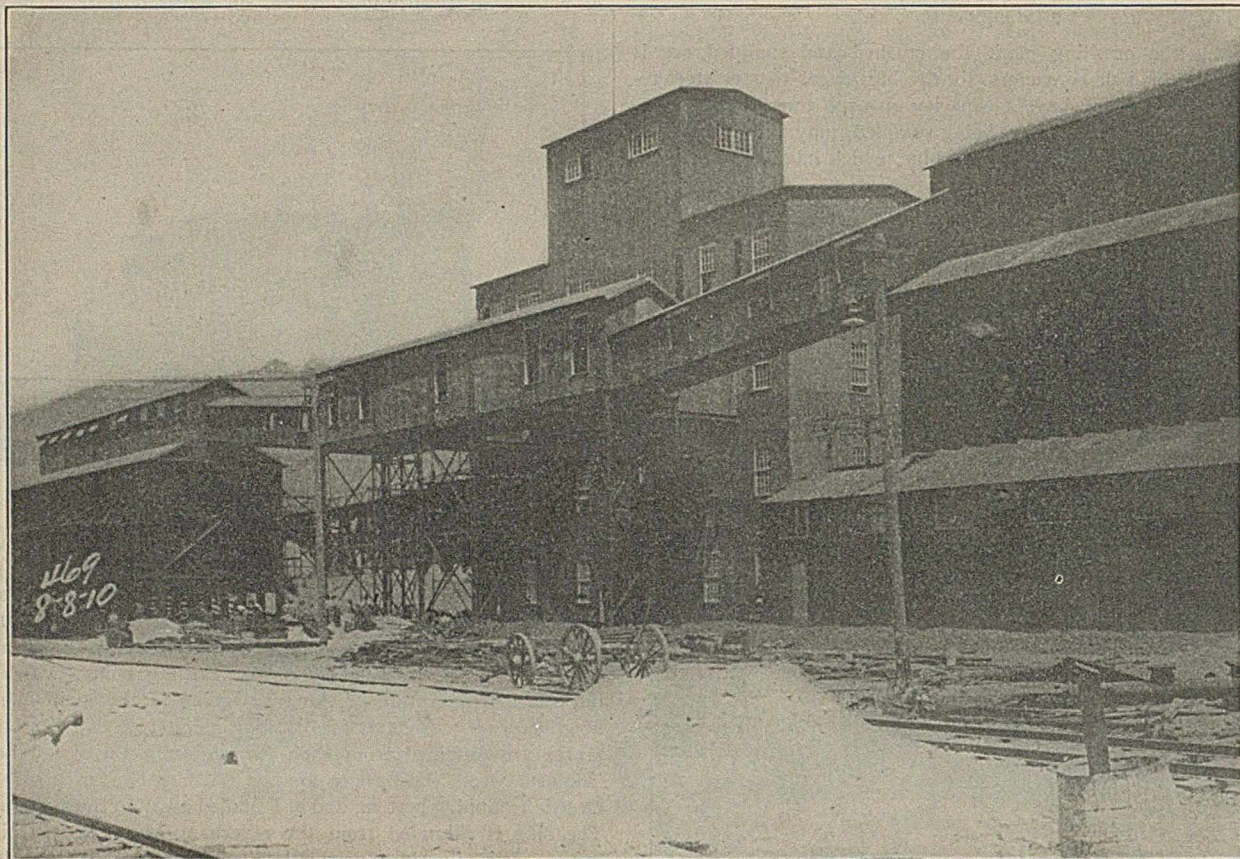


Fig. 6.—Blast furnace bins at left. Sampling and crushing plant in centre. Roaster ore bins at right.

converters used are of the horizontal barrel type, and are 96 inches in diameter x 150 inches in length. The converters are electrically operated. The main aisle is served by one 60-ton electric traveling crane. The casting department is served by a 30-ton electric traveling crane. As stated previously the matte is received in launders directly from the reverberatory furnaces. The end sections of these launders are pivoted, so that the matte may be poured directly into the converter opposite a reverberatory furnace, or the launder may be turned so that the matte will fall into a ladle, and be transferred to any of the other converters in the building. The slag from the converters is poured into unlined cast steel ladles, and transferred to the reverberatory furnaces by means of overhead cranes. There are two of these cranes, of 12.5-ton capacity each. The blister copper is poured into a ladle and transferred by the crane and transfer car to the casting department. In the casting department the ladle is handled by a crane and its contents emptied into anode moulds, which completes the operation of producing pig copper. The pig copper contains 99 per cent. copper and the gold and silver. It is shipped East, where it is further refined and the gold and silver extracted.

*Converter Lining.*—The converters are lined in the main converter building, but the lining material is prepared in a building 24 ft. x 40 ft., adjacent to the ore-crushing plant and receiving bins. The lining material contains a high percentage of silica, having gold and silver values. The material is crushed by the crushers in the crushing plant, and conveyed to a 7-ft. dry pan and pug mill, in the clay and silica mixing and grind-

ing plant. From the grinding pan the material is transferred to the converter, where it is tamped around a cast-iron form by a special Ingersoll-Sargent tamping machine, 5 inches diameter 20-inch stroke. The tamping machine is supported by a re-

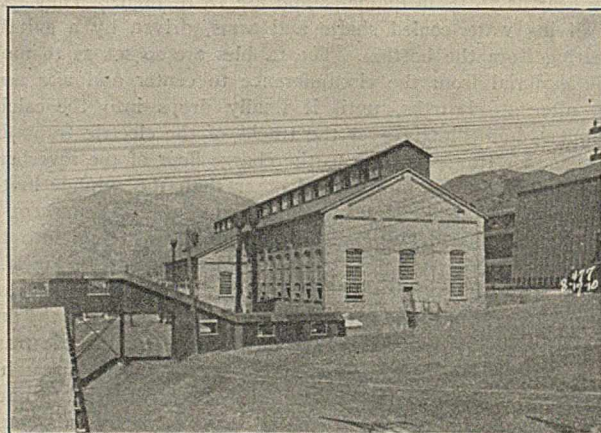


Fig. 7.—Power plant.

volving jib crane, the vertical motion of which is controlled by an electric hoist. After lining, the converter is removed to its stand, where it is dried.

*Smelter Power Plant.*—The smelter power plant building is of brick and steel, the main aisle of which is 52 ft. x 240 ft.

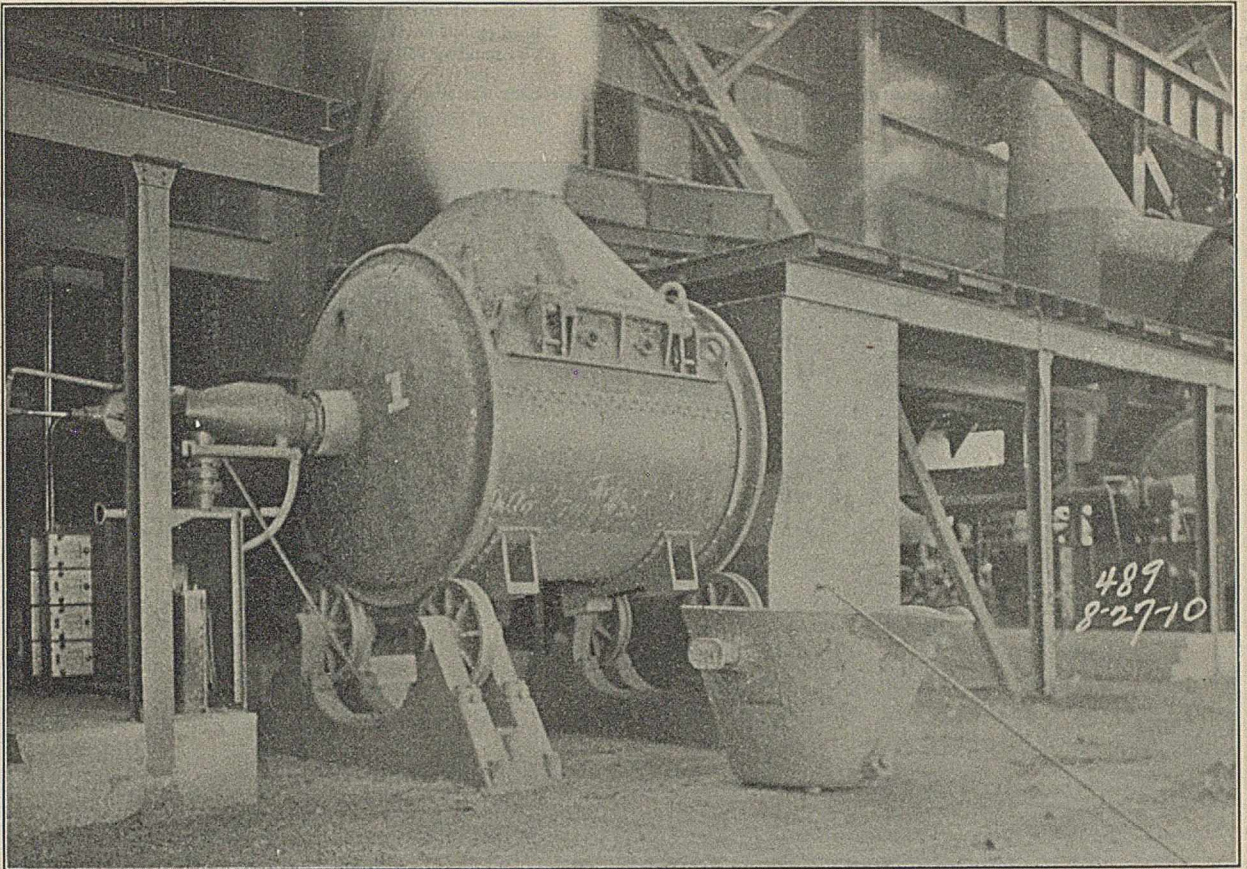


Fig. 8.—Blowing converter.

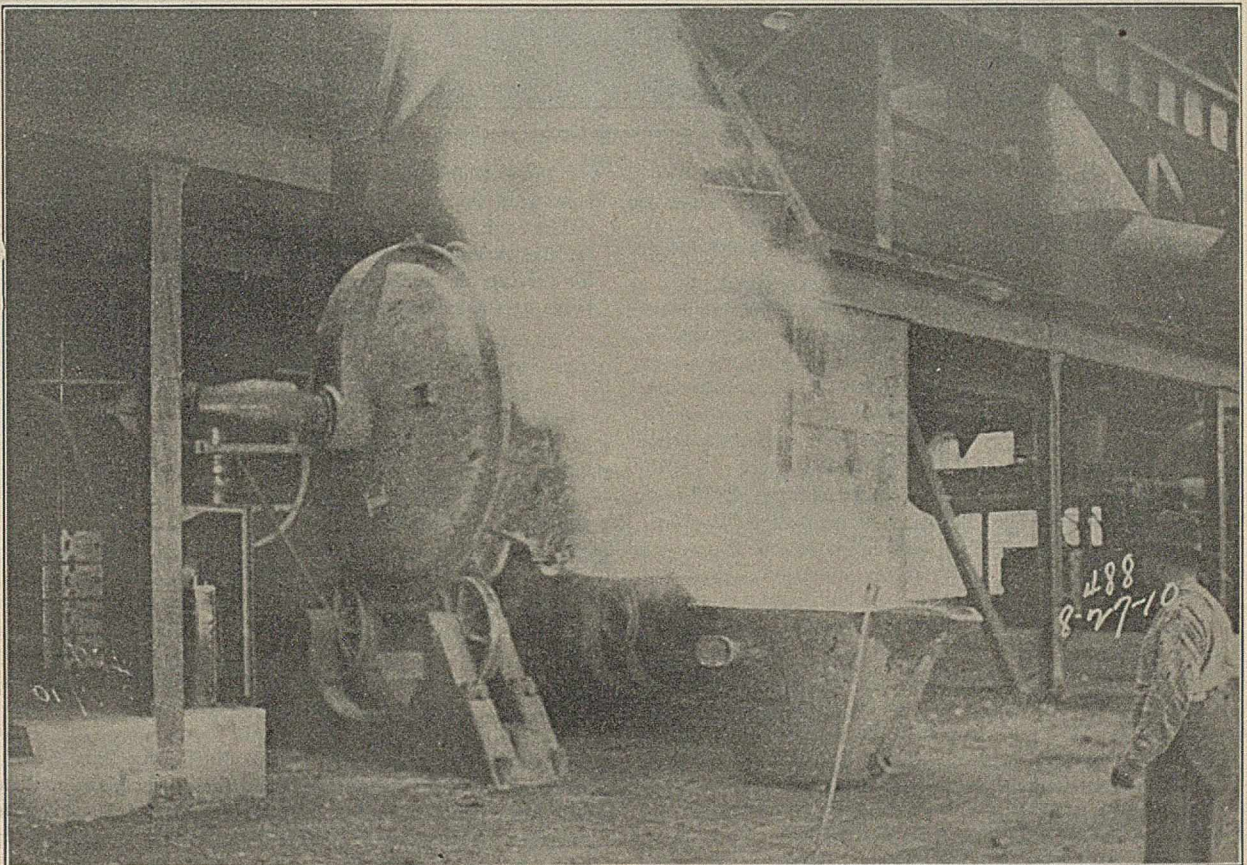


Fig. 9.—Skimming first converter at plant.

It has a lean-to 30 ft. x 90 ft. for the steam auxiliaries, and one on the other side 30 ft. x 60 ft. for the switchboard and transformer. The building contains the various power engines, blowing engines, compressors, and auxiliaries, and is equipped with an overhead electric traveling crane.

- 1 Engine-driven 50 kw. exciter generator.
- 2 Feed pumps having a total capacity of 678 gallons per minute.
- 1 Fire pump of 750 gallons per minute.

Besides the above, the plant contains the necessary condensers, vacuum pumps, feed-water heaters, traps, etc. The steam

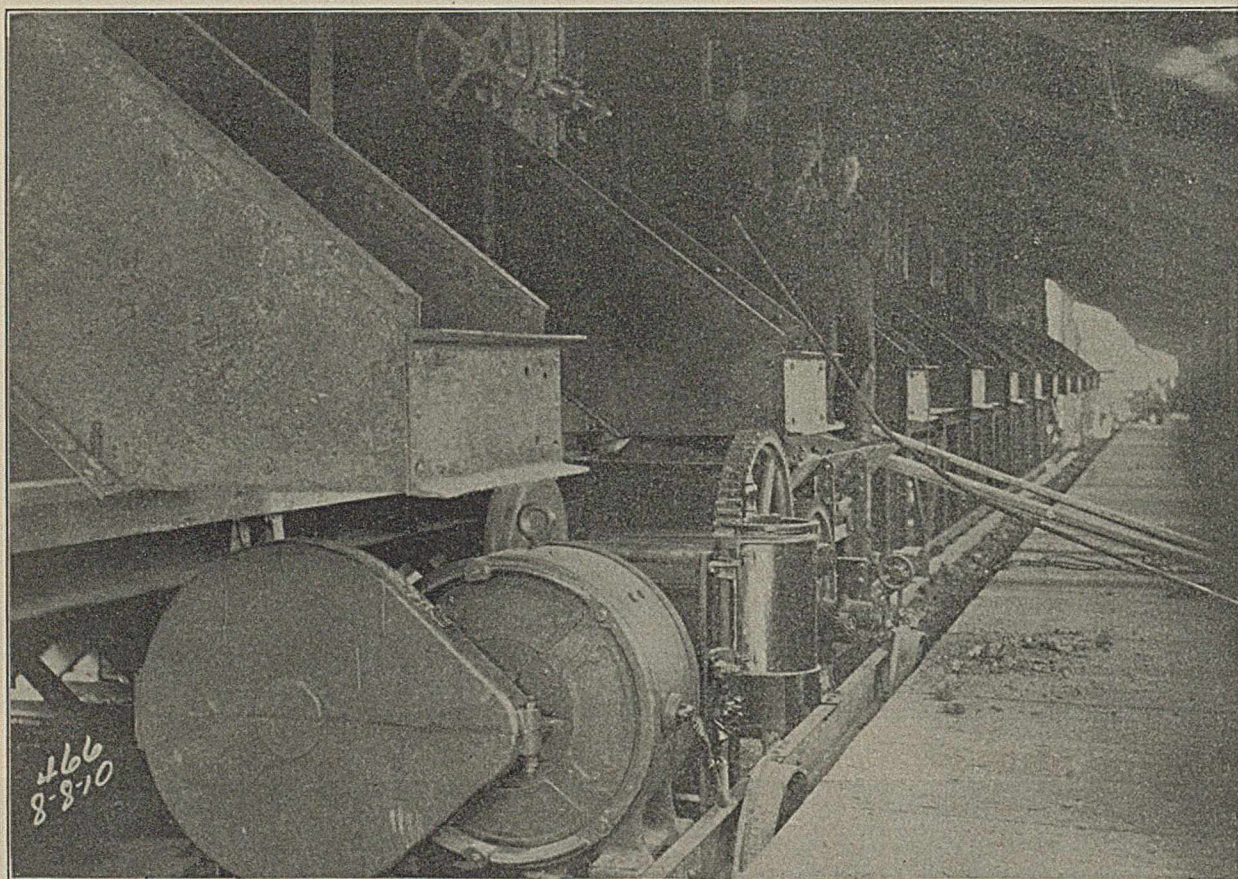


Fig. 10.—Conveyor feeding machine.

The building contains:

- 1 16" x 32" x 36" Corliss engine direct connected to a 250 kw. 500 volt D.C. generator.
- 1 15" x 30" x 36" Corliss engine direct connected to a 250 kw. 500 volt D.C. generator.
- 2 18" x 26" and 40" x 24" vertical triple expansion engines, each direct connected to one 750 K.V.A. 2200-volt generator.

for these engines is furnished by the waste-heat boilers and hand-fired boilers adjacent to the reverberatory building.

The engine-driven generators, in addition to furnishing power for the various motors about the plant, will also furnish power for driving air compressors and for hoisting and pumping purposes at the mines of the Utah Consolidated Mining Co.

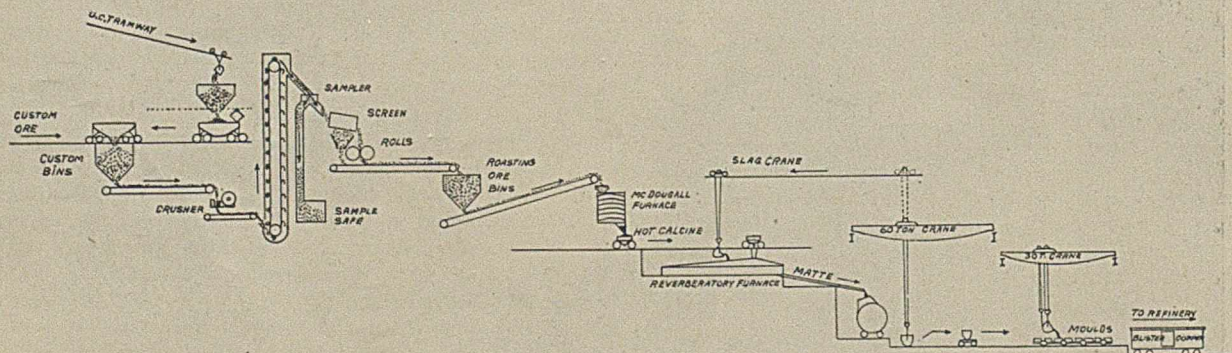


Fig. 11.—Diagram showing flow of material through Tooele plant.

- 1 15" x 30" x 36" x 42" blowing engine.
- 1 26" x 52" x 52" x 48" blowing engine.
- 1 13.5" x 26" x 26" x 15" x 36" steam-driven air compressor.
- 1 26.25" x 15.25" x 18" motor-driven air compressor.
- 1 200 kw. motor-driven D.C. generator.
- 1 50 kw. motor-driven exciter generator.

A cooling tower of the natural draft type has been constructed for cooling the water from the power plant condensers, and for cooling the cooling water for the McDougal roasting furnaces. The tower is 49 feet high, and at the base is 20 ft. wide by 140 ft. in length.

