

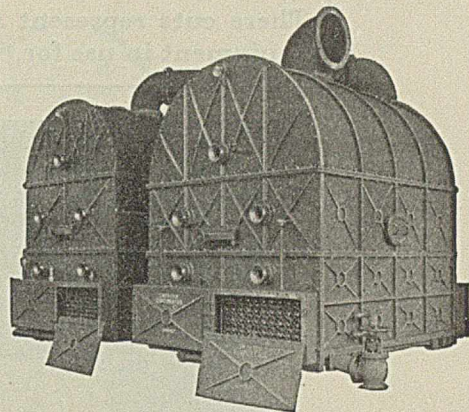
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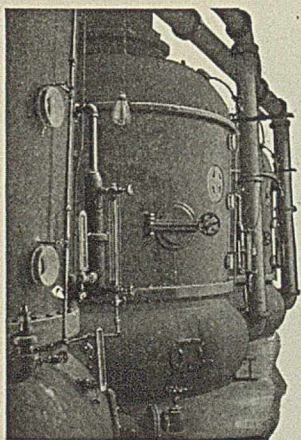
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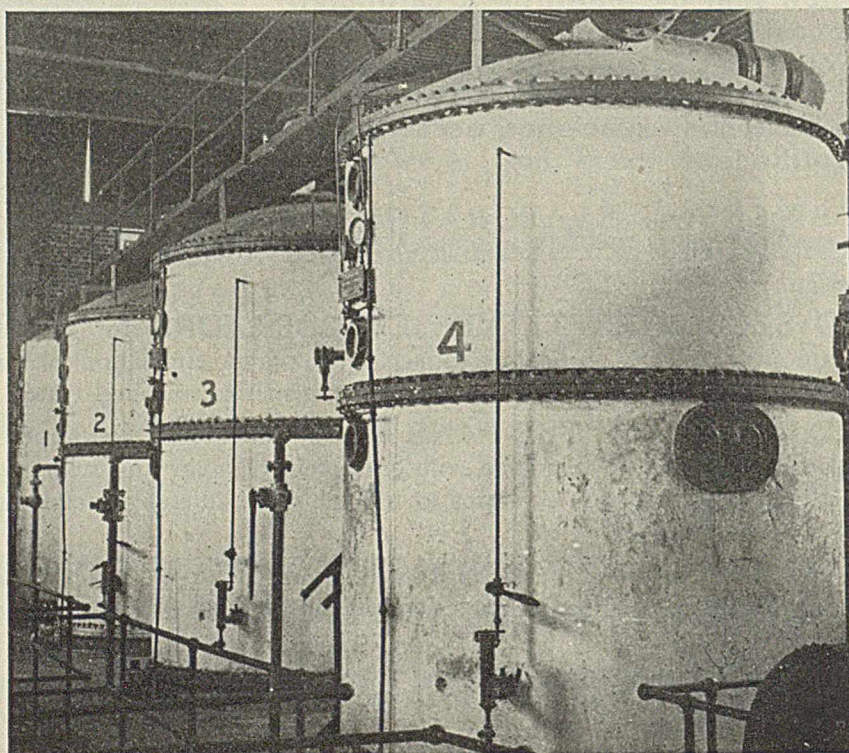
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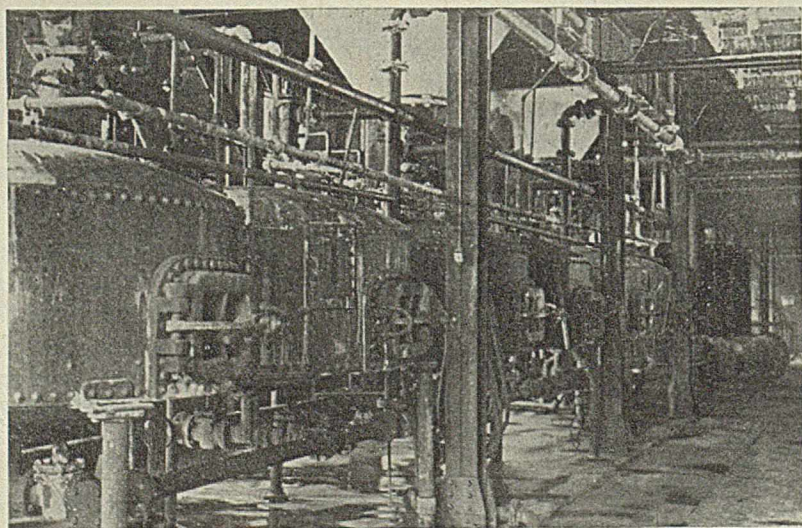
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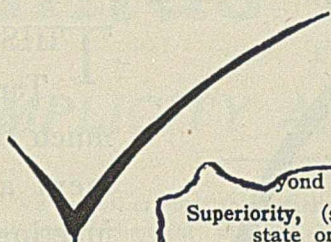
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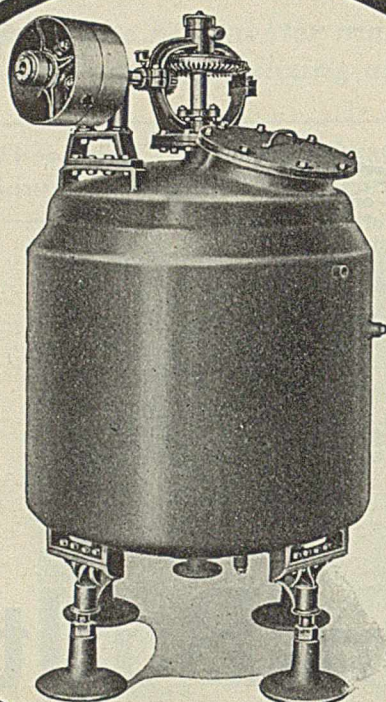
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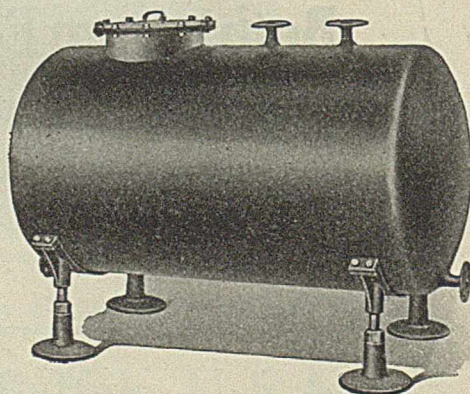