*Electric Trammig System.*—The equipment of the electric trammig system consists of:

3 7.5-ton and 2 18-ton electric locomotives.

50 cars of various kinds for handling ore, coal, calcine, flue dust, ashes and slag.

There are about ten miles of industrial tracks in the plant.

*Flues and Stack.*—The main flue which conveys the gases from the reverberatory furnaces and converters is 20 ft. wide by 18 ft. high and 1360 ft. long. One section of the converter flue is 8 ft. wide by 12 ft. deep, and 248 ft. long; the other section has a cross-sectional area of 132 ft., and is 181 ft. long. Both sections are provided with hopper bottoms and chutes for removing the flue dust. The roasting plant flue is 16 ft. x 16 ft. and is 255 ft. in length. The main and roasting plant flues are rectangular in section and of brick and I-beam construction, while the converter flues are constructed entirely of steel.

The stack is 25 ft. inside diameter at the top by 350 ft. in height above the base.

*Offices, Shops, Etc.*—The offices and shops are located in steel frame buildings, the outsides of which are sheathed and covered with corrugated iron. The office rooms are lathed with expanded metal and plastered on the inside. The main building is 74 ft. x 348 ft. and at one end are located the offices; at the other end of the building the machine, carpenter and electrical shops are located. Between the shops and office end of the building are located the warehouse, change rooms and laboratory. The blacksmith shop and boiler shop is located 180 ft. away from the machine shop. It measures in plan 74 ft. x 117 ft. Adjacent to the blacksmith and boiler shops is located the locomotive shed, which is 42 ft. x 89 ft. The locomotive shed houses the locomotives and spare electric trammig equipment.

*Water System.*—The water for various purposes in the smelting plant is obtained from Pine Canyon. The water is conveyed by gravity from a dam in the canyon through a 12" pipe, approximately 5,000 ft., to a standpipe of 50,000 gallons capacity at the plant. The water is distributed from the standpipe to the various departments.

Two tanks having a capacity of 43,900 gallons each are located at an elevation such that ample pressure is afforded for fire purposes at any part of the plant. Water is pumped into these tanks from the general water supply by the fire pump at the power plant.

## NOTES AND CORRESPONDENCE.

### *Editor Journal of Industrial and Engineering Chemistry:*

In the October number of THIS JOURNAL, page 426, I note comments made by Mr. Fred C. Weld regarding "Accuracy in Sampling," referring particularly to the paper written by me some time ago.<sup>1</sup> I believe that more benefit would be derived to the readers of the Journal if there was more discussion upon subjects of interest and commercial value, especially one which is so important as that of securing representative samples of coal. However, as Mr. Weld's article takes the tone of criticism, rather than discussion, I think a little explanation will assist straightening out the points in question.

Mr. Weld's criticism appears to cover four points, as follows: first, error in calculations made from United States Geological Survey data; second, the application of the law of probability to errors in sampling coal; third, insufficiency of 1300 experiments; fourth, coinage of new words.

With reference to the data from Professional Paper No. 48, United States Geological Survey, which was used in my original paper, I merely averaged the percentage of ash in the various samples taken from the car, as well as from the producer, steam, and coking plants, giving each an equal weight, and stated that

<sup>1</sup> THIS JOURNAL, 1, 161.

this method was not absolutely correct. Mr. Weld has attempted to recalculate these results, multiplying the weight of coal used on the various tests by the percentage of ash determined from a sample of it, but he has encountered the same difficulty which I did originally, due to the fact that the entire amount of each car was not tested or resampled at the various plants. The method which I pursued, however, gave the Survey figures the benefit of the doubt, and did not show errors of as large a degree as do those determined by Mr. Weld with his method. In the case of the Iowa coal which Mr. Weld cited, he averages the three quantities delivered to the different plants according to their weight, and gets 16.17 per cent. ash. This is then averaged with the car sample, which was taken from the entire car as it was being unloaded, giving a final average of 15.69 per cent. He states that the error due to sampling was 0.47 per cent. In order to arrive at this conclusion, Mr. Weld assumes that each of the three samples taken at the steam, producer, and coking plants absolutely represented the coal which was delivered to each place, and that all error in sampling existed in the sample taken from the car as it was being unloaded. While there may have been some variation in the true quality of coal delivered to the various plants from the same car, there was unquestionably no such difference as is shown by the variation in these analyses, nor is it probable that the accuracy of these samples varies directly as the quantity of coal sampled. The fact that many of the plant samples did not exceed 100 pounds as originally taken is very strong evidence that errors of considerable magnitude were encountered through the smallness of these samples, and this is the point which I attempted to bring out in my original paper. I also referred to the sample taken from the cars as they were being unloaded under the supervision of Professor Lord as being by far more accurate than those taken at the different plants, while Mr. Weld's argument is to the contrary. It is certainly much more reasonable to assume that all of these samples were somewhat in error, and the lesser variation between the car samples and the average, as commented upon in my original paper and borne out by Mr. Weld's figures, where he states that the maximum error is only 1.16 per cent. However, if he had determined the errors from the individual plant samples as compared with the average obtained by his method, he would have found these errors to have been greater than they were by my original calculation. His average of the Iowa coal is 15.69, and the highest ash obtained from this was 20.70, an error of 5.01 per cent. The average obtained by my method was 16.60, and the error was only 4.10 per cent.

My criticism of the government work was not of the car samples, but of the plant samples, where only 100 pound original samples were taken. There is no question but that after this coal had been unloaded, crushed, conveyed, and delivered to the various plants, that the quantities delivered to the different plants were much more uniform in quality than is shown by the various analyses reported.

The application of the law of probability is recognized to apply only to errors which occur according to the law of chance, and does not apply to mistakes, personal or otherwise. The magnitude of the errors has little to do with the application of this law, even though Mr. Weld cites authorities to the contrary. However, he has not stated what kind of errors they referred to. They undoubtedly had in mind the application of the law of probability to the readings of instruments of precision, where any reading deviating far from the average is usually a mistake and not an error. Mr. Weld objects to applying this law to results of analyses which showed errors of 4.36 per cent. in ash in a coal which had an average of 11.50 per cent. ash, or which amounted to about 40 per cent. of the ash itself. Let us assume that a series of determinations were made in like manner from a sample of pure carbon which contained one piece of pure ash. Dividing this by the riffle sampler,

or any other method, it is obvious that the final quarter would or would not contain this one piece of ash. If this experiment were repeated several times, using different similar quantities with but one piece of ash, it is very evident that by the law of chance some would contain ash, others would be pure carbon. The variation upon the basis which Mr. Weld gives would be 100 per cent., yet it is perfectly evident that the law of probability would apply to this case equally as well as it does to the tossing of a coin or the dealing of poker hands. Upon Mr. Weld's basis of figuring the comparative magnitude of errors, the tossing of a coin embodies an error of 100 per cent., for it must either be heads or tails. There is unquestionably a misconception of the application of the law of probability in regard to the size of the errors; however, the law of probability applies to all cases where variations follow the law of chance, and are therefore classed as errors. The misconception of it not applying to large errors is due to a failure to distinguish between errors and mistakes.

In regard to the third question, as to the inadequacy of 1300 experiments, I would like to know of what value any one sample of any material must be, if the results of 1300 experiments are so worthless as Mr. Weld intimates. The question of extreme accuracy has little place in commercial work, and it is the errors of 3 to 5 per cent. in ash which are of ordinary occurrence that I attempted to point out and assist to remedy in commercial sampling.

In regard to the phrase "size-weight-per cent.," I cannot quite agree with Mr. Weld that this expression could be covered by the one word "size." However, this expression could have been conveyed by "percentage of the larger pieces of slate to the total weight of sample before being divided." As this factor was referred to several times in the paper, as well as in the tabulated matter, it was considered advisable to use the shorter expression so as not to encroach upon the readers' time by making a repetition of this sixteen-word expression.

In connection with the last paragraph of Mr. Weld's letter, I beg to refer to the last paragraph of my original paper, which is as follows: "Almost every one who has given any consideration to the sampling of coal or other similar material has said that a large sample should be taken and that it should be broken or crushed fine before the successive quarterings. How large, and how fine, have been left to the judgment of the individual taking the sample, and it is the object of this paper to answer these questions with some degree of accuracy. As this data is of preliminary nature, it is hoped that others will not only verify these results, but add to them, in order that the sampling of coal and other material may be reduced to a more scientific basis." Mr. Porter's paper has borne out this contention in showing the relation between "size-weight-per cent." and accuracy in sampling fertilizer.

Subsequent work along the line of my original paper has absolutely convinced me that mathematics can be properly and advantageously applied to the sampling of any material. The use of mathematics in this connection is of great assistance in determining when it is not necessary to take an exceedingly large sample, as well as to determine when a large sample should be taken.

E. G. BAILEY.

October 19, 1910.

#### REDUCTION OF TIN DROSS IN AN ELECTRIC FURNACE.<sup>1</sup>

Electrical heat was resorted to for the smelting of tin dross because of the fact that the heat could be internally applied to the slag, which is on the bottom of a shaft-type of furnace, thus enabling the dross to be thrown on top of the slag instead of being mixed with it as is done in the old-style furnace. The dross, being on top, comes in contact with the slag only at the

point of reduction. The liberated gases filter through the dross, while any tin oxide which is volatilized is condensed in the colder portion of the dross which, as I have said, is on top of the slag. The globules of tin produced in smelting pass downward through the slag and lose most of the impurities, so very little refining of the resultant product is necessary.

In operation, the top carbon, which is movable, is brought into contact with the lower carbon, which is stationary, and an arc formed. The slag is fed in and melted, and the carbon is raised until the desired amount of slag is added. The dross, mixed with the right percentage of carbon, is added, and the tin tapped from the bottom from time to time. The loss of tin has been kept as low as 0.25 per cent., and the average below 1 per cent. The amount of tin recovered varies largely on account of the varying percentages in the drosses treated. The average is about 2,500 pounds (1,100 kg.) per day.

The plant consists of two furnaces, connected in series, both being 20 inches (50 cm.) in diameter and 80 inches (200 cm.) high inside, two 50 kw. transformers and necessary electrical apparatus. In operation they consume about 44 kw. During the run it is desired to keep the amperage as near constant as possible, the voltage varying. At the start the voltage of each furnace is about 80, but toward the end, as the slag becomes less refractory, due to the combination of the iron and zinc of the dross and the slag, the voltage of each furnace will drop as low as 45-50. This and an analysis of the slag denotes the end of the operation, and the slag must be drawn out and new put in. This is done alternately with each furnace. The furnaces run continuously until time to be relined, which is about every three or four months.

R. S. WILE.

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#### THE MODIFIED LaWALL METHOD FOR THE DETERMINATION OF SODIUM BENZOATE IN CATSUPS.

It became necessary in the course of work at this laboratory to gather some proof of the accuracy of the modified LaWall method for determining sodium benzoate in catsup. Accordingly, steps were taken to check this method with four well known brands of non-preserved catsups to which known quantities of sodium benzoate had been added. These catsups were first examined qualitatively for benzoic acid and sodium benzoate, and were found to be free from them. On account of the difficulty of obtaining sodium benzoate free from water, the preservative was weighed as benzoic acid, converted into sodium benzoate by dissolving in concentrated sodium hydroxide solution and in this condition added to 50 grams of catsup which had been previously weighed out. In order to do away with all possibility of the analyst being influenced by his knowledge of the amount of preservative added, the benzoic acid was weighed by another, and the writer was unaware of the amount added, except from his analyses, until after his results had been introduced as evidence in court.

The following table gives the per cent. of sodium benzoate added as calculated from the benzoic acid used, the per cent. found and the brands of catsup used in the experiment.

No.	Brand.	Per cent. added.	Per cent. found.
1	Columbia.....	0.118	0.118
2	Homelike.....	0.295	0.288
3	Shrewsbury.....	0.177	0.167
4	Beechnut.....	0.236	0.242

These results having proved conclusively the accuracy of the method when chemically pure preservatives were used, it next became necessary to determine its accuracy when commercial benzoate was employed. The writer in conjunction with a catsup manufacturer then made an experimental batch

<sup>1</sup> Read before the Chicago meeting of the American Electrochemical Society, October 13-15, 1910.

of catsup containing 0.1124 per cent. commercial sodium benzoate. This catsup when analyzed showed only 0.095 per cent. of the salt, and as this was obviously too low, the purity of the benzoate used was determined by dissolving 200 milligrams of the salt in 100 cc. of water, acidifying 50 cc. of this and extracting with four portions of chloroform, as is done in the actual method. This extracted solution was found by analysis to contain 86.4 milligrams of absolute sodium benzoate, and the commercial salt was therefore only 86.4 per cent. pure. When calculated on this basis of purity, the catsup showed by analysis 0.1099 per cent. sodium benzoate which is 0.0025 or 2.2 per cent. less than the amount added. This loss was undoubtedly due to part of the salt passing off with the steam in the process of boiling.

Still further investigation of the method was made by using the commercial benzoate and proceeding in exactly the same manner as when the chemically pure acid was used. In this experiment also the writer did not know the amount added until after his results were inserted in the court record.

The following table gives the amount of commercial salt added, the actual amount of salt found and the amount of commercial sodium benzoate, calculated as 86.4 per cent., pure, equivalent to the actual amount found.

No.	Brand.	Per cent. commercial salt added.	Per cent. chemically pure salt found.	Per cent. commercial salt found.
1	Columbia....	0.110	0.097	0.112
2	Columbia....	0.217	0.187	0.216

The method used was the modified LaWall and Bradshaw method, which is given as Method II on page 70, of the 1908 Proceedings of the A. O. A. C., and still further modified in this laboratory by the use of 50 grams of the sample instead of 200.

W. D. McABEE.

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### BAKELITE.

With the incorporation of the General Bakelite Company, in New York, and the Bakelite Gesellschaft, m. b. H., in Berlin, an interesting invention enters upon its real commercial career.

We may point to the fact that in our issue of March, 1909, appeared for the first time the original paper which was read by Dr. Baekeland on this subject, before the American Chemical Society. This paper drew so much attention it was copied, translated and abstracted by many scientific and technical periodicals here and abroad.

More than a year has elapsed since, and considerable progress has been made on the practical side of the question. A brief up-to-date description of Bakelite is not out of place. Bakelite is a new substance, which, in its different forms, offers the advantages of hard rubber, Japanese lacquer, celluloid and in many respects excels the properties of these products.

It is not merely a mixture or a so-called "compound" like so many rubber, shellac, or other resinous compositions, but a well-defined chemical substance of specific properties; it thus adds an important member to the industry of plastics.

In the synthesis of Bakelite, we have a more recent instance of a laboratory reaction, which seems to run along lines parallel to those of the delicate physiological changes which occur in plant life; it has some relation to the subtle process which in the Japanese lacquer tree engenders the substance known under the name of Japanese lacquer. Up till now the latter has been a product of limited applications, and an article of luxury, on account of its excessive price, and scant supply. Henceforth a new material has become available which can be manufactured in practically limitless quantities and at a price which allows a wide range of uses.

The laboratory method is an improvement on nature's process, not only because the reaction is quicker and less expensive, but the resulting artificial product is decidedly more resisting to chemical and physical influences.

Dr. L. H. Baekeland, the inventor of this process, has a record of more than a quarter of a century of research in the field of pure and applied chemistry. To those outside of the chemical profession he is more particularly known through his inventive and industrial achievements in the industry of so-called gas-light photographic papers, of which Velox is the best known representative.

He presented the first general account of the synthesis of Bakelite and its industrial applications before the New York Section of the American Chemical Society on February 7, 1909, several years after he had started his investigations, on this subject, and after he had obtained due protection by filing the necessary patents here and abroad.

The word Bakelite was selected as a simpler trade-mark for the longer and less expedient chemical name oxybenzyl-methyleneglycolanhydride.

For the layman it is somewhat startling that in the formation of Bakelite two strong smelling liquid substances (carbolic acid and formaldehyde) should, under certain well-defined conditions, react chemically upon each other and solidify to a transparent amber-like solid substance entirely devoid of odor and taste.

The various uses of Bakelite will be better understood if we mention summarily some of its properties.

The final product, Bakelite C, is infusible and can resist temperatures of 572° F. (300° C.) or over. It is insoluble in all solvents, and can withstand strong chemicals, oil, hot water, steam, etc. All this in conjunction with its dielectric properties make it an excellent electrical insulator. It can be compounded with various filling materials and shaped or molded, with great accuracy to articles of unusual strength. It can be sawed, turned and polished.

It can be used to impregnate wood and other porous bodies, rendering them harder and more resisting to chemical and physical influences. Or it can be obtained as transparent as glass, or colored to suit special requirements.

It can be purchased at a reasonable price, the latter varying with its different qualities.

Although Bakelite is stronger and harder than celluloid or hard rubber, it lacks the unusual flexibility of both these plastics. Rods or plates made of it, or its compositions, are somewhat flexible, but considerably less so than celluloid or hard rubber. On the other hand, it withstands incomparably better, high temperatures and in general all chemical and physical influences, and has the further advantage of not being attacked by solvents nor by most chemicals. It does not emanate sulphur like hard rubber, nor nitrous products like celluloid, which have a very disturbing influence in some electrical applications. If heated in a flame, it does not suddenly catch fire like celluloid nor melt like rubber; it simply chars, then burns with difficulty.

During the act of hardening, which engenders the final product, there is a shrinkage of about two per cent. in diameter, or in length. This shrinkage can be lessened by the judicious incorporation of filling materials, and if the latter be used in large amounts, the decrease in volume can be reduced to such a point as to make it hardly perceptible. Its specific gravity is about 1.25.

The Bakelite process involves the utilization of three distinct and well-defined varieties of Bakelite, designated *Bakelite A*, *Bakelite B* and *Bakelite C*. *Bakelite C* is the final product, whereas *A* and *B* are the transition products, which enable us to mold or otherwise apply the material before its final condition.

*Bakelite A* is the initial raw material and exists in liquid, pasty or solid condition. Every variety of *A*, if heated at a

sufficiently high temperature, changes into *B*, then into *C*. All varieties of *A*, whether they be liquid, pasty or solid, are still soluble in alcohol or acetone or in caustic soda, and behave as true resins.

*Solid A* is characterized by the fact that it is solid at ordinary temperatures, but melts if moderate heat is applied and stronger application of heat makes it infusible and insoluble, by transforming it into *B* or *C*.

*Bakelite B* is an intermediate solid product. It is neither so hard nor strong as *C*, and may be easily mistaken for *Solid A*, but it is different from the latter on account of its insolubility. Furthermore, it is infusible, although the application of heat may temporarily soften it, without, however, bringing it into fusion. Solvents do not dissolve it, but some of them, like phenol or acetone, may soften it or swell it, without bringing it into solution. *B* is specially characterized by the fact that although it is infusible, it will soften under the action of heat and then will mold and weld together if pressed in a hot hydraulic press. The latter fact differentiates it clearly from *C*.

*Bakelite C* is the final product, resulting from the application of heat to *A* or *B*, and may be considered as a chemical polymer of *B* resulting from a multiple molecular grouping. It is no longer a resin, because it lacks all the chemical characteristics of a resin, although physically it may resemble amber. In pure form, and if made from the first member of the phenol group, its chemical formula is represented by  $C_{43}H_{38}O_7$ .

Although the preparatory work connected with the industrial side of the process has been going on with strenuous application since 1907, it was thought advisable not to jeopardize everything by a too hasty, broadcast introduction, before each industrial use had been studied for a sufficiently long time, on a practical commercial scale. This conservative way of proceeding is not always followed by those who are not sufficiently aware of the enormous distance that exists between a laboratory conception and the practical utilization thereof.

In the meantime, Bakelite has been used continuously during the last two years, especially for electrical purposes, while undergoing the test of time and the critical observations of everyday practice under the eyes of specialists. This work has been conducted on a sufficiently large scale to remove all doubts as to the practical side of the question. Thus Bakelite is no longer a laboratory experiment but a product well tried in several industries.

Bakelite technical insulators, as well as pump valves, and other molded goods are now obtainable from several licensees of the General Bakelite Company, and some electrical manufacturers have begun the practical impregnation of coils, dynamos, motors, etc.

The General Bakelite Company will limit more specially their attention to the chemical side of the process manufacturing the raw materials, just far enough that the users thereof can limit their attention to the mechanical side of the problem.

A factory plant is being equipped now at Perth Amboy, N. J., but in the meantime the manufacturing is being carried on in Yonkers. In our November number, 1910, page 478, we have published a list of the United States patents, thus far issued.

An information book on practical uses of Bakelite can be obtained by applying to the General Bakelite Company, 100 William Street, New York, N. Y.

#### THE USE OF IMMISCIBLE SOLVENTS.

There are several methods in use by food chemists, some of them recognized as official by the A. O. A. C., which involve the use of immiscible solvents, as for instance, the modified Hess and Prescott method for determining vanillin in vanilla extracts, and Bigelow's modification of the LaWall and Brad-

shaw method for the estimation of benzoic acid in food products. It is a well-known fact that ether and chloroform which contain water or are in contact with water will take up appreciable amounts of inorganic salts. This has been found to constitute a continual source of error in such determinations.

In the Hess and Prescott method for vanillin the extraction is made with ether from a solution which contains more than 2 per cent. of ammonium chloride. With utmost care in the separation, the residue from the ether solution will still give a strong test for chlorides. Similarly in the method for benzoic acid, where extraction is made from a saturated salt solution with chloroform, considerable quantities of salt will invariably be found in the residue.

The writer has found it necessary in all cases to take up the residue with a little anhydrous ether, and again evaporate, to secure anything like concordant results.

ROE E. REMINGTON.

AGRICULTURAL COLLEGE, NORTH DAKOTA.

#### MAKING SAMPLE ALLOYS.

Those of us who are teaching qualitative analysis frequently find it difficult to obtain any number of different samples of industrial products. This has been, in my case, especially true of alloys of the more modern types such as ferro-chrome, nickel, steel, etc., which it is very desirable for the student to have practice on.

In case of these alloys it has been possible to make them with very little consumption of time. Black thermite (iron oxide and finely ground metallic aluminium) can be readily obtained. This, when placed in a common assay crucible, mixed with the element or elements with which it is wished to alloy the iron, and ignited in the usual way by means of a fuse of magnesium ribbon and an igniting mixture of finely powdered aluminium and sodium peroxide, generates sufficient heat to form a homogeneous button of the alloy desired, in the bottom of the crucible.

If alloys, which do not contain iron, are desired, equally good results can be obtained by making mixtures of the oxides of the required metals in the proper proportions with metallic aluminium and igniting as before. I have found alloys made in this way very satisfactory for qualitative analysis and that it is possible to make them with a very small consumption of time.

R. C. BENNER.

UNIVERSITY OF ARIZONA, TUCSON.

#### LABORATORY METHODS FOR ORGANIC NITROGEN AVAILABILITY.

##### MODIFIED ALKALINE PERMANGANATE METHOD.

As used by C. H. JONES, Vermont Station.

1. *Total Organic Nitrogen Basis*.—Weigh an amount of material equivalent to 50 milligrams *organic nitrogen* into a 600 cc. Kjeldahl distillation flask. Add 20 cc. of water and 100 cc. of alkaline permanganate solution (25 grams pure  $KMnO_4$  and 150 grams  $NaOH$  separately dissolved in water, the solutions cooled, mixed, and made to bulk of one liter). Connect with an upright condenser to which a receiver containing standard acid has been attached. Digest slowly (below distillation point) for 30 minutes. Gradually increase temperature and boil until 95 cc. of distillate are obtained; titrate as usual. Make a correction for any ammonia contained in the sample. During the digestion an occasional gentle rotation is desirable, and if the material shows a tendency to adhere to the sides of the flask during the distillation, the same procedure is advised. The per cent. of nitrogen obtained on the above 5 per cent. basis  $\times 20 =$  per cent. availability.

2. *Water-insoluble Nitrogen Basis*.—Weigh an amount of



material equivalent to 50 milligrams of *water-insoluble organic nitrogen*<sup>1</sup> on to a filter. Wash with successive portions of water until the filtrate amounts to about 250 cc. Dry the residue at a temperature not exceeding 80° C. and transfer same from the filter into a 600 cc. Kjeldahl distillation flask. Add 20 cc. of water and 100 cc. of alkaline permanganate solution and proceed as under 1. No correction is necessary for ammonia.

#### NEUTRAL PERMANGANATE METHOD.

As used by J. P. STREET, Connecticut Station.

Weigh a quantity of the fertilizer, equivalent to 45 mg. of water-insoluble organic nitrogen,<sup>1</sup> on a moistened 11 cm. filter paper, and wash with successive portions of water at room temperature until the filtrates amount to 250 cc. Transfer insoluble residue with 25 cc. of tepid water to a 300 cc. low-form Griffin beaker, and add 100 cc. of 2 per cent. permanganate solution. Digest in a steam or hot-water bath for thirty minutes at the temperature of boiling water, covering the beaker with a watch glass and setting well down into the bath so that the level of the liquid in the beaker is below that of the bath. Stir twice at intervals of ten minutes. At the end of the digestion remove from the bath, add 100 cc. of cold water and filter through a heavy 15 cm. folded filter. Wash with cold water, small quantities at a time, until total filtrate amounts to about 400 cc. Determine nitrogen in residue and filter, correction for the nitrogen of the filter.

#### CHEMICAL INDUSTRY AT BRUSSELS' EXPOSITION.

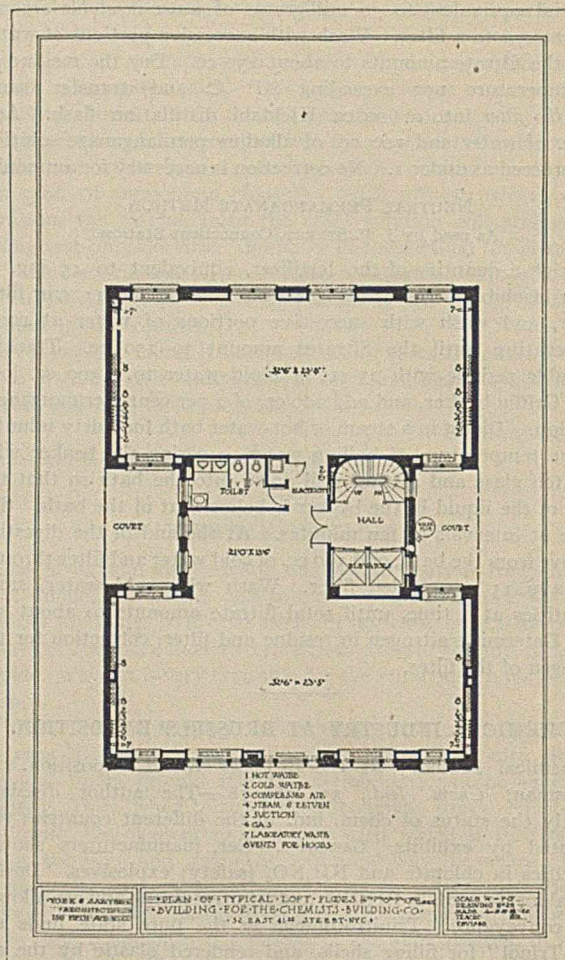
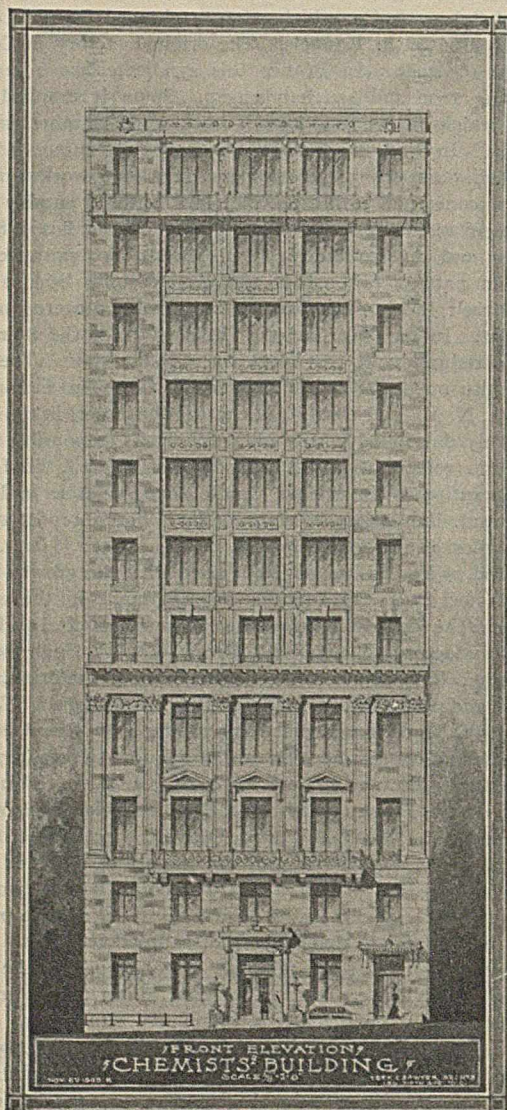
Chemical Industry at the Brussels' World Exposition. H. Grossman, *Chem. Ind.*, 33, 569-78.—The author discusses mostly the status of chem. ind. in the different countries represented by exhibits. *Germany*.—Ger. manufacturers showed novelties in chlorate and  $\text{NH}_4\text{NO}_3$  (safety) explosives. Dorfite and aldorfite contain  $\text{NH}_4\text{NO}_3$  and trinitrotoluene and are allowed rail conveyance. Trinitrotoluene in the pure state finds use as "Trinol" for filling shells, and rendered plastic by the addition of liquid dinitrotoluene and  $\text{Pb}(\text{NO}_3)_2$  finds application as "Triplastit." The perfumery and toilet soap ind. of Ger. is growing in spite of the sharp foreign competition and the domestic preference for French products. In 1907 the No. of workers in this ind. was 5000, and the imports amtd. to \$2,856,000 in 1909, being \$357,000 less than in 1908. A Munich firm exhibited aluminized balloon and aeroplane materials, the advantages claimed being the strong reflection of heat rays and the slight adhesion of atmospheric ppts. At the present time in Ger. there are 70 electric steel furnaces in action which produce 20 million kg. steel yearly. Concerning gas production, within 4 yrs. have been built or are building 507 Dessau ovens with 5414 retorts and with a daily output of about 2.2 million cu. m. gas. A Berlin firm shows "Silvalin," a textile fabric made from wood fiber, esp. adapted for workmen's clothing because of its price (less than cotton). *England*.—The Le-Blanc soda process is used by the United "Alkali" Co. and the author states that it is still in operation in 3 factories in Ger. The International Salt Co. employing the "Teer" process (which consists in removing the impurities of rock salt by fusing in a special app.) obtains 15,000 kg. pure table salt with a consumption of 1,000 kg. coal. Recently a part of the Cl obt. in the electrolysis of alk. chlorides has been converted into compds. of  $\text{C}_2\text{H}_4$  and  $\text{C}_2\text{H}_6$  used as solvents for fats. The Mond-Nickel Co. by the Mond process uses the electric current to produce an almost c. p. Ni from Sudbury ores. Sundry imports for 1907 follow expressed in millions of kg.: tallow, 105.0; palm oil, 60.7; cocoanut oil, 23.8; castor oil, 6.1; palmit oil, 14.7; corn oil, 14.4; olive oil, 12.3. In 1908 were imported 617

million kg. cottonseed as against 750 in 1907. From this was extracted 110 million kg. oil. Since the first of 1909 no less than 400 million kg. of soy beans have been imptd. from Japan, the bean serving not only for its oil but the albuminous resid. as food. The candle ind. consumes about 40 million kg. paraffin, half being from Scotland and half from Amer. The soap exports of Eng. amtd. in 1907 to \$7,085,880. In the past yr. in Scotland nearly 3 billion kg. bituminous shale gave a yield of 309 million l. of raw oil which upon refining gave the following amts. of oils: burning, 100 million l.; power, 18 million l.; gas, 40 million kg.; and 25 million kg. paraffin, with a by-production of 60 million kg.  $(\text{NH}_4)_2\text{SO}_4$ . *France*.—The discovery of large deposits of an excellent calcareous Fe ore in the basin of Briey in French Lorraine is noteworthy. The output of this ore has risen from nothing a few yrs. ago to 1.68 billion kg. in 1909 and now constitutes nearly 60 per cent. of the entire Fr. output. *Belgium*.—Here the chem. ind. is concerned mostly with the working up of sol. products, esp. minerals. The rich coal fields in the south have caused the growth of a considerable tar and  $(\text{NH}_4)_2\text{SO}_4$  production. The latter is obt. by the direct process after a precooling of the hot retort gases. This salt is the only fertilizer used in Belg. Most of the tar products are exported.  $\text{H}_2\text{SO}_4$  is obt. in great amts. as a by-product in the roasting of Zn blende and is partly worked up into superphosphate and  $\text{Na}_2\text{SO}_4$  and partly exported to Ger. In Belg. glass manuf., the chief consumer of  $\text{Na}_2\text{SO}_4$  is of extreme importance. Nine companies belong to the international trust. The central office of Solvay & Co. which controls the soda market of the world is situated in Brussels. The original factory in Couillet employs 430 men. In France this syndicate has 2 factories employing 2100 and 450 hands resp. Spain is supplied by a factory which, inclusive of its salt works and coal mine, employs 600 men. In Eng. the Solvay Co. is heavily interested in a Co. which possesses 5 factories and has 4000 workmen. In Ger. it is concerned with a Co. that in 6 factories employ about 5,000 men and uses over 21,000 H. P. Russia has 3 Solvay factories and Austro-Hungary 5. The S. Co. possesses the European patents of Castner and Kellner and besides mfg. NaOH itself it also has licensed numerous concerns on the continent. In its Belg. factories it has introd. the 8-hr. day with no reduction in pay from the 9½-hr. day. The 8-hr. day is also operative in the English S. Co. The factories in Syracuse, N. Y., and Detroit, Mich., are the largest in the world. The highly developed textile ind. of Belg. is responsible for the great soda consumption. A very successful artif. silk factory is in operation. The stearin candle soap, gelatine and glue, and pharm. industries are noteworthy. For a report on the Belg. explosive and match ind. cf. *C. A.*, 4, 2572. *Italy*.—The extraction of Fe ore has not kept pace with the growth of the Fe and steel ind. Considerable steel is made in the electric furnace. The explosive, cheddite, is mfd. in Italy, France (the home factory), Switzerland, Greece, Tonkin, Eng., Reunion Isle, Belg., Uruguay and Ger. The tanning materials, soap, perfume and pharm. inds. of Italy are highly developed. *Canada*.—In 1907 C. stood in first place as a producer of Ni and asbestos (and latterly Co), in 3d for Cr ore, in 4th for Ag ore, in 7th for Cu, in 8th for Au, and in 10th for coal. Cf. the excellent publication of the *Bureau of Mines*, "Geol. Sketches and Mineral Resources of C.," by G. A. Young, Ottawa, 1910; also cf. *Chem. Ind.*, 33, 402. *Brazil*.—In 1907 the export of Mn ores amtd. to 237 million kg. valued at \$4,500,000. That of monazite sand amtd. to 4,437,000 kg. as \$890,000. Coal and Fe production is in its infancy due to lack of railroad facilities. There are large deposits of these minerals of good quality, the latter showing a high Fe content. The State Mines Geraes in 1909 produced nearly 4,000 kg. Au. Similarly situated as Brazil in respect to their human material and railroad conditions are Uruguay, Nicaragua, Guatemala etc., where the smelting of ores and the winning of valuable drugs have as yet made little

<sup>1</sup> Determined by washing one gram of the material on a 11 cm. filter with water at room temperature, to a volume of about 250 cc. Dry and determine nitrogen in the residue, making a correction for the nitrogen in the filter paper if necessary.

advance although the possibilities exist. *French Colonies.*—A table shows the phosphate output of Tunis and Algiers, its value and the amts. exported for the yrs. 1899-1909 incl. In 1909 the value was \$5,257,513 and the Algerian expt. 333,400,000 kg. The mineral averages 58-68 per cent. Ca phosphate. Despite the crisis in the phosph. market the output of Tunis of 1909 was but little less than that of 1908, and an increase is to be expected next yr. In 1909 there were 44 mining concessions which exported Zn, Pb, Cu, and esp. Fe ore to the value of \$2,211,780. From Algiers were exptd. the folwng. amts. of ores expressed in millions of kg., the output being for 1905-'09 incl.: Fe, about 800; Cu, 4.5; Pb, 19; Zn, 70; Sb (since 1907), 1.5. Sea salt is extr. in Tunis to the amt. of 150 million kg. yearly which is exported. Alpha grass used in the manuf. of paper is a valuable export. New Caledonia specializes in Ni ore production, the output being worked up in France by "Le Nickel." It also produces much Cr. *Congo State.*—This next to Brazil yields the greatest amt. of rubber, 4,650,000 kg. valued at \$8,488,140 being the 1907 output. Of palm oil, palm nuts and copal there were exported in 1908 the folwng. resp. amts. expressed in millions of kg.: 2.1 at \$231,600; 5.6 at \$335,820; and 1.66 at \$345,470. Inland are extended deposits of high per cent. Cu, Pb and Zn.

L. RAY FERGUSON.



CHEMISTS' BUILDING.

The Chemists' Building Company of New York City, organized to promote the interests of Chemical Science and Industry in America, has erected a ten-story fire-proof building, on a lot 56 ft. wide and 100 ft. deep, at 50-54 East 41st Street, New York City.

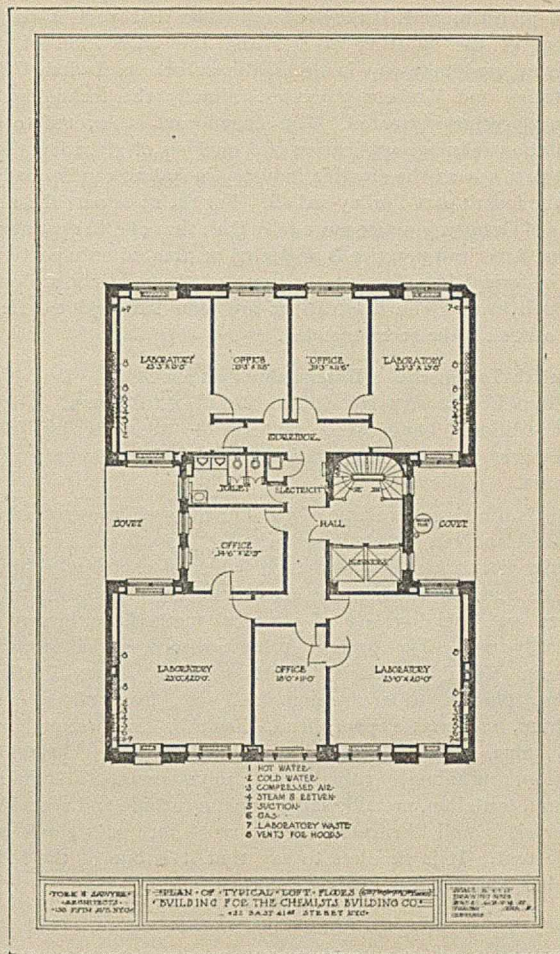
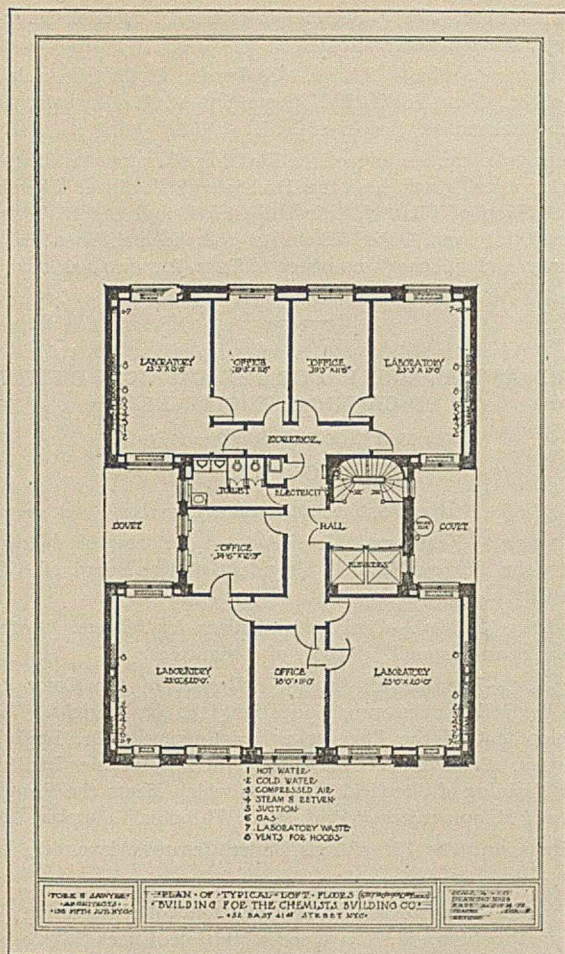
The lower half of the building is leased to the Chemists' Club, and contains all the appurtenances of a social club, together with a large auditorium for scientific meetings and ample space for a complete chemical library and museum.