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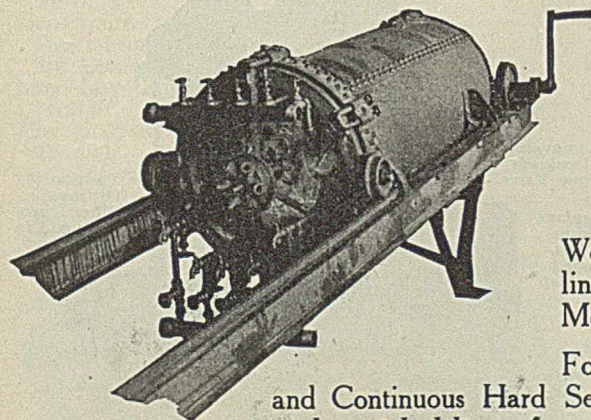
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Iodine (5 Gm.)	none
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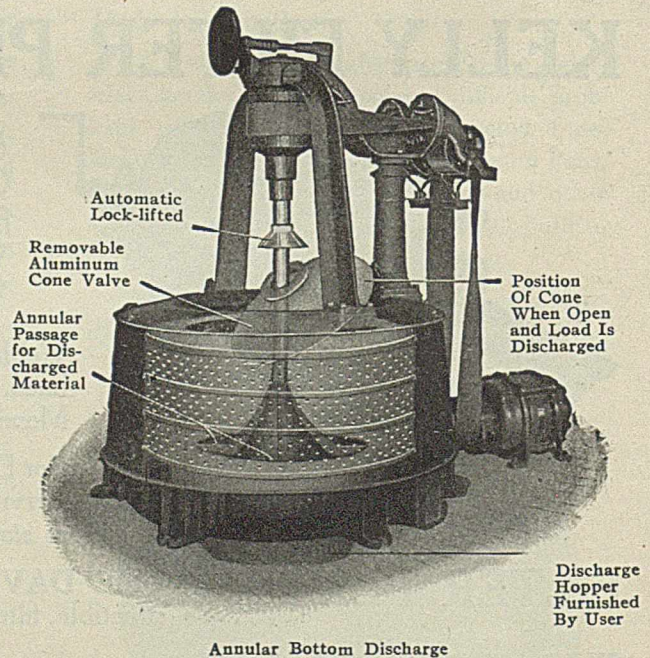
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SPRING MEETING AMERICAN CHEMICAL SOCIETY

The Fifty-Second Meeting of the American Chemical Society was held at the University of Illinois, Urbana-Champaign, April 17th to 21st. The meeting was the largest to date, the total registration being 728 (570 members and 158 guests).