The five upper stories have been specially constructed for laboratory purposes, and can be rented either as entire floors, or in suitable sub-divisions, to analytical, commercial or research chemists, physicists, electrochemists, bacteriologists, etc.; but not as manufacturing laboratories.

They are provided with ventilating flues, water, gas and electric mains, steam and compressed air lines, in suitable locations; but the tenants are expected to make their own connections and provide their own fixtures.

Rental will include free janitor and elevator service, heat and electricity for lighting purposes, and the Company will construct proper partition walls for the subdivision of the laboratories, according to the tenants' wishes. It is intended to charge low rentals and in many ways facilitates the prosecution of scientific and industrial research.

*Location.*—Close to the Grand Central Station and the 42nd Street Express Station of the Subway, as well as to the prospective termini of the "Steinway" and "McAdoo" terminal systems; a few minutes' walk from the New York Public Library, Engineering Society's Building and Academy of Medicine.



*Advantages within the Building.*—Excellent light and ventilation; construction equal to that of university laboratories; command of a complete chemical library; opportunities for social and scientific intercourse; the natural meeting-place of out-of-town chemists and manufacturers, for whom the Club provides excellent apartments; possibility for reduction of laboratory expenses through coöperative installation of expensive apparatus.

The value of this neighborhood for such purposes has been further indicated by the erection of a large physicians' and dentists' building alongside, and the attention of physicians and pathologists is called to the advantages which the Chemists' Building laboratories could afford them for their own researches.

Until February 1st, communications should be addressed to Dr. Morris Loeb, President, 106 West 55th Street. After that date, his office will be in the Building, 50 East 41st Street.

## BOOK REVIEWS AND NOTICES.

**A Text-Book of Botany and Pharmacognosy.** Intended for the Use of Students of Pharmacy, as a Reference Book for Pharmacists, and as a Hand-Book for Food and Drug Analysts. By HENRY KRAEMER, Ph.D., Ph.B. 888 pages, illustrated, 4th edition, revised and enlarged. Philadelphia: J. B. Lippincott and Co. 1910. Price, \$5.00 net.

This book is well known in schools of pharmacy where for some years it has been recognized as a standard work, while the nature of the book makes it naturally of somewhat limited interest to chemists; it possesses certain features which deserve more than a passing notice in this place.

The work is divided into four parts: Part I, in five chapters, covers the general subject of botany as related to medicinal plants; Part II is concerned with a study of crude drugs as derived from these plants, while Parts III and IV, which are much shorter than the others, deal with reagents and technique and methods of microchemical analysis.

In Part II there is a great deal of information on this subject of plant constituents which will be found very useful to any one interested in the chemistry of drugs and drug analysis. In

view of the many questions coming up under the Food and Drugs Act the data found in this section of the book should be appreciated. Professor Kraemer has devoted much study to the microchemistry of drugs and methods of identification. In Part IV the newer developments in this field are discussed; the opinion is expressed that the petrographical microscope will prove as useful in the study of the crystalline constituents of drugs as it has in other directions. The value of this general method is illustrated by the details of a number of practical examinations on well-known crystals which occur in certain drugs. The method of securing the crystals is explained and enough is presented to make the general plan of identification helpful and suggestive to the drug analyst.

J. H. LONG.

**Handbuch der Chemie und Technologie der Oele und Fette.** In four volumes, Vol. 3, first part. By L. UBBELOHDE AND F. GOLDSCHMIDT and a large number of collaborators. Large 8vo. pp. xx + 380. Leipzig: S. Hirzel, 1910. Price, paper, 12 Marks.

The previous volumes of this large work on the oils and fats have been noticed in these columns. The present volume considers the chemistry, analysis, and technology of the fatty

acids, glycerin, and Turkey-red oil. The first part is on the subject of the splitting of fats and the production of raw glycerine, and takes up in detail the autoclave, Twitchell fermentative and Kretz processes. Finally the technology of crude glycerine is treated. The second part is devoted to the distillation refining, application and analysis of glycerine. The third part covers the stearine industry including candle-making and the fourth part Turkey-red oil. For the most part the work treats of German practice more fully than that of other countries. Recent American practice is neglected or treated only partially. The historical introductions to most of the subjects are good although brief. The illustrations are abundant and excellent. It is a book to be recommended.

**Chemisch-Technische Untersuchungsmethoden.** By DR. GEORG LUNGE AND DR. ERNST BERL AND OTHERS. Vol. 2, 6th edition. Large 8vo. pp. xvi + 869. Berlin: Julius Springer, 1910. Price, paper, 20 Marks. Bound, 22.50 Marks.

This is the second volume of Dr. Lunge's well-known book on technical analysis which has reached the sixth edition. It is the only work which covers the whole field of chemical technical analysis and, considering the great number of subjects to be treated and the diversity of chemical methods, covers it remarkably well. The present volume discusses the following subjects: Cyanides, clays, ceramics, glass, lime, Portland cement, plaster, water, sewage, soil, air, iron, silver, gold, platinum, mercury, copper, lead, bismuth, tin, arsenic, antimony, zinc, cadmium, nickel, cobalt, manganese, chromium, tungsten, uranium, vanadium, molybdenum, aluminium, thorium, tantalum, metallic salts, calcium carbide and acetylene. The work is well illustrated for the most part with small cuts in the text. It is needless to say that it is one of the indispensable books in the analyst's library.

## SCIENTIFIC AND INDUSTRIAL SOCIETIES.

### AMERICAN CHEMICAL SOCIETY.

Winter Meeting, Minneapolis.

The Winter meeting of the American Chemical Society will be held in Minneapolis, December 28-31, 1910. The American Association for the Advancement of Science meets in Minneapolis at the same time. The local committee is hard at work under the leadership of Dr. G. B. Frankforter, and the meeting will probably be one of the largest and most enthusiastic ever held. The officers of the various Divisions and Sections are shown in the following list:

#### Divisions.

**Agricultural and Food Chemists.**—Chairman, H. E. Barnard, Board of Health, Indianapolis, Ind. Secretary, B. C. Curry, Durham, N. H.

**Fertilizer Chemists.**—Chairman, F. B. Carpenter, Richmond, Va. Secretary, J. E. Breckenridge, Carteret, N. J.

**Industrial Chemists and Chemical Engineers.**—Chairman, A. D. Little, 93 Broad St., Boston, Mass. Secretary, F. E. Gallagher, 93 Broad St., Boston, Mass.

**Organic Chemists.**—Chairman, E. C. Franklin, Stanford University, Cal. Secretary, Ralph H. McKee, Orono, Maine.

**Pharmaceutical Chemists.**—Chairman, A. B. Stevens, University of Michigan, Ann Arbor, Mich. Secretary, B. L. Murray, Merck & Co., New York City.

**Physical and Inorganic Chemists.**—Chairman, E. C. Franklin, Stanford University, Cal. Secretary, S. L. Bigelow, Ann Arbor, Mich.

#### Sections.

**Biological Chemists.**—Chairman, to be announced.

**Chemical Education.**—Chairman, H. P. Talbot, Mass. Inst.

Tech., Boston, Mass. Secretary, James F. Norris, Simmons College, Boston, Mass.

**Chemistry of India Rubber.**—Chairman, C. C. Goodrich, 25 Broad St., New York City. Secretary, F. J. Maywald, 1028 Seventy-second St., Brooklyn, N. Y.

Reports of the sessions of the Division of Industrial Chemists and Chemical Engineers, the Division of Fertilizer Chemists, the Division of Pharmaceutical Chemists, and the Division of Agricultural and Food Chemists will be published in the January and February numbers of THIS JOURNAL, as usual.

### THIRD ANNUAL MEETING OF THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.

New York City, December 7 to 10, 1910.

#### PROGRAM.

WEDNESDAY, DECEMBER 7, 1910.

9.30 A.M.—Meeting at Hotel Astor. Address of Welcome, Hon. John Purroy Mitchell, President of the Board of Aldermen, City of New York.

**Business Session.**—Canvass of ballots for officers. Reports of officers and council. Report of committees.

11 A.M.—Reading of Papers: "Report of the Committee on Chemical Engineering Education," F. W. Frerichs. "The Development of the Chemist as an Engineer," Dr. Fred W. Atkinson, President of the Brooklyn Polytechnic Institute. "The Training of Chemical Engineers which Meets the Requirements of Manufacturers," Prof. M. C. Whitaker, Columbia Univ.

Discussion: The Fitzgibbons Boiler, Jerome Alexander.

12.30 P.M.—Luncheon.

1.30 P.M.—Excursions: Marx and Rawolle Glycerine Refinery, Brooklyn, N. Y. Wood's Multiple Effect Still are in operation at this plant.

8.00 P.M.—Meeting at Columbia University. Address of Welcome, Prof. M. T. Bogert. Reply, The President of the Institute. "Manufacture of Hydrated Lime," Richard K. Meade. Address of Retiring President, Chas. F. McKenna, "The Evolution of Portland Cement Processes." Discussion.

THURSDAY, DECEMBER 8, 1910.

9.30 A.M.—Excursions: Chamber Acid Plant of the Standard Oil Company at Bayonne, N. J. This is a very large modern plant, the concentration apparatus being especially interesting. Through the courtesy of the Standard Oil Company the members of the Institute and their guests will be conveyed by a steam lighter to Constable Hook and return. The boat will leave Pier 4, North River, at 9.30 A.M. Luncheon at Hugot's Restaurant, New Brighton, S. I., 75 cents.

2.00 P.M.—Visit to the Borough of Richmond Garbage Destructor at the invitation of the Heenan Destructor Co.

7.00 P.M.—Subscription dinner at Hotel Astor, \$3.00.

FRIDAY, DECEMBER 9, 1910.

9.30 A.M.—Meeting at Hotel Astor. Installation of Officers. Business session.

10.30 A.M.—Reading of Papers: "Manufacture of Lignite Briquettes," Henry S. Renaud. "Bleaching Oils with Fuller's Earth," David Wesson. "Action of Fruit Juices on Metallic Containers," Edward Gudeman.

1.00 P.M.—Excursions: Visit to Candle House of the Pratt Works of the Standard Oil Company at Blissville, L. I.

3.30 P.M.—Visit to Grease Works of the same Company at Blissville, L. I.

8.15 P.M.—Joint meeting with the New York Section of the

American Chemical Society, at Chemists' Club, 108 West 55th St., Prof. Charles Baskerville, Chairman of the Section, presiding. Reading of Papers: "The Principles of Sewage Disposal," Geo. C. Whipple. "Sewage Disposal in Europe," Rudolph Herring. "Sewage Disposal in New York and Vicinity," Dr. Geo. A. Soper. "Sanitary Conditions in Their Relation to Water Supplies in the Vicinity of New York," Nicholas S. Hill, Jr. "The Unsolved Problems of Sewage Disposal," Prof. Chas. E. A. Winslow. Discussion.

SATURDAY, DECEMBER 10, 1910.

Excursions: Inspection of Chemical Museum and Laboratories of Columbia Univ. Inspection of Chemical Building and Laboratories of the College of the City of New York.

Headquarters at Hotel Astor, Times Square. Rates at this hotel, European plan:

- Room without bath, one person..... \$2.50 and up.
- Room without bath, two persons..... \$3.50 and up.
- Room with bath, one person..... \$3.50 and up.
- Room with bath, two persons..... \$4.50 and up.

COMMITTEE OF REVISION OF THE PHARMACOPOEIA OF THE UNITED STATES OF AMERICA.

Sub-Committees, with Chairmen.

- No. 1.—Scope (Admissions and Deletions). S. Salis Cohen, M.D., Philadelphia.
- No. 2.—Therapeutics and Pharmacodynamics. Torald Sollmann, M. D., Cleveland, O.
- No. 3.—Biologic Products and Diagnostic Tests. J. F. Anderson, M.D., Washington, D. C.
- No. 4.—Botany and Pharmacognosy. Henry Kraemer, Ph.D., Philadelphia.
- No. 5.—General and Inorganic Chemistry. Chas. H. LaWall, Philadelphia.
- No. 6.—Organic Chemistry. Geo. D. Rosengarten, Ph.D., Philadelphia.
- No. 7.—Proximate Assays. A. B. Stevens, Ph.D., Ann Arbor, Mich.
- No. 8.—Volatile Oils. H. W. Wiley, Ph.D., Washington.
- No. 9.—Fluid and Solid Extracts, Tinctures. G. M. Beringer, Philadelphia.
- No. 10.—Aromatic Waters, Spirits, Liquors. C. Lewis Diehl, Louisville, Ky.

No. 11.—Syrups and Elixirs. W. C. Alpers, Sc.D., New York.

No. 12.—Cerates and Ointments. Otto Raubenheimer, Brooklyn.

No. 13.—Miscellaneous Galenicals. C. S. N. Hallberg, M.D., Chicago.

No. 14.—Tables, Weights, Measures. A. B. Lyons, M.D., Detroit.

No. 15.—Nomenclature. Chas. Caspari, Baltimore.

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

Twenty-seventh Annual Convention, Washington, November 10-12, 1910.

The program of this meeting has already been published in these columns (see September number). The officers elected for 1910-1911 are:

- President, F. W. Woll, Madison, Wisconsin.
- Vice-Presidents, H. J. Patterson, Maryland.
- Secretary, H. W. Wiley, Washington, D. C.
- Additional Members of the Executive Committee. H. C. Lythgoe, Massachusetts; P. F. Trowbridge, Missouri.

The meeting opened on Thursday morning, November 10th, at the Raleigh, with President W. A. Withers, of Raleigh, N. C., in the chair.

No report was offered by the referee on phosphoric acid, W. F. Hand, of Agricultural College, Mississippi, but a paper on the Wagner method was read by W. L. Whitehouse, of the Coe-Mortimer Company, New York City. Mr. Haskins, of the Massachusetts Station, stated that he would like to see this method adopted by the Association, as he considered it the only one satisfactory for the determination of phosphoric acid in basic slag, and that the state officials were obliged to handle many different brands of this material. No action was taken.

C. H. Jones, of the Vermont Station, referee on nitrogen, presented no recommendation on nitrogen, but gave a short paper dealing with the availability of organic nitrogen by laboratory methods. This paper was presented merely as a suggestion for further work. Fig. 1 shows plotted results.

The report on potash was submitted by E. L. Baker, of the Geneva (New York) Station, and consisted in a continuation of the study of the Drushel's Volumetric Cobalti-Nitrite method in comparison with the official. In addition a gravimetric

TABLE I.—COMPARATIVE RESULTS OF OFFICIAL, VOLUMETRIC AND GRAVIMETRIC COBALTI-NITRITE METHODS.

	Sample No. 1.			Sample No. 2.			Sample No. 3.			No. 3.
	Official method.	Volumetric cobalti-nitrite method.	Gravimetric cobalti-nitrite method.	Official method.	Volumetric cobalti-nitrite method.	Gravimetric cobalti-nitrite method.	Official method.	Volumetric cobalti-nitrite method.	Gravimetric cobalti-nitrite method.	
B. E. Curry, Durham, N. H.....	Ave. 50.70	50.11	51.19	12.45	12.16	12.48	4.64	4.48	5.37	4.71
P. L. McCreary and P. L. Hibbard.....	Ave. 51.68	47.22	50.61	12.73	12.21	12.44	4.68	4.07	4.96	4.48
Cornelius Beatty, College Park, Md.....	Ave. 53.25 <sup>1</sup>	51.43	52.22	12.67	12.65	12.87	4.92 <sup>1</sup>	4.54	5.15	5.07 <sup>1</sup>
W. W. Murray, Baltimore, Md.....	Ave. 52.12	51.53	52.49	12.60	12.18	12.41	4.63	4.54	4.94	4.70
I. R. Rothrock and A. C. Johnson.....	Ave. 51.71	51.75	51.80	12.51	12.54	12.55	4.74	....	....	4.66
O. M. Shedd, Lexington, Ky.....	Ave. 52.01	51.60	....	12.82	12.60	....	4.66	4.66	....	....
R. C. Wiley, Manhattan, Kan.....	Ave. 51.99	47.56 <sup>1</sup>	47.14	12.82	10.85 <sup>1</sup>	11.94	4.89	4.69	6.31	4.85
L. F. Whipple, Kingston, R. I.....	Ave. 51.05	50.86	51.98	12.60	13.01	12.95	4.76	4.52	6.79	....
R. M. Pinckney, Bozeman, Mont.....	Ave. 52.02	51.56	54.35	13.12	12.41	13.23	4.56	4.43	6.48	....
E. L. Baker, Geneva, N. Y.....	Ave. 51.96	52.09	51.18	12.86	12.93	12.81	4.62	4.65	4.83	4.81
William Rodes, Lexington, Ky.....	Ave. 52.00	....	....	12.72	....	....	4.72	....	....	4.86
Otto McCreary, Geneva, N. Y.....	Ave. 51.99	53.01	53.80	12.76	12.76	12.95	4.65	4.71	4.66	4.86
H. H. Hill, Blacksburg, Va.....	Ave. 51.93	51.80	51.95	13.00	12.84	13.11	4.67	4.50	4.56	4.80
M. P. Sweeney, Geneva, N. Y. <sup>2</sup> .....	Ave. 51.89	51.42	51.95	12.63	12.97	12.93	4.70	4.62	4.66	4.89
C. C. Hedges and F. E. Rice <sup>2</sup> .....	Ave. 52.02	51.04	51.99	12.83	12.54	12.86	4.65	4.38	4.76	4.78
J. C. Jurrjens, Madison, Wis. <sup>3</sup> .....	Ave. 50.85	50.01	50.41	12.27	12.31	12.61	4.77	4.69	7.77	5.28
L. E. Morgan, Columbia, Mo. <sup>2</sup> .....	Ave. 52.34	53.78	54.85	13.73	13.20	13.18	4.98	4.86	5.38	....
General average.....	51.77	50.92	50.72	12.73	12.61	12.72	4.69	4.53	5.33	4.81

<sup>1</sup> Omitted from average.

<sup>2</sup> Received too late to be included in average.

<sup>3</sup> Precipitated at a concentration of 5 cc. and used 15 cc. of reagent.

method using the cobalti-nitrite reagent as a precipitant, and the test of the modification of the official method by making up the potash solution as described by Breckenridge<sup>1</sup> were included in the work. The three samples used were commercial muriate, kainit, and a complete mixed fertilizer. The comparative results obtained are given in Table I. The conclusions reached were as follows: "By the volumetric method as outlined the majority of the analysts have obtained satisfactory results. Probably the variation occurring in the muriate

Mr. J. A. Bizzell, of the Ithaca (New York) Station, associate referee on available potash, stated that "With our present knowledge of soils we are not justified in attempting to devise laboratory methods for the determination of available potash. The loss of water-soluble potash, when potash salts are mixed with acid phosphate, should be further investigated."

The next report presented was that on soils by J. G. Lipman, of the New Jersey Station. In the absence of Dr. Lipman the report was read by Mr. Cathcart. The coöperative work con-

TABLE II.—INORGANIC PLANT CONSTITUENTS.

Analyst.	No. of determinations.	Sulphur in plants—Peroxide method.					
		Graham flour, per cent. SO <sub>3</sub> .			Linseed meal, per cent. SO <sub>3</sub> .		
		Min.	Max.	Ave.	Min.	Max.	Ave.
W. H. Ross, Tucson, Ariz.....	3	0.357	0.466	0.413	0.748	0.857	0.797
Firman Thompson, Newark, Dela.....	3	0.339	0.377	0.352	0.832	0.913	0.866
W. H. Peterson, Madison Wis.....	3	0.442	0.474	0.457	0.911	0.952	0.937
R. O. Baird, Stillwater, Okla.....	6	0.350	0.408	0.377			
	5				0.823	0.899	0.867
O. M. Shedd, Lexington, Ky.....	4	0.364	0.394	0.379			
	2				0.820	0.833	0.826
W. H. McIntire, State College, Pa.....	2	0.367	0.383	0.375	0.824	0.875	0.850
F. W. Sherwood, W. Raleigh, N. C.....	4	0.285	0.352	0.321	0.692	0.731	0.708
A. T. Charron, Ottawa, Canada.....	2	0.463	0.470	0.467	0.922	0.926	0.924
J. P. Aumer, Urbana, Ill.....	3	3.340	0.353	0.346			
	2				0.833	0.853	0.843
O. B. Winter, E. Lansing, Mich.....	4	0.353	0.391	0.373	0.858	0.947	0.887
R. M. Pinckney, Bozeman, Mont.....	4	0.306	0.412	0.377			
	3				0.699	0.830	0.773
G. E. Boltz, Wooster, O.....	1		0.394			0.874	

Average of 39 determinations on the graham flour shows 0.381 per cent.  
Average of 37 determinations on the linseed meal shows 0.841 per cent.

may be avoided by increasing the size of the aliquot. It seems safe to predict that with slight modification an accurate optional method may be developed. Results obtained upon mixed fertilizers by the modified official method show an increase of potash recovered." The only recommendation made was that a further study be made of the volumetric and gravimetric cobalti-nitrite methods; and also of the modified official method by washing a weighed amount of the sample through filter paper, with hot water, to determine potash in the filtrate. These recommendations were adopted.

sisted in a further comparison of the J. L. Smith and the Modified Cobalti-Nitrite method as well as the making of acidity determination according to the Sichtung and the Veitch methods. Three lots of acid soils from the Rhode Island and Ohio Stations were used for this purpose. The recommendation of the referee that the Modified Cobalti-Nitrite method be made an optional official method for the determination of total potassium in soils was modified by the Committee on Recommendations to read that the method be further studied and was so adopted by the Association. The other recommendation of the

TABLE III.—INORGANIC PLANT CONSTITUENTS.

Separation of Fe<sub>2</sub>O<sub>3</sub> and Al<sub>2</sub>O<sub>3</sub>—Molybdate Method. Synthetic solution containing 2.00 per cent. Fe<sub>2</sub>O<sub>3</sub> and 3.98 per cent. Al<sub>2</sub>O<sub>3</sub>.

Analyst.	No. of determinations.	Per cent. Fe <sub>2</sub> O <sub>3</sub> .			Per cent. Al <sub>2</sub> O <sub>3</sub> .		
		Min.	Max.	Ave.	Min.	Max.	Ave.
W. H. Ross, Tucson, Ariz.....	3	1.98	1.98	1.98	4.44	4.48	4.46
H. B. Eggers, Newark, Del.....	4	1.94	1.96	1.96			
	3				4.42	4.90	4.61
R. O. Baird, Stillwater, Okla.....	3	2.16	2.16	2.16	3.46	3.50	3.48
O. M. Shedd, Lexington, Ky.....	5	1.99	2.02	2.01			
	4				4.04	4.06	4.05
W. H. McIntire, State College, Pa.....	1		2.14				
	2				3.92	4.86 <sup>2</sup>	4.39
J. S. Jones, Moscow, Idaho.....	3	2.28	2.28	2.28	4.16	4.28	4.21
F. W. Sherwood, W. Raleigh, N. C.....	3	2.06	2.10	2.08			
	2				4.08	4.22	4.15
O. B. Winter, E. Lansing, Mich.....	2	2.52 <sup>3</sup>	2.60 <sup>3</sup>	2.56			
	4				3.60	3.80	3.71
J. P. Aumer, Urbana, Ill.....	2	0.70 <sup>3</sup>	0.76 <sup>3</sup>	0.73	5.55 <sup>3</sup>	6.15 <sup>3</sup>	5.85
G. E. Boltz, Wooster, O.....	2	1.94	2.04	1.99			
	1					4.05	
R. M. Pinckney, Bozeman, Mont.....	3	1.78	1.92	1.83			
	7				4.57	5.53 <sup>3</sup>	5.19

Percentage Fe<sub>2</sub>O<sub>3</sub> and Al<sub>2</sub>O<sub>3</sub> combined.

	Min.	Max.	Ave.
E. S. Erb, State College, Pa.....	11.06	11.20	11.13
A. T. Charron, Ottawa, Canada.....	6.04	6.28	6.16

Average of 27 determinations on above solution shows 2.04 per cent. Fe<sub>2</sub>O<sub>3</sub>.  
Average of 26 determinations on above solution shows 4.12 per cent. Al<sub>2</sub>O<sub>3</sub>.

<sup>1</sup> THIS JOURNAL, 1, 409.<sup>2</sup> P<sub>2</sub>O<sub>5</sub> present in the ignited precipitate.<sup>3</sup> Omitted from the general average.

referee, that the study of the method for the quantitative estimation of the soil acidity be continued, was adopted.

A recommendation, introduced by Mr. Shedd, of Kentucky, that the referee on soils for 1911 be instructed to investigate a more accurate method for humus determination was adopted.

The closing report on the allied subjects of soils and fertilizer analysis was given by the referee on inorganic plant constituents, O. M. Shedd. The methods studied were the peroxid method for sulphur in plants (Table II) and the method for the separation of the ferric and aluminic oxides in an ash solution (Table III). The samples used were graham flour

the Association of Official Agricultural Chemists for several years, it was finally decided that the subject be brought to the attention of the International Congress of Applied Chemistry by the following resolution, adopted at the meeting of 1907:

"That the suggestion of the committee looking toward the ultimate adoption of the element system be approved, but that no state should discontinue the use of the terms now in use until such discontinuation is also approved by this Association, and that meanwhile the subject should be brought before the International Congress of Applied Chemistry in an effort to secure international agreement."

TABLE IV.—ANALYSES OF WATERS.  
Expressed in Parts per Million.

Analyst.	SiO <sub>2</sub> .	SO <sub>4</sub> .	HCO <sub>3</sub> .	NO <sub>3</sub> .	Cl.	Fe.	Al.	Mn.	Ca.	Mg.	K.	Na.	Li.	NH <sub>4</sub> .	
No. 1.....	4.9	219.1	286.6	1.5	48.0	....	0.3	....	None	107.1	32.0	7.2	54.8	0.7	Traces
No. 2.....	2.82	223.75	309.57	44.16	1135.0	1.32	....	0.49	None	110.3	41.2	16.8	110.3	11.3	10.34
No. 3.....	4.45	219.85	281.5	2.52	49.75	....	0.33	....	Trace	108.25	31.05	6.55	55.9	0.67	0.088
No. 4 (a).....	5.0	216.33	271.45	42.24	49.70	2.19	....	0.65	None	108.65	30.98	6.71	54.75	0.83	0.119
No. 5 (b).....	6.3	211.9	....	1.99	52.0	....	1.19	....	0.94	116.51	39.59	6.88	56.46	1.07	0.069
No. 6 (c).....	6.03	237.6	274.5	1.10	53.1	3.94	....	....	None	104.1	22.34	4.72	35.66	0.65	0.128
No. 7.....	6.6	223.6	271.45	0.017	45.75	....	1.33	....	None	109.9	33.6	5.6	40.2	0.64	0.089
No. 8.....	3.1	220.1	302.0	1.00	57.1	9.8	....	....	....	119.0	41.2	4.6	42.5	....	1.1

Comments of Analysts.

(a) It seems to me that after silica has been determined by volatilization with sulphuric acid and hydrofluoric acid the residue of iron and aluminum should be dissolved in hydrochloric acid and the solution added to the filtrate from the digestion of the insoluble residue first obtained before that filtrate is made up to definite volume. Again, in the determination of K and Li a correction factor is used. It occurs to me that in the case of K particularly the correction factor should be somewhat dependent upon the particular aliquot portion used.

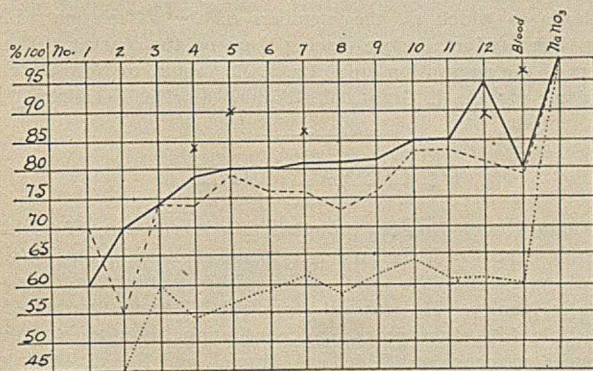
(b) In the evaporation of the original sample for silica determination a porcelain instead of a platinum dish was used.

(c) We evaporate the water in porcelain dishes instead of platinum. Iron is determined from an aliquot by the Zimmerman-Reinhardt method. Lime was determined by the same permanganate solution that was used for the iron. We use these methods for iron and lime because we have found them more rapid and quite as accurate.

and linseed meal for the sulphur work and a synthetic hydrochloric acid solution for the separation of ferric and aluminic oxid. The referee recommended that the peroxid method for sulphur in plants be made official, stating that the method had been before the Association since 1903, and had been found

FIG. 1, NITROGEN AVAILABILITY.

Nitrogen from water-insoluble portion of commercial fertilizers. Results from pot experiments compared with figures by the modified alkaline permanganate method on similar samples.



— Average availability from three crops on bases of blood = 80%.  
 Furnished by B. L. Hartwell and F. R. Pember.  
 - - - Modified alkaline permanganate method by C. H. Jones.  
 ..... Original alkaline permanganate method by C. H. Jones.  
 X X Neutral permanganate method by J. P. Street.

satisfactory. The motion was carried. It was further ordered that the methods on the determination of ferric and aluminic oxid be further studied before they were adopted.

The Committee on Unification of Terms for Reporting Analytical Results in Soils, Fertilizers and Ash reported through the chairman, Mr. R. J. Davidson, as follows:

The question of the unification of terms for reporting analytical results in soils, fertilizers and ash having been before

The committee proposes to communicate with the secretary of the Eighth International Congress and request that the executive committee of that congress be asked to make provision for the full consideration of the matter.

Mr. J. K. Haywood presented a paper giving the results of coöperative work on mineral water analysis, which started a lively discussion. The methods used were those published in Bureau of Chemistry, *Bull.* 91 and *Circular* 52 and the results are shown in Table IV. The results are similar to those generally reported at the beginning of coöperative analytical work.

Thursday night the members and guests were entertained at a smoker given in their honor by the Washington Section of the American Chemical Society. The smoker was held at the Cosmos Club and was well attended and enjoyed.

On Friday the morning and afternoon sessions were devoted to food adulteration, and were mainly of a formal and routine character. At the beginning of the morning session Secretary Wilson, of the Department of Agriculture, delivered a short address on the work of the Association and the operation and enforcement of the Pure Food and Drugs Act.

After the afternoon session members and guests were invited to inspect the new laboratories of the Bureau of Chemistry, and considerable time was spent in examining the splendid equipment of the Bureau. The general arrangement of the floors and laboratories is shown by the following directory:

6TH FLOOR.			
Rooms	601-603	Bacteriological Laboratory	Dr. Stiles.
"	607-608	Pharmacological Laboratory (Div. Drugs)	Dr. Salant. Dr. Hudson. Dr. Weber.
Room	610	Enzyme Investigation Laboratory	Dr. Weber.
Rooms	611-613	Animal Physiological Laboratory	Mr. Trescott.
Room	614	Nitrogen Section	
5TH FLOOR.			
Rooms	502-504	Microchemical Laboratory	Mr. Howard.
DIVISION OF DRUGS.			
Room	501	Essential Oils Laboratory	Mr. Nelson.
Rooms	505-506	Drug Division Laboratory	Dr. Kebler.
"	507-508	Offices of Division	Dr. Kebler.
Room	509	Drug Inspection Laboratory	Dr. Hoover.
Rooms	511-512	Synthetic Laboratory	Dr. Emery.
"	513-514	Offices of the Chief Inspector	Mr. Campbell.
4TH FLOOR.			
Rooms	413-414	General Offices of the Bureau.	Dr. Wiley.
Room	407	Offices of the Chief Secretary of the Board	Dr. Dunlap.

<sup>2</sup> A. O. A. C. Proceedings, 1908, p. 93 (*Bull.* 122, Bureau of Chemistry).

3RD FLOOR.		
Rooms 301-302	Sugar Laboratory (Constant Temperature Polariscope rooms are located on this floor ad- joining the Sugar Laboratory.)	Mr. Bryan.
Room 303	Dr. Wiley's Private Laboratory	Mr. Schreiber.
DIVISION OF FOODS.		
Rooms 304-308	Wash. Food Inspection Laboratory	Mr. Tolman.
Room 310	Offices of the Chief	Dr. Bigelow.
Rooms 311-312	In Charge of Chief of Division	Dr. Bigelow.
Room 313	Laboratory of Food Technology	Mr. Chace.
" 314	Oil, Fat and Wax Laboratory	Mr. Bailey.
2ND FLOOR.		
" 201	Fermentation Laboratory (Div. Foods)	Dr. Lee.
MISCELLANEOUS DIVISION.		
Rooms 202-203	Cattle Food Lab. and General Extrac- tion Room	Mr. Bidwell. Mr. McDonnell.
Room 204	Insecticides Laboratory	Dr. Haywood.
" 205	Trade Wastes Laboratory	Dr. Haywood.
" 206	Offices of Division	Mr. Skinner.
Rooms 207-209	Water Laboratory	Dr. LeClerc.
" 211-214	Vegetable Physiological Laboratory	
1ST FLOOR.		
" 101-106	Contracts Laboratory	Mr. Walker.
" 107-111	Leather and Paper Laboratory	Mr. Veitch.
" 112-114	Dairy Laboratory	Prof. Patrick.
BASEMENT.		
" 10 & 11	Fruit Investigation Lab. (Div. Foods)	Mr. Gore.

Cold Storage Plant of the Bureau is located in the northeast corner. Machine Shop, Sample Room, Glassblower's Room and Milling Room will also be found on this floor.

Friday night the members were the guests of The City of Washington Branch of the American Pharmaceutical Association at a meeting to discuss "The Pharmacopeia of the United States." Dr. H. W. Wiley presented a communication on "The United States Pharmacopeial Convention and the Future of the Pharmacopeia," which was discussed by prominent members of the American Pharmaceutical Association.

The meeting closed on Saturday, November 12th.

#### EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY, 1912.

Satisfactory progress is being made by the officers and committees of the Eighth International Congress. The presidents and vice-presidents of the Sections and Sub-sections have been appointed, and a list of them is given below. Their first meeting was held November 21st, at the Waldorf-Astoria, in New York City, under the presidency of Dr. Wm. H. Nichols, President of the Congress, and the Honorary President, Professor E. W. Morley. The list follows:

#### SECTIONS AND SUB-SECTIONS AND THEIR PRESIDENTS AND VICE-PRESIDENTS. NAMES OF PRESIDENTS ARE GIVEN FIRST, THE NAMES OF THE VICE-PRESIDENTS FOLLOWING.

1. Analytical Chemistry—Dr. W. F. Hillebrand, Washington, D. C.; Prof. H. P. Talbot, Boston, Mass.
2. Inorganic Chemistry—Prof. C. L. Parsons, Durham, N. H.; Prof. Charles Baskerville, N. Y. City.
  - 3a. Metallurgy and Mining—Prof. J. W. Richards, So. Bethlehem, Pa.; Dr. J. B. F. Herreshoff, N. Y. City.
  - 3b. Explosives—Prof. C. E. Munroe, Washington, D. C.
  - 3c. Silicate Industries—Dr. A. S. Cushman, Washington, D. C.; Dr. Karl Langenbeck, Boston, Mass.
4. Organic Chemistry—Prof. M. T. Bogert, N. Y. City; Prof. W. A. Noyes, Urbana, Ill.
  - 4a. Colors—Hon. H. A. Metz, N. Y. City; Eugene Merz, Esq., N. Y. City.
  - 5a. Industry and Chemistry of Sugar—Dr. W. D. Horne, Yonkers, N. Y.; Dr. F. G. Wiechmann, N. Y. City.
  - 5b. Industry and Chemistry of India Rubber and Other Plastics—Dr. L. H. Baekeland, Yonkers, N. Y.; C. C. Goodrich, Esq., N. Y. City.

5c. Fuels and Asphalt—Dr. David T. Day, Washington, D. C.; Dr. F. Schniewind, N. Y. City.

5d. Fats, Fatty Oils and Soaps—David Wesson, Esq., N. Y. City; Dr. Martin H. Ittner, Jersey City, N. J.

6a. Starch, Cellulose and Paper—A. D. Little, Esq., Boston, Mass.; Dr. T. B. Wagner, Chicago, Ill.

6b. Fermentation—Dr. Francis Wyatt, N. Y. City; Dr. Robert Wahl.

7. Agricultural Chemistry—Dr. F. K. Cameron, Washington, D. C.; Prof. H. J. Wheeler, Kedgwick, R. I.

8a. Hygiene—Prof. W. T. Sedgwick, Boston, Mass.; Dr. L. P. Kinnicutt, Worcester, Mass.

8b. Pharmaceutical Chemistry—Prof. J. P. Remington, Philadelphia, Pa.; Prof. V. Coblentz, N. Y. City.

8c. Bromatology—Dr. W. D. Bigelow, Washington, D. C.; Dr. A. L. Winton, Chicago, Ill.

8d. Physiological Chemistry and Pharmacology—Prof. J. J. Abel, Baltimore, Md.; Prof. W. J. Gies, N. Y. City.

9. Photochemistry—Prof. W. D. Bancroft, Ithaca, N. Y.; R. J. Wallace, Esq., St. Louis, Mo.

10a. Electrochemistry—Prof. W. H. Walker, Boston, Mass.; Prof. C. F. Burgess, Madison, Wis.

10b. Physical Chemistry—Dr. W. R. Whitney, Schenectady, N. Y.; Prof. Alexander Smith, Chicago, Ill.

11a. Law and Legislation Affecting Chem. Industry—(No officers elected as yet).

11b. Political Economy and Conservation of Natural Resources—Prof. J. A. Holmes, Washington, D. C.; Prof. C. R. Van Hise, Madison, Wis.

#### WOOD TURPENTINE ASSOCIATION.

A meeting of the Wood Turpentine Association was held at Jacksonville, Florida, on September 24th, and was attended by representatives of a large number of plants engaged in the manufacture of high-grade wood spirits of turpentine and pine oil.

The main object of the association at the present time is to improve the quality of their products and to establish uniform standards to which all the members of the association will bring their products before placing them on the market. The officers of the association are: Dr. J. E. Teeple, of New York, President; Mr. A. J. Grant, of Orlando, Florida, Secretary.