The Council met on Monday evening at 6 o'clock in the Woman's Building, where they dined as guests of the local Councilors. The dinner was served by the Department of Home Economics and was followed by the regular business meeting, which was held in the library of the new Chemistry Building. Among the various items of routine business transacted and reported directly in the *Journal of the Society*, the following are of especial interest.

Mr. Crane, Editor of *Abstracts*, reported that advance subscriptions to the number of 1,938 had been received for the ten-year index to *Abstracts*. On the basis of this report Mr. Crane was authorized to proceed at once with his plans for getting out the index. Further discussion of the details will be found in a note to be published by Mr. Crane in the next issue of THIS JOURNAL.

The Committee on Industrial Diseases reported that they are planning a symposium on industrial diseases for the next general meeting of the Society; the installation of plants for the manufacture of dyes has brought up several points worthy of discussion.

A committee was appointed to consider the possibility of the establishment by the Society of a publicity bureau to aid in the dissemination of correct information of a chemical character to the public through the newspapers and the popular magazines.

At the suggestion of President Herty, the editors of the *Journal of the Society* and of THIS JOURNAL were authorized to exchange dates of issue. As soon as the necessary arrangements can be made, THIS JOURNAL will appear on the first of the month and the *Journal of the Society* on the sixth of the month.

The regular opening session was held in the University Auditorium Tuesday morning. Professor W. A. Noyes introduced President Edmund Janes James, who welcomed the Society in the name of the University. President James outlined the history of the University, and pointed out the influence of the people of the State on the growth and development of the university departments, citing the Ceramics department as an example; the Clay Workers' Association of Illinois have been responsible for the increase of the building appropriations for this department from \$1,000 to \$150,000 in a period of eight years.

President Herty responded for the Society and contrasted the meagre appropriations ordinarily allowed by the various States with those obtained for the University of Illinois. President Herty was of the opinion that the great success of the University of Illinois was due to the broadmindedness and efficiency of the various departments and to the sympathetic attitude maintained toward the people of the State.

He emphasized the part that institutions of this sort must play in meeting the chemical problems now before the American people, one of the principal ones being the necessity of making clear to the public that the foundation of the dyestuffs industry is absolutely necessary in order that proper equipment and the trained men essential to the manufacture of explosives in case of war may be available. To meet this need the chemical departments of the various universities must necessarily expand, but the administrative heads are warned against encouraging the students to leave with Bachelor's degrees in order to accept the large salaries that will be offered for control work. For the proper development of the chemical industries and chemical science in the United States it is absolutely necessary that the number of men up for the Doctor's degree must likewise increase, since upon these men will devolve the research upon which all progressive industrial development is based.

The opening addresses were followed by the five general addresses listed in the Society program printed elsewhere in this issue.

The public lectures given complimentary to the people of Urbana-Champaign by Professor Charles L. Parsons and Doctor Curtis F. Burnam on the production of radium and its use in the treatment of cancer were well attended. The lectures were well illustrated by specimens, models and moving pictures.

On Wednesday afternoon the new Chemistry Building of the University of Illinois was dedicated, the exercises being held in the auditorium.

ORDER OF EXERCISES

HONORABLE EDWARD F. DUNNE, GOVERNOR OF ILLINOIS, Presiding	
SCRIPTURE READING AND PRAYER, REV. GEORGE P. HOSTER, D.D., Rector of Emmanuel Episcopal Church, Champaign	
MUSIC.....	"Illinois"
ADDRESS.....	PRESIDENT EDMUND JANES JAMES
ADDRESS, "THE TRAINING OF CHEMISTS," ALEXANDER SMITH, Professor of Chemistry, Columbia University	
ADDRESS, "RESEARCH AS A NATIONAL DUTY," WILLIS RODNEY WHITNEY, Member of the U. S. Naval Board, Director of the Research Laboratory of the General Electric Company	
MUSIC.....	"America"

The addresses by President James, Professor Smith and Doctor Whitney, with an illustrated description of the new building, will appear in the next issue of THIS JOURNAL. After the regular program the audience adjourned for an inspection of the Chemistry Building, and for a reception at which Mrs. W. A. Noyes, Mrs. E. W. Washburn and Mrs. Arthur W. Palmer were hostesses.

The meetings of the Divisions were held in the various lecture rooms of the Chemistry Building. All the Divisions were unusually well attended, and offered programs of exceptional interest. The programs are printed elsewhere in this issue, and a large number of the papers will appear in full in the Journals of the Society. Some notable features were the special program on Home Economics held by the Division of Biological Chemistry; the Symposium on the Activated-Sludge Method of Sewage Purification, offered by the Division of Water, Sewage and



SCENE AT BANQUET HALL ON WEDNESDAY NIGHT, WHEN 402 MEMBERS, DELEGATES AND WOMEN GUESTS GATHERED IN LARGE DINING ROOM IN TEMPLE

Sanitation; and the Symposium on "The Chemist and Food Control" by the Division of Agricultural and Food Chemistry.

The University of Illinois has the only brigade of college students in America, and the largest number of cadets, 2,100 men being enrolled. On Tuesday afternoon a review of the University Brigade was held on the drill grounds, and was witnessed by a large audience. The University Military Band is claimed to be the best college band in America; the complete assembly of two bands, with a trumpet and drum corps, offers a monster band of 160 to 170 pieces. The First Regiment Band of 75 pieces, which is the concert band of this organization, gave a concert in the University Auditorium at 7.30 P.M. on Tuesday. This was much enjoyed by the large audience present. It was followed by the "Get-Together Smoker" in the gymnasium. Here refreshments were served as a measure of preparedness for the rest of the evening. The entertainment consisted of novel experiments illustrating various principles such as are usually treated in the courses on physical, inorganic, analytical, organic, pharmaceutical, physiological and agricultural chemistry. The audience was invited to join in the songs and limericks, copy of which was furnished in the program. The various stereopticon views shown furnished considerable amusement.

The regular banquet was held on Wednesday evening at the Masonic Temple. The room was lavishly decorated with pink roses and pink and white carnations furnished by the greenhouses of the University.

Four hundred and two guests sat down to an elegant eight-course repast, after which President Herty proposed a toast to the University of Illinois, rendered in the single word "Pep." He then introduced as toastmaster Professor Bogert, of Columbia University, who, with his well-known humor, presented the following speakers:

GEORGE B. FRANKFORTER, Dean of the School of Chemistry, University of Minnesota.
 LOUIS KAHLENBERG, Professor of Chemistry, University of Wisconsin.
 WILDER D. BANCROFT, Professor of Physical Chemistry, Cornell University.
 WILLIAM B. MCKINLEY, Congressman from the Nineteenth District of Illinois.
 HENRY P. TALBOT, Professor of Chemistry in Charge of Department, Massachusetts Institute of Technology.

The central idea of the speeches was the willingness of the American chemist to cooperate in defense of our country and the necessity for extensive application of scientific knowledge to the multitude of industrial problems now before the American people. The management of the Beardsley Hotel Company is to be especially complimented for the efficient and rapid manner in which they handled the serving of the banquet to such a large number of people.

Delicious luncheons were provided in the Gymnasium Annex on Tuesday, Wednesday and Thursday, by the Department of Home Economics. The convenience of this arrangement was greatly appreciated and the department deserves much praise for serving so many people with excellent food.

The regular Abstractors' dinner was held in the Y. M. C. A. building on Tuesday evening at 6 o'clock, the dinner being served by the management of the

Y. M. C. A. Cafeteria. Brief talks were made by Editor Crane, former Editor J. J. Miller and Dr. Bigelow.

Tuesday and Thursday afternoons from 1.30 to 4.30, and Wednesday afternoon after the dedication were given over to excursions about the buildings and grounds of the University. The visitors were divided into small groups furnished with special guides. The 16-page itinerary of excursions containing statistical data and much information concerning the various buildings and departments was found exceedingly useful and the thoughtfulness of the Illinois Section in providing them was greatly appreciated.