#### PERSONAL NOTES.

William Henry Brewer, professor emeritus in the Sheffield Scientific School of Yale University, died at New Haven, Nov. 2d. He was one of the most distinguished members of Yale's scientific faculty. He was 91 years old. He was graduated from Yale fifty-eight years ago, continuing his studies with prolonged residence at Heidelberg, Munich and Paris. During the Civil War period he was professor of chemistry in the College of California, which he left about 1865 to take the chair of agriculture at Yale. Professor Brewer had served on more than forty government and state commissions. He was chairman of the commission organized at the request of President Roosevelt to draw up a plan for a scientific survey of the Philippine Islands. During his term in office at Yale he declined the presidency of some thirty agricultural colleges in various parts of the country. His relaxation was exploration and mountain-climbing.

Dr. Henry Wurtz, chemist and scientist, died November 11th at his home, in Brooklyn, in his 83d year. He was born at Easton, Pa., and was a graduate of Princeton University and of the Massachusetts Institute of Technology. He was the author of many scientific treatises and was the first investigator to



prove the existence of gold in sea water. He held many Government positions.

*Warning.*—A person calling himself "John Pearson" has been going about among members of the *Chemical Society* and the *Society of Chemical Industry*, representing that he is a relative of the undersigned, in needy circumstances, and attempting to negotiate loans, etc., on that basis. The relationship story is utterly false. (Signed) WATSON SMITH,

*Editor of the "Journal of the Society of Chemical Ind."*

A man giving his name as John Pearson and talking and acting like an Englishman was in Columbus, O., recently, asking assistance from chemists, and stating that he was injured in a fire in Toledo, O., about six weeks ago. He stated that he was a relative of Mr. Schweitzer, of the *Society of Chemical Industry*, and also claimed acquaintance with Dr. Arthur Noyes, Dr. Wm. A. Noyes, and other prominent chemists. Dr. Schweitzer has disavowed any knowledge of this man.

## RECENT INVENTIONS.

The following patents relating to Industrial and Engineering Chemistry are reported by C. L. Parker, Solicitor of Chemical Patents, McGill Building, 908 G St., N. W., Washington, D. C.

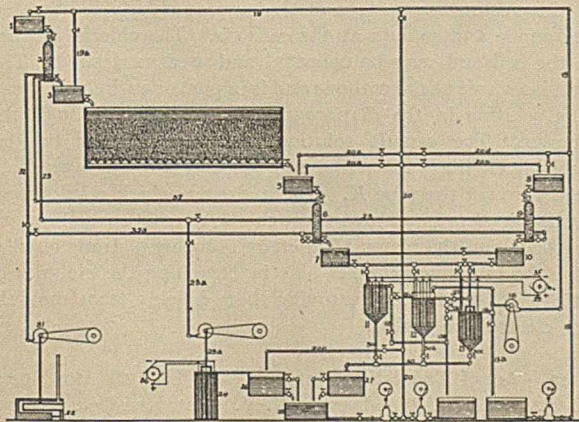
Only a few patents which are deemed of greatest importance are abstracted in this department.

Abstracts of all patents appear regularly in *Chemical Abstracts*, to which publication the reader is referred.

973,776. Process of Extracting Metals from Their Ores. WILLIAM E. GREENWALT. Patented Oct. 25, 1910.

This invention relates generally to process of extracting metals from their ores but it will be described more particularly in its application to copper ores, and to ores containing copper with variable quantities of gold, silver, lead, nickel, cobalt, zinc, and other metals.

Copper ores usually contain variable quantities of other metals, and these metals cannot be recovered by any one of the wet methods now in use. One and sometimes two additional treatments are necessary to extract the gold and silver occurring with the copper, and the lead is invariably lost. One of the essential difficulties with acid process has been that the acid is usually too expensive to admit of extended use in mining



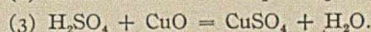
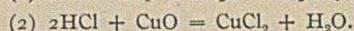
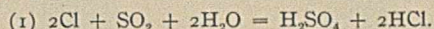
districts, which are ordinarily far from the source of acid supply. It takes approximately 1.5 pounds of sulfuric acid to dissolve one pound of copper as sulfate. If hydrochloric acid is used, it takes approximately 0.6 pound of acid to extract one pound of copper as cuprous chlorid, and 1.1 pound as cupric chlorid. Much of the acid, whether sulfuric or hydrochloric, combines with the base elements of the ore and serves no useful purpose.

The amount of acid which is necessary to provide, in any acid process, is considerably more than that combining with the copper, and all the acid is irrecoverably lost when iron is used as the precipitant. Theoretically, 88.8 pounds of iron are required to precipitate 100 pounds of copper from sulfate solutions. In practice, it takes from 200-300 pounds of scrap iron. Here, again, a large expense is incurred in providing iron with which to precipitate the copper. The fundamental difficulty, therefore, in treating copper ores in the past by these methods has been the excessive cost of the materials.

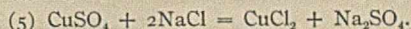
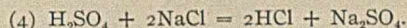
In this electrolytic process, the copper is dissolved by dilute acid chlorid solutions, and then precipitated by electrolysis, while at the same time the acid, which was combined with the copper, is multiplied and again regenerated as free acid, at the expense of sulfur dioxid and water. Salt is the only chemical to provide, which is not usually contained in the ore. Sulfur dioxid, derived from roasting sulfid ore, is the active chemical consumed. Theoretically, the chlorin in the salt is not consumed; nevertheless, in practice, about one-eighth pound of salt should be provided for every pound of copper produced.

The oxid, carbonate, and silicate ores of copper may be treated without roasting. The sulfids are roasted. If the ore is roasted, salt may be added during the roasting.

In working the process, the ore, after being suitably crushed, is placed in large leaching vats for chemical treatment. The first step in the chemical process consists in combining chlorin, generated from metal chlorids by electrolysis, with sulfur dioxid produced by roasting concentrates or sulfid ore, in the presence of water, to form acid. This may be shown by the following reactions:



Both sulfuric acid and copper sulfate react with common salt to form hydrochloric acid or cupric chlorid, so that neither the sulfuric acid nor the copper sulfate could exist in the solution. These well-known reactions are:



Cupric chlorid, when warm and in the presence of other metal chlorids, acts readily on silver and its compounds in the ore to form silver chlorid, thus:



From 80-90 per cent. of the silver may, in this way, be extracted with the copper, especially if the ore is given a chloridizing roast. Lead is similarly extracted. If the ore contains considerable silver it is desirable to leach with a fairly concentrated solution of base metal chlorids.

The solubility of chlorid in water is limited. By the indirect method of combining the chlorin with sulfur dioxid and water to form acid, any desired strength of acid solution may be obtained from the copper, and a chlorin solution of sufficient strength for the gold.

The cupric chlorid solution issuing from the leaching vat is saturated with sulfur dioxid obtained from roasting sulfid ore. This converts the cupric chlorid into the cuprous chlorid, thus:



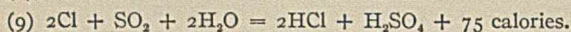
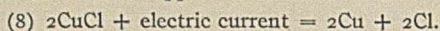
The object of this is:

First, the electric current deposits twice as much copper, theoretically, per ampere, from a cuprous as from a cupric solution, and with an expenditure of only 65 per cent. of the energy per unit of copper.

Second, the sulfur dioxid, reacting with cupric chlorid and water, produces large quantities of acid. A molecule of acid is in this way regenerated for every molecule of cupric chlorid reduced to cuprous chlorid. For every pound of copper reduced

from the cupric to the cuprous condition, 1.4 pounds of acid regenerated.

Third, the excess of sulfur dioxide combines with the chlorine liberated during electrolysis of the cuprous chloride to precipitate the copper, thereby again regenerating 1.4 pounds of acid for every pound of copper reduced from the cuprous condition to metallic copper. The reactions are:



These reactions may take place in the electrolyzer. Usually the excess of chlorine will be conducted to a separate chamber where it may combine with the sulfur dioxide in the solution.

Fourth, the above reactions rise to an electromotive force working with the current, thereby reducing the necessary voltage in the deposition of the copper.

Fifth, it dispenses with the necessity of diaphragms in the electrolyzers, although at times diaphragms may be desirable.

Sixth, it is possible, by this method, to extract the other valuable metals from the ore, with the copper and with the same solution. This is not possible when working on a sulfate basis.

Seventh, insoluble anodes, decomposing chloride solutions, are vastly more durable than when decomposing sulfates. Graphitized carbon electrodes have proved effective for the decomposition of chlorides, while the production of a suitable insoluble anode for the decomposition of sulfate may still be regarded as one of the unsolved problems of electrometallurgy.

972,947. Electrolytic Decomposition of Solutions. CLINTON P. TOWNSEND, of Washington, D. C. Patented Oct. 18, 1910.

This invention relates to the electrolytic decomposition of solutions, and particularly to a process of collecting the products of such decomposition.

According to the invention, one of the products of the electrolysis, or a secondary product resulting from the action of the primary product upon the electrolyte, or upon the immiscible liquid, hereafter mentioned, is collected in, under and above an immiscible liquid, which serves several important functions.

The cell comprises a central compartment, *B*, containing an anode, *D*, and one or more lateral or cathode compartments, *C*, shown as two in number, the lateral compartments being separated from the central compartment by the cathodes and diaphragms.

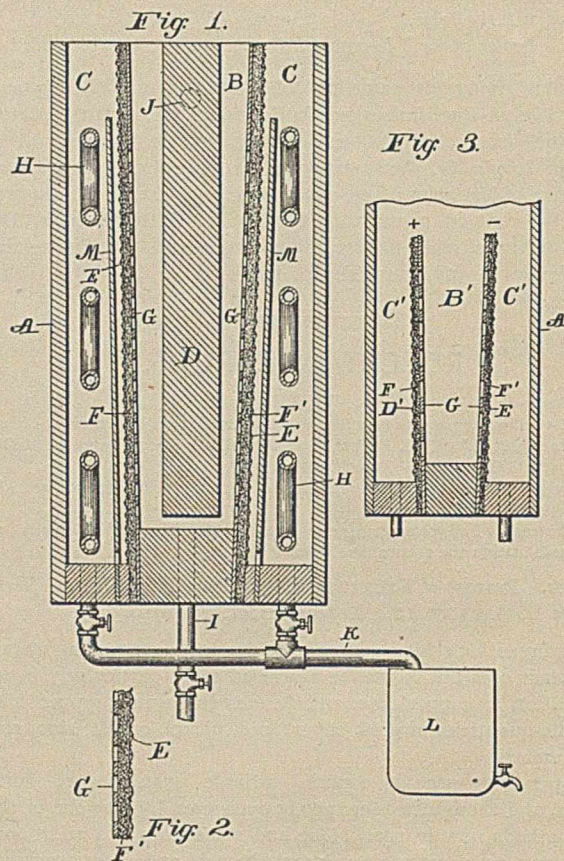
*FF'* are diaphragms of asbestos or other suitable pervious material supported between the perforated sheet or wire gauze *E*, and the perforate or pervious plate *G*. As shown, *EE* are of metal and constitute the cathodes of the cell. The plates *G*, which may be of hard rubber or earthenware, hardened asbestos or any suitable material, are preferably non-conducting and serve to support the diaphragm proper; they may, of course, be dispensed with, if the diaphragm be so treated as to be capable of supporting itself. They are shown as imperforate in their upper portions. It will be noted that the cathodes are shown as inclined slightly from the vertical, but such inclination is not essential.

*M* represents a sheet of metal, as iron, adjacent and approximately parallel to the cathode. This plate terminates a slight distance above the bottom of the cathode compartment and below its top, for a purpose hereinafter described.

*H* is a coil suitably connected and employed for heating or cooling the liquid in the cell to maintain its temperature at any desired point.

As illustrated, the cathode compartments *C* are somewhat deeper than the central or anode compartment, and are provided with valve-regulated drain pipes communicating with a main conduit, *K*, leading to the tank *L*, from which the solution may be withdrawn as desired.

In operation, the central compartment is filled with sodium chloride solution, and a continuous flow is preferably maintained through this compartment from below upward, the inlet *I* and the outlet *J* being provided to this end. The lateral compartments are filled to a higher or lower level with a liquid which is substantially immiscible with water or aqueous solutions and inert toward the products of electrolysis liberated



in contact therewith, or the secondary products resulting from the oxidation or other chemical modification of said products. Of such liquids, the non-saponifying oils may be taken as an example. Upon the passage of the current chlorine is liberated at the anode and sodium at the cathode. The chloride escapes from the cell and may be collected and used as desired. The sodium is set free at the cathode and is in part or entirely oxidized by the solution in the diaphragm or percolating through the diaphragm. The caustic solution so formed under the oil detaches itself freely from the cathode and is withdrawn from the cell through the pipe *K*. The hydrogen which results from the reaction escapes upward through the narrow space between the cathode and the plates *M*, thereby inducing a strong circulation of the oil, which further aids in detaching the globules of caustic solution, thereby removing them quickly from the field of the electrolytic action.

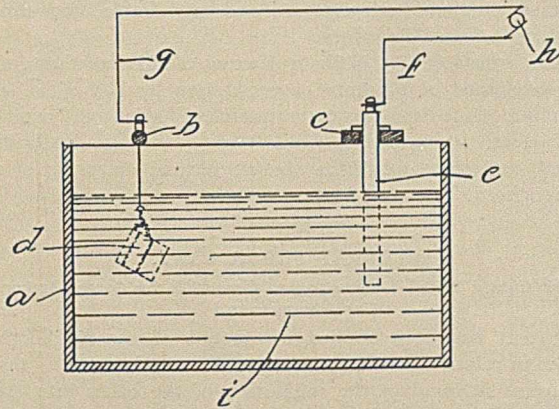
971,641. Art of Enameling Metals. GEO. L. RICE AND BENJ. W. GILCHRIST, of Woodhaven, N. Y. Patented Oct. 4, 1910.

This invention relates to the art of enameling metal and particularly to the art of enameling household utensils and other articles of manufacture or merchandise composed of iron or steel.

In the accompanying illustration is shown at *a* an ordinary electrolytic cell provided with the usual cathode and anode supports *b* and *c*, and from the cathode support *b* is suspended a utensil, *d*, which constitutes the article to be enameled, and

from the anode support *c* is suspended the usual anode 3, and connected with the parts *b* and *c* or through said parts with the parts *d* and *e* are the usual circuit wires *f* and *g* which connect with a generator, *h*, or other source of electricity.

The cell *a* contains an electrolyte, *i*, of which sulfur and a salt of metal or metals form a part, and the operation of this apparatus will be the same as that of all similar apparatus of this class. In this operation there is a film or covering of material deposited on the utensil *d*, and this film or covering contains



sulfur which may be present either in the free or combined state. The invention is particularly designed for use in enameling various utensils or articles composed of iron or steel, and in practice we prefer that the electrolyte in the cell *a* shall contain salts of magnetic metals and sulfur.

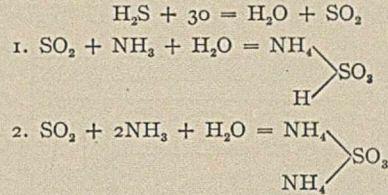
In the enameling of articles composed of iron or steel, as this process has heretofore been produced, it has been found difficult to unite the enamel with the body of the utensil or article in such manner as to produce a perfect union, and the enamel easily shells off or breaks off, but with the process the sulfur in the magnetic covering or coating which is first placed on the utensil or article to be enameled enables the enamel to adhere to the body of the utensil or article and to practically form an integral part thereof, or in other words the union between the iron or steel body, the magnetic film or coating and the enamel is such that these parts cannot be separated, and while the enamel may be broken by violent or rough usage it will not separate from the metallic body.

973,164. Process of Obtaining Ammonium Salts from Gas. KARL BURKHEISER, of Aix-la-Chapelle, Germany. Patented Oct. 18, 1910.

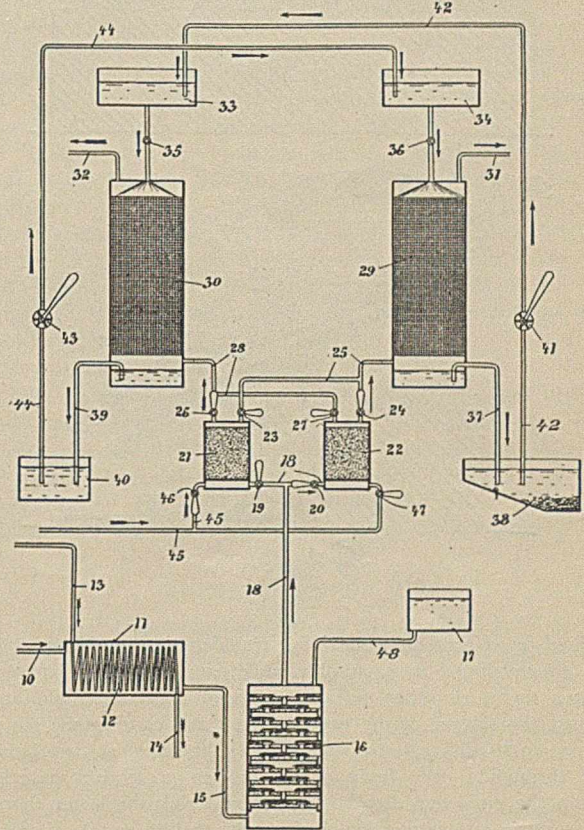
This invention relates to a process of obtaining ammonium salts from gases, such as illuminating gas or coke-oven gas, in a simple and economical manner. For this purpose the sulfur and ammonia in the gas are caused to so interact to directly produce ammonium sulfite or ammonium sulfate.

In carrying out the process, the gas passes over a substance which is capable of giving off oxygen, such as roasted bog iron ore, said substance being heated to a temperature at which condensation of the water contained in the gas is prevented, said temperature being under normal conditions 60-70° C. The oxidizing substance is either continuously regenerated by adding air or pure oxygen to the gas passing thereover, or it is intermittently regenerated by passing alternately gas and air currents over said substance. If the oxidizing substance is continuously regenerated and heated to the temperature of oxidizing sulfuretted hydrogen, the latter is decomposed into sulfurous acid and water, while at higher temperatures and with a sufficient supply of oxygen, sulfuric anhydrid is formed. If, however, the oxidizing substance is intermittently regenerated, there occurs first an oxidation to sulfur compounds which are subsequently higher oxidized when oxygen is passed over said

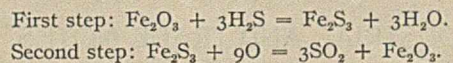
compounds. The sulfur dioxide or sulfur trioxide reacts on the ammonia contained in the gas with which it will form acid or neutral sulfite or sulfate of ammonia. The reactions taking place with a continuous regeneration of the oxidizing substance yield, in the first case, an acid salt, while in the second case, a neutral salt is obtained, owing to the combination of twice the quantity of ammonia with the same quantity of sulfurous acid, the reactions being as follows:



For illustrating the reactions that take place when intermittently regenerating, it may be assumed that oxid of iron be used as oxidizing agent. During the first step the sulfuretted



hydrogen combines therewith, while during the second step the oxidizing substance is regenerated and the sulfur oxygen compound is formed according to the following formulae:



Owing to the contact between the sulfur oxygen compounds thus formed and the ammonia, the above-described reactions will either yield an acid or a neutral salt according to the quantity of ammonia present.

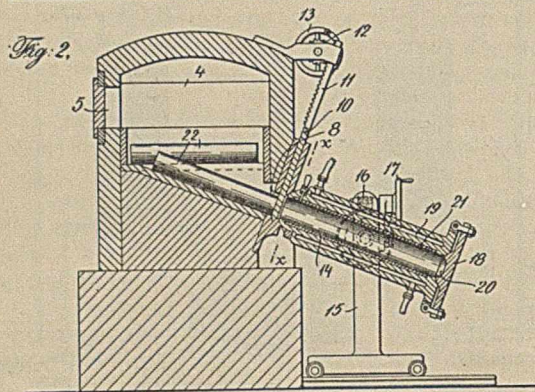
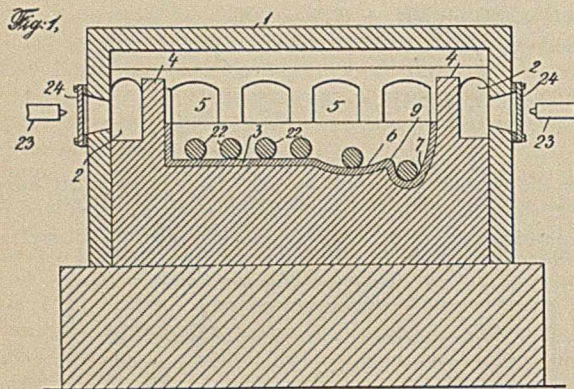
The accompanying drawing illustrates a diagrammatic elevation of a plant for carrying out the process.