The College of Agriculture was an especially popular place; it runs an especially modern and efficient creamery, which contains the only dry hardening room operated by a dairy department in this country, and owns the only commercial sized condensing pan operated by any school dairy department in this country. In the Animal Nutrition and Dairy Husbandry Laboratory, charts, photographs and exhibits illustrated the cutting of beeves, the composition of feedingstuffs, the study of rations of different protein contents upon the growth and development of pigs, and the influence of different proportions of concentrates and roughages and of varying amounts of feeds upon the digestibility of cattle rations. Especial interest was shown in the exhibits of plant breeding in the crop production laboratories and pot-culture department. The experimental plots started by Professor Morrow in 1879 are the oldest in the United States. The greenhouses have a floor space of 28,000 square feet under glass, and twenty-four professional students are busy carrying out experiments, mainly on commercial fertilizers and plant diseases. In the Genetics Building are 400 cages, containing 2500 mice and rats; a total of about 10,000 mice have been raised; 33 generations consisting of 55,000 individuals of the fruit fly, *Drosophila*, have been grown; twelve experiments are being carried on relating to the different phases of heredity and variation. In the Stock Pavilion the visitors inspected representatives of the University herd, flocks, and studs, which include about 500 pure-bred beef cattle, sheep, swine and horses; several hundred fowls, ducks and turkeys; and 100 pure-bred and 80 grade cattle.

Among the other buildings visited the following deserve special mention: The Locomotive Testing Laboratory, fireproof building, 117 ft. by 42 ft., connected by a spur with the Illinois Traction System's tracks; the Ceramics Engineering Building, built of texture brick and polychrome terra-cotta, and intended to present modern achievement in the use of ceramic structural materials; the Ceramics and Mining Laboratory, containing a large kiln, a large furnace room, a mining engineering laboratory, a chemistry laboratory for the Department of Mining Engineering, and a mine rescue station equipped and arranged for training men in the methods of mine rescue work; the Physics Laboratory; Engineering Hall; the Pumping Station of the University Water Works, containing a masonry reservoir providing for the fire reserve supply and

having the various pumps, tanks and connections arranged to give opportunities for experimental work; the Laboratory of Applied Mechanics; the Electrical Engineering Laboratory; the Botany Annex; the Central Heat and Power Plant; Mechanical Engineering Laboratory; the Vivarium, intended to provide the Departments of Zoölogy and Entomology and the State Laboratory of Natural History with facilities for experimental work with living animals under controlled conditions; the Metal Shops; the Library Building; and the Law Building erected in 1878 as a chemical laboratory and so used until the building of the larger chemical laboratory in 1902.

In the basement of the Chemistry Building the chemical show described in our previous issue was available for visitors during the entire session of the meeting. The exhibits were as follows:

- Abbé Engineering Company, New York. Laboratory ball mill, vacuum pump, model of tube mill.
- American Coal and By-Products Co., Chicago. Coal-tar products.
- Armour Ammonia Works, Chicago. Anhydrous ammonia.
- P. Blakiston's Son & Company, Philadelphia. Technical books.
- Braun Corporation, Los Angeles. Analytical electrolytic outfit.
- Celluloid Zapon Co., Chicago. Lacquer materials.
- Central Scientific Co., Chicago. General laboratory apparatus.
- Chattanooga Chemical Company, Chattanooga. Coal-tar products.
- Dearborn Chemical Co., Chicago. System of boiler water treatment with typical examples of flue corrosion.
- J. P. Devine Co., Buffalo. Display of photographs of chemical machinery.
- Duriron Castings Co., New York. Duriron.
- Edison Storage Battery Co., Chicago. Edison cells.
- Eimer and Amend, New York. General laboratory apparatus.
- Elyria Enameled Products Co., Elyria, Ohio. Glass enameled apparatus.
- Fairview Fluorspar Lead Co., Golconda, Ill. Fluorspar.
- General Electric Co., Schenectady. The Research Laboratory exhibit from the Panama-Pacific Exposition.
- Henry Holt & Company, New York City. Technical books.
- Herold China Pottery Co., Golden, Colo. Chemical porcelain.
- Laboratory Supply Co., Columbus. General laboratory apparatus.
- Leeds & Northrup Company, Philadelphia. Electrical measuring apparatus. Room 165.
- Lenz & Naumann, Inc., New York. Chemical apparatus.
- Libby Glass Company, Toledo. Chemical glassware.
- Longmans, Green & Co., New York. Technical books.
- Emil E. Lungwitz, New York. Filter press.
- Macbeth-Evans Glass Company, Pittsburgh. Chemical glassware.
- Manhattan Rubber Co., Passaic, N. J. Rubber from crude state to finished products.
- McGraw-Hill Book Company, New York. Technical books.
- McIntosh Stereopticon Co., Chicago. The stereopticons used in the sessions of meeting.
- Metallurgical Chemical Engineering, N. Y.
- Mitchell Lime Company, Mitchell, Indiana. Lime products.
- Mojonier Bros. Company, Chicago. Milk testing machinery.
- National Carbon Company, Cleveland. Electric cells and carbon specialties.
- National Lead Company, Chicago. Lead products.
- Norton Company, Worcester. Alundum.
- Palo Co., New York. Thermometers.
- The Permutit Company, Chicago. Demonstration of Permutit process.
- Pfaudler Company, Rochester. Enameled tanks.
- Sarco Company, Inc., New York. Temperature regulators and steam traps.
- Schaeffer & Budenberg Mfg. Co., Chicago. Gauges and thermometers.
- Schutte & Koerting Company, Philadelphia. Chemical manufacturing machinery.
- Scientific Materials Company, Pittsburgh. Laboratory apparatus.
- Sharples Specialty Company, Chicago. Demonstration of centrifugals.
- Sowers Manufacturing Co., Buffalo. Vacuum pans, kettles, etc. Duplicate of exhibit at New York show.
- E. R. Squibb & Sons, New York. Chemicals.
- Standard Calorimeter Company, Moline, Ill. The Parr apparatus.
- Sweetland Filter Press Company, New York. Demonstration of filter press.
- Thermal Syndicate, New York. "Vitreosil."
- Thwing Instrument Company, Philadelphia. Pyrometers.
- Toch Brothers, New York. Paints and enamels.
- U. S. Bottlers Machinery Company, Chicago. Bottling machinery.

U. S. Metals Refining Co., Chrome, N. J. Samples of precious metals.
Walrus Mfg. Co., Decatur, Ill. Laboratory desks.
John Wiley & Sons, New York. Technical books.

Members and guests to the number of 206 left Urbana-Champaign on Friday morning at 8 o'clock for Danville. A special train was furnished by the Illinois Traction System. Members of the Chemistry Faculty and of the State Geological Department pointed out and explained the geology and the plants of interest as they were passed by the party. The cars stopped first at the Hegeler Zinc Smelter. This plant began operations in August, 1908, with 1800 retorts: at the present time there are 5400 retorts in operation with a daily production of 75 tons of spelter. High-grade Joplin blende concentrates are roasted in Hegeler multiple hearth kilns, the sulfur dioxide being utilized in sulfuric acid manufacture by the lead chamber process. The acid systems have a daily capacity of 150 tons of H_2SO_4 (60° Bé.). The roasted ore is mixed with anthracite slack coal and carried by belt conveyors to the charge bins in the furnace building. The distillation furnaces are of the Hegeler producer-gas fired type and have 900 retorts each. Boilers are installed upon some of the furnaces to utilize waste heat. During the morning visit all the operations connected with the beginning and end of the 24-hour cycle for each retort were seen, including drawing and casting of the zinc, removing and cleaning the condensers, removing residues from the retorts, recharging the retorts, setting up and closing the ends of the condensers.

The party was entertained in Danville by the Chamber of Commerce, who furnished a most delicious luncheon, cafeteria style, consisting of an enormous variety of cold meats, salads, relishes and sandwiches, with steaming hot coffee.

In the afternoon the parties divided, one section going to a glassworks, which is making window glass, and the other to the Carbon Hill Stripping Mine. In this mine a 5-yard steam shovel with a 90-ft. boom is operating along a face from a quarter to a half mile long, taking out a strip from 28 to 35 feet wide, with an overburden from 8 to 45 feet in thickness. The coal seam averages about six feet in thickness and the product is of good quality. Of unique interest to chemists is the pyrite washery operated at this mine, which runs through 75 tons of material per day, yielding 35 tons of high-grade pyrite. This is sold to acid manufacturers as "coal brasses" on a guarantee of 47 per cent sulfur. The company also

owns the Mission Field Mine, the oldest and most extensive stripping in the district. This was seen from the train on the return trip to Champaign: it has been worked for over 25 years and is now exhausted: underground operations are continued, however, by means of slope and drift mines.