972,561. Method of and Apparatus for Producing Coated Metal Objects. JOHN F. MONNOT, of New York, N. Y. Patented October 11, 1910.

This invention relates to methods of, and apparatus for, producing coated metal objects, particularly compound ingots

comprising unlike metals weld-united, and consists in means whereby a billet or object to be coated may be heated to a high temperature while immersed in a bath of flux or like fused protective material, and may be transferred to a mold while still submerged in such protective material, and then may have a layer of molten metal cast about it and united to it as the metal so cast solidifies.

The invention consists in the process comprising the heating of an object to be coated, under protection of an enveloping



bath of fused protective material, transferring the object while still so enveloped to a suitable mold, and casting a body of molten metal or other suitable material into said mold and against the surface of the heated object and causing the metal so cast to solidify against such object, the metal so cast being cast through a deep body of the molten protective material within the mold and displacing such material, the latter therefore serving as a wiping material for the molten metal, whereby the molten metal as cast is purified and freed from entrained and occluded gases, oxid impurities, etc.

## INDUSTRIAL AND TRADE NOTES.

### A BRITISH RADIUM DISCOVERY.

[From Consul Frederick I. Bright, Huddersfield.]

It is reported that a new process of extracting radium from pitchblende produced at Cornish mines has been adopted, by means of which more radium can be extracted in two months than in one year by the present methods employed on the continent of Europe. The following statement is from a Yorkshire paper:

Sir William Ramsay received a party of gentlemen at the radium works, established in Limehouse by a subsidiary company of the St. Ives Consolidated Mines (Limited), and an-

nounced to them that for the first time radium had been produced in Great Britain from British ore. Up to now 550 milligrams of pure radium have been produced, and the process adopted by Sir William Ramsay and his chief assistant, Mr. Norman Whitehouse, is so rapid that radium which is extracted in two months at Limehouse could only be extracted in a year by the latest method in use on the Continent.

Those who visited the works were shown 2,600 milligrams of 10 per cent. radium, the present market price of which is about £20 per milligram. It is stored in a specially constructed safe lined with lead and asbestos, and remarkable precautions are taken to insure its safety.

In an interview, Sir William Ramsay said that there was every likelihood of the rate of production he had spoken of continuing. But there was a great demand for it from hospitals and doctors. Its curative qualities were being gradually discovered, and there would be no difficulty in disposing of all they produced.

### POWDERED SUGAR CANE.

[Extract from a British Guiana paper, forwarded by Consul Arthur J. Clare, Georgetown.]

A patent has been applied for in one of the neighboring colonies in relation to "improvements for treating sugar cane." The invention involves the separation of the canes into their two principal structural parts, pith and woody fiber, by mechanically reducing the canes to fine shreds and then completing the separation by a screening or sifting operation and separately collecting the two parts, all this with the retention of the natural juices. The stalks are passed end-wise through rotary cutters by which they are shredded into a mass in which the pith exists in sawdust-like particles and the fiber in fine filamentary shreds. The sugar cane, thus reduced to dust and shreds, is intended for export in this condition, the idea underlying the enterprise being to escape the duty chargeable on sugar on admission to the United States.

### BRIQUETTING OF IRON ORES.

[From Consul F. I. Bright, Huddersfield, England.]

At a recent meeting of the British Iron and Steel Institute the following rules were recommended for the successful briquetting of iron ores:

(1) The iron ore briquettes must have a certain resistance against mechanical influences. They must resist a pressure of not less than 2,000 pounds per square inch, and when dropped from a height of 10 feet on a cast-iron plate they must not fall into dust, although they may break into pieces.

(2) They must resist heat. Heated to 900° C., they may commence to sinter, but they must not disintegrate into small fragments.

(3) They should be capable of being placed in water for a certain time without softening.

(4) They must resist the influence of steam at 150° C., without crumbling.

(5) They must possess a certain amount of porosity in order to allow the carbon monoxide in the blast furnace to penetrate the interior of the briquette, and to exercise its beneficial reducing influence.

(6) The binding material, if any is used, should not contain noxious substances (sulphur, arsenic) to such an extent as to be injurious to the quality of the pig iron produced.

(7) The cost of producing briquettes should not exceed the difference in the prices between lump ore and fine ore.

### POTASH SALTS IN GALICIA.

[From Consul-General Charles Denby, Vienna.]

The operations of the syndicate formed for exploiting the

potash salt deposits at Kalusz, in the Austrian Province of Galicia, continue to attract wide attention.

Up to the present the mining operations are developed only within an area of 1,148 by 1,800 feet, wherein four shafts have been sunk of less than 920 feet in depth. The quantity of potash (kainit, sylvin, and sylvinite) produced is regarded as a guaranty of future success. According to expert estimate, a supply of 33,000,000 pounds per annum may be obtained from existing shafts for eighteen years, but it is believed that greater depth of borings will show much greater productiveness. This hypothesis is based on the geological resemblance of the Kalusz field to the fields at Stassfurt, Germany, where kainit, sylvin, sylvinite, and karnallit have been found only in shafts over 980 feet deep, the various shafts in Germany in nearly every case running from that to a depth of 2,438 feet.

It is the purpose of the Austrian syndicate not only to dig deeper, but to open additional shafts and to introduce better mining methods.

Up to the present time the Kalusz field has produced kainit and sylvinite chiefly, the kainit containing uniformly 12 per cent. to 15 per cent. of potash. During the years 1904 to 1908 the quantity of kainit sent from Kalusz to market amounted to 122,260,000 pounds; for the last of those years the amount was 24,840,000 pounds, valued at \$35,000. The reports for 1909 are not available.

Austria is annually importing an increasing quantity of chloride of potassium from Germany, *viz.*, 8,800,000 pounds in 1902 and 154,000,000 pounds in 1909. It is the plan of the Austrian syndicate not only to supply the Austrian demand, but to compete with Germany in foreign fields, and it is believed that, by cutting the present German monopoly prices, the demand can be largely increased.

Owing to the feature of the law of Austria which forbids the manufacture of mineral salts by private parties, the Kalusz field is to be worked under the form of a lease, the syndicate delivering the salt to the Government at a fixed price. The Government will erect and operate a factory at Kalsuz for its preparation for market. There are many features of the proposed joint working of the Government and the syndicate which are still to be determined, *viz.*, contract price for delivery of salt by the syndicate, terms of lease of additional territory, terms for syndicate participation in manufacture, etc. The syndicate, however, is a powerful one; financially it is equal to a great undertaking, and it has the support of a person of high rank in its dealings with the Government.

Offers from foreign countries to furnish capital and participate in the syndicate's operations have been received and rejected. It is the firm intention of the interested parties to maintain the enterprise as a purely Austrian undertaking. Herein lies the greatest advantage to the American purchasers, namely, a large supply from works independent of the German monopoly, at competitive prices.

#### SMELTING BY ELECTRICITY.

[From Consul P. Emerson Taylor, Stavanger, Norway.]

The Electro-Metallurgical Commission has completed its work and filed its report. In speaking of the work of the commission Professor Farups, of the University of Christiania, one of the members, says:

It is quite possible for us, in electric smelting of iron ore, to compete with smelting ovens of the old type in other countries. The iron ore is no more expensive here than in other places, and Norway is richer in electric energy, and electric power here is much cheaper than in other countries. Besides, we have very good export seaports, with our waterfalls and electric power close to the sea. Should the electric smelting of iron and steel, in spite of all this, become more expensive than smelting by the old methods, it will still be able to compete with the old method

of smelting because of the much finer quality of the product. In Sweden, where the new electric smelting ovens have been installed, the results show that the new method is a success and in an advanced stage of progress, and Norway will, with her electric power and transportation facilities, have many advantages over Sweden.

#### PETROLEUM OIL GUSHER.

The Palmer Oil Co. brought in another gusher Nov. 1st. Its well No. 3 was finished a week ago and put on the pump. From the first it is reported to have yielded over 200 barrels per day, while the veins in the oil sands were being opened up. Finally it came in as a gusher, flowing over 700 barrels with tremendous gas pressure. President Frank L. Brown, in a telegram, says: "It gives every indication of opening up into a bigger production than either well No. 1 or No. 2. Well No. 1 flowed constantly for almost two years at over 1,500 barrels a day. Last July well No. 2 came in, producing 300 barrels a day while it was being cleaned out, and then started to flow at the rate of 8,000 barrels a day—producing in August over 230,000 barrels. In September this well was shut off until the big storage tanks can be completed, but will be turned on again in a few weeks. With its three completed wells all gushers, the Palmer company can produce over 10,000 barrels a day.

"Because of its heavy production of oil the Palmer Company has joined with the Palmer Junior Oil Co. in building its own pipe lines to tidewater at Avalon, Cal., where it will have its own dock facilities and reservoirs capable of storing 1,500,000 barrels of oil. The pipe line will be completed by Jan. 1st, when these two companies will begin delivering their oil through their own pipe line, by their own tank steamers to San Francisco and other markets."

The American Viscose Company is building a new artificial silk factory at Chester, Pennsylvania. This Company is practically owned by Samuel Courtauld & Company, Ltd., London, England. It is capitalized at \$250,000 and is a Pennsylvania corporation. The Treasurer of the Company is William M. Kitzmiller, 144 East Washington Lane, Philadelphia, Penna.

#### PURCHASE OF IRON MINES.

All the Corrigan-McKinney mines on the Gogebic range were inspected recently by officials of the U. S. Steel Corporation, which is in negotiations for the purchase of all the mining and furnace interests of this company.

On this range its holdings consist of the Colby, Winona and Ironton, the three mines producing this year over 500,000 tons, though now closed down until the first of the month. The company also has large holding on the Menominee and Mesaba ranges, being the largest ore producers in the Lake Superior district outside the trust.

The deal, if consummated, will involve over \$20,000,000 in mine value, aside from any furnace interests at Cleveland and elsewhere.

#### MONAZITE AND ZIRCON PRODUCTION.

[From advance chapter of Mineral Resources of United States, by the Geological Survey.]

There is a constant demand for minerals carrying thorium for the manufacturer of incandescent gas mantles. A large number of such minerals are known to the mineralogist, though only one, monazite, has been found in quantities large enough to supply the commercial demand. Two other minerals that carry a large percentage of thoria—thorite and thorianite—have been obtained in small quantities from Ceylon.

Monazite is a phosphate of cerium, lanthanum, praseodymium, and neodidymium containing a variable percentage

of silica and thoria. Its content of thoria ranges from less than 1 per cent. to more than 20 per cent. The quantity in monazite used for commercial purposes ranges from 3 to 9 per cent. In color monazite ranges from grayish to yellow, reddish, brownish, or greenish. Its luster is resinous and is especially brilliant on cleavage faces. It is opaque to translucent or subtransparent. Its specific gravity ranges from 4.9 to 5.3 and is generally over 5, so that it is readily concentrated by ordinary methods of washing. It is brittle, having a hardness of 5 to 5.5. Monazite generally occurs in small crystals with brilliant faces in the original rock matrix. When set free from the rocks and deposited in gravel beds by streams these crystals are rounded by attrition.

The world's sources of supply of monazite for many years have been Brazil and the United States. The Brazilian output (\$225,000 worth shipped from Bahia in 1908) is shipped to Germany, Austria, and England for manufacture into thorium salts. The greater part of the monazite produced in the United States is used in this country, though small quantities are exported annually. For a number of years past the supply has come from North Carolina and South Carolina, but it is probable that Idaho will add materially to the production hereafter. Deposits of monazite exist in other Western States and in Georgia and Virginia.

Practically all the monazite of commerce is derived from placer or gravel deposits. Unsuccessful attempts have been made to extract it from its original rock matrix on a commercial scale in North Carolina. Monazite placer deposits are worked like gold placer deposits, by sluicing and hydraulicking, and the crude sand obtained is further cleaned on concentrating tables or by electro-magnetic machinery. In the United States the final cleaning of monazite before shipment is accomplished by three different types of electro-magnetic cleaning machines. These are especially adopted forms (1) of the Wetherill, in use by the German American Monazite Company, (2) a machine devised by the Carolinas Monazite Company, and (3) a new type made and patented for the Centerville (Idaho) Mining and Milling Company. These machines can be adjusted to clean the sand to 95 per cent. monazite, though the shipping grade is not generally so carefully cleaned.

The statistics of the production of monazite in the United States have been collected coöperatively by the Bureau of the Census and the United States Geological Survey. The production of crude monazite sand amounted to 1,976,329 pounds, averaging about 25 per cent. monazite. The crude concentrates yielded 541,931 pounds of refined sand, whose value before cleaning was \$65,032 or 12 cents per pound. Of this, 391,068 pounds, valued at \$46,928, came from North Carolina, and 150,863 pounds, valued at \$18,104, from South Carolina. The value of 12 cents per pound placed on the monazite is the rate paid the miners per pound of refined sand obtained by electro-magnetically cleaning their crude concentrates. It does not represent the value of the refined material, but of the quantity of crude concentrates necessary to yield 1 pound of refined monazite. The cost of cleaning is not included. The average price of crude monazite concentrates was  $3\frac{1}{3}$  cents per pound.

The following table gives the United States production and value of monazite from 1893 to 1902, inclusive; of monazite and zircon in 1903; of monazite, zircon, gadolinite, and columbite in 1904; of monazite, zircon, and columbite in 1905; of monazite and zircon in 1906 and 1907; and of monazite in 1908 and 1909.

The production of monazite in the United States in 1909 was, as usual, confined to North Carolina and South Carolina. Some mining and cleaning of monazite was done at Centerville, Idaho, but none of the sand was placed on the market. The company operating in this region is holding its output with the expectation that monazite will have an increased value through the

discovery of some use for its other constituents than thoria. An extensive series of tests are being made with this in view.

Year.	Quantity.	Value.
1893.....	130,000	\$7,600
1894.....	546,855	36,193
1895.....	1,573,000	137,150
1896.....	30,000	1,500
1897.....	44,000	1,980
1898.....	250,776	13,542
1899.....	350,000	20,000
1900.....	908,000	48,805
1901.....	748,736	59,262
1902.....	802,000	64,160
1903.....	865,000 <sup>a</sup>	65,200
1904.....	745,999 <sup>b</sup>	85,038
1905.....	1,352,418 <sup>c</sup>	163,908
1906.....	847,275 <sup>d</sup>	152,560
1907.....	548,152 <sup>e</sup>	65,800
1908.....	422,646	50,718
1909.....	541,931	65,032

<sup>a</sup> Including 3,000 pounds of zircon, valued at \$570.

<sup>b</sup> Including the small production of zircon, gadolinite, and columbite.

<sup>c</sup> Including a small quantity of zircon and columbite.

<sup>d</sup> Including 1,100 pounds of zircon, valued at \$248.

<sup>e</sup> Including 204 pounds of zircon, valued at \$46.

The production of refined monazite in the United States in 1909 was greater by 119,285 pounds in quantity and \$14,314 in value than in 1908. This increase was due to larger outputs in both North Carolina and South Carolina. The production was less by 6,017 in quantity and \$722 in value than in 1907 and was considerably smaller than in 1906.

According to the Bureau of Statistics of the Department of Commerce and Labor, there were 69,988 pounds of monazite and thorite, valued at \$8,324, and 17,549 pounds of thorium oxide and other salts, not nitrate, valued at \$19,596, imported into the United States during 1909. The imports of thorium nitrate were large, and are given, along with those of the preceding six years, in the following table:

Year.	Quantity.	Value.
1903.....	64,520	\$232,155
1904.....	58,655	249,904
1905.....	52,378	269,504
1906.....	40,090	139,929
1907.....	51,441	152,666
1908.....	65,289	173,239
1909.....	127,833	236,057

The imports of thorium nitrate for 1909 were but little less than twice as great as the imports for any one of the six preceding years. The price per pound in foreign markets as deduced from the table was only \$1.85, as against \$2.65 in 1908 and \$2.97 in 1907. If the imports of oxide of thorium and other thorium salts, not nitrate, are added to that of the nitrate, it will be seen that the quantity of manufactured thorium salts imported in 1909 was considerably over twice as great as in any previous year. According to the London Times, the price of thorium nitrate was dropped from \$2.81 per pound to \$2.37 and then to \$1.72 by the Austrian Welsbach Company. This was done in retaliation for the breaking of a certain unwritten agreement between the Welsbach Company and the German Thorium Convention. It is said with the method of extraction used by the thorium convention thorium nitrate costs about \$1.94 per pound, while the Austrian method is less expensive. With a 3 per cent. discount on the \$1.72 rate, making \$1.67 per pound, the Welsbach Company disposed of some 145,464 pounds of thorium nitrate in a few days. The thorium convention was greatly embarrassed, since the contracts with its customers called for the advantage of low market rates. The convention placed its price at \$2.05 per pound. It is not known whether a new understanding will be reached and the price become settled again.

The reduction of the duty on monazite imported into the United States, under the terms of the new tariff revision, from

6 to 4 cents per pound, including thorite under the same rating, has opened a small market, at least for foreign monazite and thorite.

No exports of monazite were recorded by the Bureau of Statistics, though the output of one of the companies operating in the Carolinas is shipped to Germany.

There was a production of about 2,000 pounds of zircon, valued at \$250, from the Jones mine, near Zirconia, N. C., operated by M. C. and C. F. Toms. Of the output of zircon at the mine of C. H. Hackney, of Le Harpe, Kans., in the Wichita Mountains, obtained during prospecting, none was placed on the market.

**MINE RESCUE SERVICE.**

A life-saving service for the rescue of miners in time of disaster is about to be inaugurated by the United States Bureau of Mines. Six specially constructed cars, manned by a corps of miners trained in rescue work, and equipped with the latest rescue apparatus and first aid to the injured appliances, will be located in the midst of the great coal districts of the country. These cars will be ready at a moment's notice to proceed to the scene of a disaster.

The cars will each contain eight so-called oxygen helmets, a supply of oxygen in tanks, one dozen safety lamps, one field telephone with 2,000 feet of wire, resuscitating outfits and a small outfit for use in demonstration.

The first car will be located at Monongahela City, Pa., where the first demonstration of rescue apparatus will be given. Four other cars will make their headquarters at Rock Springs, Wyo., Billings, Mont., Salt Lake City, Utah, and Knoxville, Tenn.

Last year 2,412 men were killed in coal mines and 7,979 injured.

**MEXICAN CEMENT PLANT.**

The "Tolteca" Cement Co. has just completed the most modern plant in Mexico at Tolteca, state of Hidalgo. This factory has been under construction since September, 1909, and has cost upward of 1,000,000 pesos. The company is composed of American capitalists, who have a parent plant at Louisville, Kentucky.

There is not a user of cement in Mexico who will not realize what it means to have a cement manufactured in the country equal in every respect to the best imported article. To begin with, the prices will be materially lower, as the duties and freight rates will be done away with. Unnecessarily high prices have hitherto been a great obstacle to the general use of this material in Mexico.

**CEMENT FROM BLAST FURNACE SLAG.**

[From Consul-General John L. Griffiths, London.]

American inquiries have been made concerning the new cement, similar to Portland, but which has been manufactured in an entirely different manner. A number of letters were addressed by this consulate-general to English architects and engineers, with the result that no one knew anything about the process. The following statement was finally secured from a consulting chemist:

From the nature of the process, namely, the use of blast furnace slag in a perfectly fluid condition, complete combination of the acid and basic oxides—namely, silica, alumina and lime—is insured, and in consequence it might be predicted that the product would be free from any tendency to mechanical unsoundness which not infrequently occurs in cements which contain chemical bodies in an unsaturated or loosely combined condition. Direct and repeated tests show this to be the case. I have no instance on record of a sample of Collos cement which has not proved itself to be absolutely sound. When tested in the

usual way by being made into briquettes, both neat and with sand, it has a high and increasing tensile strength. Tests on concrete blocks show similar good resistance to compressive stresses.

SAMPLE 1.—TENSILE TESTS BRIQUETTES, 1 BY 1 INCH SECTION, BOHME HAMMER, 150 STROKES.

[Neat—3 sand : 1 cement.]

7 days.	28 days.	7 days.	28 days.
Pounds.	Pounds.	Pounds.	Pounds.
500	675	320	450
485	660	320	425
495	645	320	415
485	615	310	405
465	600	295	405
460	600	250	400
483 <sup>1</sup> / <sub>3a</sub>	632 <sup>1</sup> / <sub>2a</sub>	302 <sup>1</sup> / <sub>2a</sub>	416 <sup>2</sup> / <sub>3a</sub>

a Average.

COMPRESSION TESTS, 5-INCH CUBES.

[Cubes—1 cement : 5 Thames ballast.]

Crushed.

	Base area.	Stress.	Per square foot.	
	Sq. inch.	Pounds.	Tons.	
7 days.....	{ 25.10	16,800	43.0	} 45.4
	{ 25.10	17,940	46.0	
	{ 25.25	18,580	47.3	
28 days.....	{ 25.00	50,450	129.8	} 135.5
	{ 25.00	55,200	142.0	
	{ 24.15	50,600	134.7	
3 months.....	{ 24.90	47,400	122.4	} 129.6
	{ 25.00	53,060	136.5	
	{ 25.30	51,100	129.9	
6 months.....	{ 25.10	62,450	160.0	} 115.5
	{ 25.00	61,600	158.5	
	{ 25.00	57,500	147.9	
12 months.....	{ 25.00	63,600	163.6	} 167.5
	{ 25.00	65,700	169.0	
	{ 25.10	66,300	169.8	

SAMPLE 2.—TENSILE TESTS BRIQUETTES, 1 BY 1 INCH SECTION, BOHME HAMMER, 150 STOKES.

[Neat—3 sand : 1 cement.]

7 days.	28 days.	7 days.	28 days.
Pounds.	Pounds.	Pounds.	Pounds.
585	720	340	430
565	700	325	420
550	685	320	410
550	685	320	410
540	650	305	390
510	640	290	390
550 <sup>a</sup>	75 <sup>5</sup> / <sub>8a</sub>	315 <sup>a</sup>	408 <sup>1</sup> / <sub>3a</sub>

a Average.

COMPRESSION TESTS, 5-INCH CUBES.

[Cubes—1 cement : 5 Thames ballast.]

Crushed.

	Base area.	Stress.	Per square foot.	
	Sq. inches.	Pounds.	Tons.	
7 days.....	{ 25.40	18,630	47.1	} 46.1
	{ 25.10	19,410	49.7	
	{ 25.15	16,185	41.4	
28 days.....	{ 25.00	40,600	104.4	} 106.3
	{ 25.05	44,910	107.6	
	{ 25.15	41,850	107.0	
3 months.....	{ 25.10	52,250	133.9	} 136.4
	{ 25.20	55,700	142.1	
	{ 25.30	52,450	133.3	
6 months.....	{ 25.20	67,200	171.5	} 161.8
	{ 25.20	66,300	169.2	
	{ 25.15	56,550	144.6	
12 months.....	{ 25.40	64,620	163.6	} 164.8
	{ 25.40	66,780	169.1	
	{ 24.90	62,580	161.6	

I have myself seen the process in operation at Porz and at Harzburg in Germany and have tested numerous samples

made there as well as some prepared at Coltness and by the Consett Iron Company in this country, the tests in some cases being extended over a year.

The preceding table of tests may be of interest. The figures indicate that the cement in addition to its quality of soundness has ample mechanical strength and possesses all the characteristics of a reliable constructional material.

### GERMANY'S POTASH DEPOSITS AND MINES.

[From Consul Robert J. Thompson, Hanover.]

Germany is mining over 6,600,000 tons of potash salts yearly. Her exports of this valuable mineral fertilizer already amount in value to \$35,000,000 annually, and by the opening of some 40 more projected mines the output may attain an increase of 100 per cent. within the next decade. The most remarkable feature of the potash industry is that at present Germany holds a world monopoly of this precious soil-rejuvenating product, and it is shown that her mines will continue to yield their wealth for hundreds of years to come, probably long after the exhaustion of her coal mines. Thus her potash mines are coming to be regarded as the unparalleled national treasure of the German economic world.

Many millions of dollars have been lost in the opening of unprofitable mines, speculation, and overproduction. Owing to the temporary disintegration of the great potash trust, or syndicate, the industry was for a short time in a very critical state, but with the renewal of the combination last year, its encouragement by the Prussian Government, and the general improvement of financial conditions it is again making great strides toward a fixed and healthy business condition.

The first kali syndicate (kali is the general term used in Germany for potash) was formed in 1884 in order to regulate the sale of potash and protect the market from overproduction. The present syndicate owns or controls some 60 mines and it is reported well, within a few years, be operating not less than 100. It has 40 branch offices in Germany and abroad and issues extensive and effective propaganda in furthering the sale of its product for agricultural purposes. It has been noted that through its advertising the sales have been increased about \$2,500,000 per year over the average amount sold before this phase of the business was attended to.

Hanover is the recognized center of the potash district, although most of the mines are south and east of here, in the vicinity of the Hartz Mountains. It is claimed that potash deposits are known to exist in Florida, also in China, but if these claims are true, the locations have been held secret and are known only to certain individuals.

In arriving at the present theories respecting the geological formations of the kali beds, or potash salt deposits, of northern Germany, the German scientists go back to the earliest periods of the history of the earth. The millions of years through which the same has passed, since the hardening of its surface crust and the precipitation of its aqueous vapors, are divided by geology into four great groups of formation—the Archean, Paleozoic, Mesozoic, and Cenozoic. These, as well as their subdivisions, are distinguished by their various beds of deposit formed by the gradual washing away of the titanic primeval mountains and slowly cemented into a new stone (sediment stone) through the great pressure of the later deposits.

Calculating from the seventh of these formations, the so-called "permformation," which up to the present time has been followed by five later formations (trias, jura-limestone, chalk, tertiary, quaternary), and which lies at about the middle age of the geological development, two under-formations—zechstein (magnesian limestone) and the lower new red sandstone—have been developed.

The term "zechstein" was given to the gray limestone in

the Mansfield copper mines, owing to the fact that to reach the copper, shafts or "zechen" were driven through this limestone to the copper layers underneath; thus the denomination came into use for the whole formation found in northwest Germany.

According to Miller and Lyell (1850) and Ochsenius (1878), these limestone deposits originated at a time when high mountains were found in the north and west of northwest Germany, with wide plains stretching themselves to the east, and in what is to-day north and middle Germany, a large, flat inland lake covered the land and was separated from the southern ocean by a barrier dry at ebb tide but under water at high tide. This lake was probably joined to the ocean by a shallow canal, at the bottom of which the concentrated salt solution of the lake was deposited by evaporation. Nevertheless, the salts accumulated through evaporation of the saline water, constantly brought in from the ocean, until anhydrite, sodium chloride, etc., salts not generally easily dissolved were finally separated.

The foregoing theory, known in connection with potash deposits as the barrier theory, was advanced by Professor Ochsenius and elaborated by Everding, and it is now accepted by the Geological Landes-Anstalt at Berlin and many other geologists. On the other hand, other prominent scientists, such as Professor Walther and Professor Erdmann-Halle, maintain the opinion that the salt deposits formed themselves in deserts by the erosion of vast salt mountains, Professor Erdmann claiming that at the time of the zechstein formations all middle Europe was covered by a wide inland sea; that this sea evaporated and the salts were separated, and afterwards the saline deposit of the former lake having been redissolved by water, they accumulated again in hollows and subsidences of the earth's crust.

Near Unseburg (Stassfurt, Saxony), where the rock salt has been found 80 meters (meter = 39.37 inches) below the level of the surface of the earth, the whole deposit has been penetrated by boring and found to be 1,170 meters thick. The average thickness of the German potash deposit is therefore estimated to be 1,000 meters.

About 90 per cent. of this deposit consists of layers of rock salt 8-9 centimeters in thickness, between which thin anhydrite layers of 7 millimeters thickness, termed "year rings," are embedded.

According to modern science these anhydrite layers crystallized during the hot season, as anhydrite crystallizes only under high temperature. During the cold season, according to the Precht theory, the sodic chloride crystallized. Counting the year rings, it is estimated that the rock-salt deposit required a period of 10,000 years to form.

Owing to the separation of the anhydrite and large quantities of sodic chloride, various salts, such as magnesium salt and potash, accumulated, although in the beginning small quantities only were present. Toward the end of the period the saline solution consisted mostly of sodic chloride, magnesium sulphate, chloride of magnesium, chloride of potassium, and calcium sulphate. As the evaporation progressed, the barrier disappeared, or the canal was closed and the further supply of water discontinued. The calcium sulphate, potash sulphate, and magnesium sulphate crystallized and formed the so-called polyphalite bands which are found to-day and which lay about 60 meters thick above the rock salt which is 600 meters thick. These polyphalite bands form the second salt zone. In the center of this zone is a compound of calcium sulphate, magnesium sulphate, and potash sulphate:  $2\text{CSO}_4, \text{MgSO}_4, \text{K}_2\text{SO}_4, 2\text{H}_2\text{O}$  (formula supplied by Dr. P. Krische).

In the beginning of the crystallization process a mixture of anhydrite, carnallite, and kieserite with large quantities of rock salt were crystallized, later kieserite and carnallite only; this layer is therefore termed the kieserite layer, and the upper part of the layer, containing mostly kieserite and car-



nallite, is known as the carnallite region and forms the main potash deposit of about 25 meters thickness. These crystallizations are not deposited in regular horizontal layers, but followed each other, forming irregular bands dipping and rising and running at tangents.

After this period the potash and magnesium salts, being the easiest to dissolve, were crystallized by evaporation. The light, brilliantly colored mass of salt was covered up eventually by dust, and through this protecting cover and the dry temperature of the desert the potash has remained unaffected by the earthquakes and surface shiftings of later periods. Various depressions were formed in the earth's surface in which water accumulated and salts again crystallized, until finally the layer of dust grew so thick that the rain could not reach the potash lying underneath.

It appears that another great subsidence took place later and another large inland lake appeared which evaporated, leaving new deposits of rock salt, anhydrite, and potash above the original or elder salt. The anhydrite and potash were washed away, but the rock salt remained, and it is through this firm protection that at least one layer of the precious potash salt, in spite of its illuiveness, has been preserved to the present age. Through the shiftings of the ground and earthquakes, the deposits which at first lay in level zones were torn asunder and thrown into a confused mass; they were partly washed away and crystallized again in distant places.

According to the indicated shiftings of the earth's crust there are three different kinds or deposits of potash: First, the mother salt, or that which did not change after its original crystallization; second, the descendant salts, or those which crystallized themselves directly out of the former in consequence of ground-shiftings; third, posthume salts, or those which formed still later in consequence of earthquakes, floods, etc.

At first the potash crystallized as double-salt carnallite; this is called by Everding the main salt. It is found everywhere where potash exists and forms the base, so to speak, of all potash salts. When floods occurred, the first thing washed away was the chloride of magnesium, leaving a mixture of carnallite, kieserite and rock salt, which changed into a mixture of chloride of potassium, kieserite, and rock salt. This mixture is called hard salt and was formed, as shown by experiments made by van't Hoff, at a temperature of 730° C.

Through a falling temperature and the disappearance of chloride of magnesium, caused by floods and the formation of a solution of magnesium sulphate and potassium sulphate, another double salt evolved, namely, kainite or chloride of potassium-magnesium sulphate ( $KCMgSO_4 \cdot 3H_2O$ ).

Everding, one of the chief authorities on this subject, is of the opinion that, to form kainite, the floods must have been in effect for a long period of time. According to his theory the chloride of magnesium was washed away, the kieserite then changed into sulphate of magnesium and this sulphate, in combination with chloride of potassium, afterwards changed into the double-salt kainite.

Through long-continued floods the kieserite, or sulphate of magnesium, was also washed away and a mixture of sylvine—another denomination for chloride of potassium—and rock salt was crystallized. This mixture is called sylvinite.

Beside the various kinds of potash referred to there are a number of other salts, though rarely to be found, such as schönit, langbeinit, krugit, etc.

Potash was first found at Stassfurt near Magdeburg. The formation of the potash deposits at this place was such as to show very clearly the different layers. Since the days of the old Carolingian kings salt mines and saline springs have been commercially operated here. In the Middle Ages deep wells were made and yielded their owners a considerable profit by the sale of the salt recovered. In 1797 the Prussian Govern-

ment bought the Stassfurt saline works, shafts were bored, and rock salt was found. In 1856 a new colored rock salt was found, an unknown mineral, tasting bitter; the value being unknown it was thrown away as waste salt. Afterwards chemists discovered that the so-called waste salts contained magnesium and potash, and thereupon the chemical industries became interested. Successful experiments were made, and very soon a flourishing chemical industry sprang up at Stassfurt. The original rock salt was neglected, there being a great demand by the chemical works as well as the agricultural interests for potash.

The potash deposits at Stassfurt stretch very regularly in the form of a saddle of 20 kilometers length, with layers extending from this saddle at both sides. In mining, potash is not loosened from above but from below with blasting work and tunnels running diagonally upward. The ore is thrown into 300 to 1,000 meters deep shafts and from the bottom of the mine hauled up through the main shaft.

On being elevated to the mouth of the mine the potash is despatched directly to the mill, where it is ground and sold as manure salt, or to chemical plants for further reduction. The majority of the potash mines are therefore combined with a chemical factory (chloride of potassium plant), and nearly all have railway connections.

## OFFICIAL REGULATIONS AND RULINGS.

### FOOD INSPECTION DECISION NO. 127.

The following decision of the Attorney-General in regard to the labeling of whiskey is hereby promulgated as Food Inspection Decision No. 127.

WILLIS L. MOORE,  
*Acting Secretary of Agriculture.*

WASHINGTON, D. C., October 26, 1910.

DEPARTMENT OF JUSTICE,  
WASHINGTON, October 19, 1910.

The honorable the SECRETARY OF AGRICULTURE.

SIR: I have received your letter of July 28, 1910, in which you submit to me the following question of law for my opinion:

Is "Canadian Club whiskey" such a distinctive name, under the provisions of Section 8, paragraphs 10 and 11, of the Food and Drugs act of June 30, 1906 (34 Stat., 768), as to relieve a mixture of two separate and distinct distillates of grain from the requirement of being labeled "A blend of whiskies," under Section 8, paragraph 12, of the same act?

Your letter informs me that—

"Canadian Club whiskey" is a mixture of grain distillates, duly aged after mixing, without further admixture, and reaches the consumer at 90° proof. It is a particular kind and brand of whiskies made by Hiram Walker & Sons (Limited), at Walkerville, Ontario, and is now and has been for years known and sold under the name "Canadian Club whiskey." It is known by that name and no other to the trade and consumers in the United States and other countries, and no other whiskey is known by that name. "The Department of Agriculture," you advise me, "claims that the product is required to be labeled 'a blend of whiskies,' under the law as interpreted in Food Inspection Decision 113. The distillers contend that 'Canadian Club whiskey,' under Section 8 of the Food and Drugs act, is such a distinctive name as is there described, and therefore that the product is not required to be labeled as a blend."

By arrangement between your Department and Messrs. Hiram Walker & Sons (Limited) briefs were submitted to me by the Solicitor of your Department and the counsel of Messrs. Hiram Walker & Sons, respectively, in support of their respec-

tive contentions; and I have also had the assistance of oral argument by such Solicitor and counsel.

\* \* \* \* \*

The brief of the Solicitor of the Department of Agriculture contends that the distinctive name under which a mixture or compound may be sold must, in its entirety, be purely arbitrary or fanciful, and must not contain the name of the component elements of the compound. A mixture of wheat and barley, he concedes, might be sold as "Force" or "Vita" without stating of what elements it was composed, but a mixture of two kinds of barley could not be sold as "Melrose barley" without stating that it was a "blend of barleys." It seems to me that such a construction of the term "distinctive name" is not only unwarranted, but undesirable. The two main purposes which the pure-food law was designed to accomplish are first, to prevent the sale of adulterated foods, and, second, to prevent deception being practiced on the public. It would seem to me that the latter purpose is more apt to be secured by permitting the sale of a product under its own name, qualified by some distinguishing characterization, than by requiring it to be masked in an anonymity which would give no clue to any of its component elements.

But, without entering into an analyses of the many decisions cited in the briefs of the respective parties, or further pursuing a discussion of the question, it appears to me clear that the name "Canadian Club whiskey" is a distinctive name, so arbitrary and so fanciful as to clearly distinguish it from all other kinds of whiskey or other things, and a name which, by common use, has come to mean a substance clearly distinguishable by the public from everything else. (See *United States v. 300 Cases of Mapleine*, per Sanborn, D. J.; Notice of Judgment 163, Food and Drugs Act, p. 3.)

In my opinion, therefore, it is not necessary that the label under which "Canadian Club whiskey" is sold shall state that it is "a blend of whiskies."

I have the honor to be, respectfully,

GEO. W. WICKERSHAM,  
*Attorney-General.*

FOOD INSPECTION DECISION NO. 128.

*Sago and Tapioca.*

It has come to the attention of the Board of Food and Drug Inspection that there exists among the trade in various parts of the United States a very general misunderstanding with respect to sago and small pearl tapioca. Sago is prepared from the starch obtained from the pith found in the stem of several species of palm trees, natives of the East Indies, and tapioca is prepared by heating in a moist state the starch made from the root of the cassava or tapioca plant, which is indigenous to

certain South American countries. Both products ordinarily reach the consumer in granulated form and are designated as "pearl sago" and "pearl tapioca," respectively. While "pearl sago" and "pearl tapioca" are separate and distinct articles of commerce, each resembles the other closely in appearance, and fine pearl tapioca frequently has been labeled and sold as sago.

Under the Food and Drugs Act of June 30, 1906, articles of food are misbranded if the labels or packages contain statements which are false or misleading, or if particular articles are imitations of or offered for sale under the distinctive names of other articles. In the opinion of the Board the name "sago," or "pearl sago," without qualification, means the product obtained from the pith of East Indian palm trees, and starch products of different origin will be held to be misbranded under the act if labeled or offered for sale as "sago," "pearl sago," etc. The prepared starch product derived from the root of the cassava plant is tapioca, and should be sold and labeled as such.

There is also on the market an imitation sago made from potato starch. Imitation food products are misbranded under the act unless they are labeled so as to indicate plainly that they are imitation products and unless the word "imitation" is also plainly stated on the packages in which imitation products are offered for sale. Potato or other starch prepared to resemble pearl sago, therefore, should be labeled, for example, "Imitation sago. Made from potato starch," the words "Imitation" and "Made from potato starch" being declared as plainly and conspicuously as the word "sago." The word "Imitation" must appear on the label, but an equivalent expression may be substituted for "Made from potato starch," which will indicate unmistakably that the product is not made from the pith of East Indian palm trees, but is derived from a different source.

H. W. WILEY,  
F. L. DUNLAP,  
GEO. P. McCABE,

*Board of Food and Drug Inspection.*

Approved:

JAMES WILSON,  
*Secretary of Agriculture,*

WASHINGTON, D. C., October 31, 1910.

CORRECTION.

The title of my paper (THIS JOURNAL, 2, 385) should read "A Comparison of Bolling's and Harding's Modification of Drehschmidt's Method for Determining Sulphur in Illuminating Gas." In the last table the word grains should be substituted for grams.

DR. E. P. HARDING.