The party then proceeded to the plant of the Western Brick Company, which manufactures a number of different kinds of brick and tile. The shale used is taken from the strata lying above the coal seam in the company's strip mine adjacent to the plant. The company has two other plants in the vicinity of Danville. In all they operate 76 kilns and have an annual production of 100 million brick.

The number of ladies at the meeting was not as large as usual. The ladies of the town and the ladies of the faculty, under the leadership of Miss Isabel Bevier, were especially active in looking after those present. On Tuesday afternoon, Mrs. S. T. Busey and Mrs. David Kinley were hostesses at a reception in the Woman's Building; afterwards automobiles were available for excursions through the grounds. All the exercises of the regular program were attended by the ladies and their guests. On Wednesday a reception and luncheon at the Champaign County Country Club, with Mrs. B. F. Harris, Mrs. D. P. McIntyre and Mrs. Stanley Boggs as hostesses, was given in honor of the visitors. On Thursday afternoon the Woman's Building was open for inspection, and Mrs. Bartow and Mrs. Green were hostesses. The ladies present expressed themselves as not only well entertained, but considerably educated by their visit, as the Home Economics Department is an exceedingly complete and efficient one, and the Woman's Building, with its wonderfully complete equipment, offered many interesting suggestions to home-makers.

The visiting members were amazed at the efficient manner in which arrangements had been made to carry out smoothly the various features of the program; everywhere one noted the pains that had been expended on the plans to make comfortable in a small town the large number of guests present. The Local Committees, headed by Professor Edward Bartow, and made up almost entirely from the faculty of the Chemistry Department, can be congratulated on having engineered our most successful and largest general meeting and on having furnished another illustration of the executive ability of the American chemist.

ORIGINAL PAPERS

THE DEVELOPMENT OF LOW EXPANSION GLASSES¹

By E. C. SULLIVAN

Low thermal expansion coefficient in glass is useful mainly because it carries with it the property of withstanding sudden heating and cooling without fracture. The expansion is one of six factors which determine the ability of the glass to resist such treatment.²

This coefficient of thermal endurance is proportional directly to the tensile strength and to the square root of the heat conductivity and proportional inversely to the expansion coefficient and to the modulus of elasticity and to the square roots of the specific gravity and of the specific heat. Thanks to the pioneer work of Otto Schott of Jena, Germany, we know that the expansion can be varied over a very wide range. Disregarding quartz glass and speaking only of glasses

¹ Presented before the Society of Chemical Industry on March 24, 1916.

² Winkelmann and Schott, *Ann. Phys. Chem.*, 51 (1894), 730.

which can be melted and worked by the usual methods, the expansion of glass now can be varied in the ratio of six or seven or more to one. There is no reason to think that any such range is possible with respect to the other properties mentioned.

Ordinary lead glass has a linear expansion coefficient of 0.000092 while lime glass is somewhat higher. Glasses are made without difficulty having expansions as high as 0.000130 or 0.000140, copper by way of comparison being 0.000175, iron 0.00013. Going down the scale we find the Jena normal thermometer glass 19'' at 0.000085, and Jena borosilicate thermometer glass 69'' at 0.000064. The well-known brands of laboratory ware are made of glass having expansion from 0.000055 to 0.000075. A glass recently developed in America which is finding some application for laboratory ware and for culinary utensils, although the bulk of it goes into battery jars and lantern globes for railroad purposes, has expansion of 0.000032.¹ This expansion is practically the same as that of the best porcelain and the glass makes a satisfactory permanent seal with porcelain. Quartz glass has an expansion of 0.000006 to 0.000007.

The glass maker who endeavors to reduce the expansion of his glass soon encounters the serious difficulty that as expansion decreases, fluidity is likely to decrease also. The glass of low expansion tends to become very stiff at the ordinary glass-melting temperature. This is obviated to some extent by the use of boric oxide, but this has its limitations not only because the expansion of the glass passes through a minimum and begins to increase again as the amount of boric oxide is increased, but also because boric oxide, used in large quantities, affects the stability of the glass very injuriously. One successful low expansion glass containing an unusual percentage of boric oxide was slowly but completely soluble in water. Jars of this glass $\frac{1}{8}$ in. thick went to pieces with water in them in two or three months, while acid ate through them in a few days, and yet the glass was perfectly satisfactory for certain service and hundreds of tons of it were used.

Two glasses of equally low expansion will not, however, in general have precisely equal viscosity and it is by taking advantage of slight differences in viscosity when the expansions are alike that the most favorable relation between expansion and meltability is worked out step by step.

THE EXPANSION is measured by the method of Holborn and Day in a water-jacketed electric furnace consisting of a horizontal porcelain tube wound with resistance wire. Within the tube is supported horizontally a rod of the glass to be measured, about 3 mm. in diameter and 25 cm. long and pointed at each end. Directly beneath the pointed ends of the rod are vertical openings in the bottom of the furnace through which, by means of totally reflecting prisms, small telescopes can be sighted on the points. Cross-hairs and a micrometer screw on each telescope fix the position of the extremities of the rod and so its

length. The temperature cold is determined by means of a thermometer thrust into the end of the porcelain tube and hot by means of platinum-platinum-rhodium thermocouples which extend half the length of the tube. The temperature is carried usually to 350° C. or 400° C. and the expansion coefficient as determined is accurate to a few tenths of one per cent which is adequate for the purpose.

A more direct comparison of coefficients of thermal endurance which requires less time than the expansion measurement, is made by heating eight or ten glass rods in a vertical electric furnace to a definite temperature and then dropping the rods all at once into water by removal of the supporting asbestos slide. The temperature at which 50 per cent of the rods fracture is a figure which for purposes of comparison represents the coefficient of thermal endurance of the glass in question.

THE SOFTENING TEMPERATURE is measured by a method similar to that described by Dr. Schaller of the Jena laboratory.¹ A thread of glass approximately 1 mm. in diameter and 23 cm. long is suspended vertically through a small electric furnace in such a way that the thread is heated through the upper 9 cm. of its length. The temperature is raised and noted at short intervals and as the thread elongates of its own weight the movement of the lower end is read off on a scale and plotted against the time. The moment at which the thread was elongating at the rate of 1 mm. per minute is read from the curve at a glance and the temperature of the upper part of the thread at that moment is taken as the softening point of the glass. This is, of course, an arbitrary point.

This method gives us the viscosity at low temperatures and is useful in determining the sealing qualities of a glass. It does not, however, give us as much information as we should like regarding the viscosity at high temperatures, which goes far toward determining the ease of melting. Behavior when worked in a hot flame gives some indication on this point.

THE WORKABILITY of a glass depends on its freedom from tendency to crystallize, on its viscosity curve, and on its surface tension. The glasses which are most satisfactory in the hands of the glassworker are those which remain pasty through an extended range of temperature. It is this possession of a viscosity curve which is low at comparatively low temperatures and yet does not decrease rapidly as the temperature rises which gives lead glass its advantage in the construction of electric incandescent lamps and other apparatus. The lead glass after being sealed to wire or other glass as it cools remains soft to a low temperature and thus can yield to stresses caused by uneven cooling or unequal expansions and can cool without strain. Lime glass is more like a crystalline substance, which remains rigid until a definite temperature (its melting point) is reached, when it at once becomes very fluid. The viscosity curves of such glasses cross, and the lead glass which is softer, that is, less viscous than the lime glass at low temperatures, is harder or more viscous

¹ Sullivan and Taylor, *THIS JOURNAL*, 7 (1915), 1064.

¹ Abegg, "Handb. d. anorg. Chem." Bd. III, Abt. 2 (1909), 373.

at high temperatures. This is easily shown in the pull-test, which is a simple method used by the glass-worker for comparing the working qualities of glasses. The two glasses in cane or tube of the same diameter are sealed together and heated as nearly alike as possible and are then removed from the flame and slowly pulled out a few inches, the joint being first slightly blown up in the case of tube. The harder glass will have greater diameter at the joint than the softer after pulling out. This is a sensitive and very useful method for checking up the uniformity of different lots of glass. In this test as already indicated the result in the case of glasses which differ widely in composition may depend on the temperature of pulling. A lead glass which appears softer than a lime glass at low temperatures may turn out to be harder than the same lime glass if the test is made quickly when the glasses are very hot.

THE TENDENCY TO CRYSTALLIZE is determined by a method described by Schaller.¹ A number of small crucibles containing the glass under investigation are maintained at a low temperature favorable to crystallization for a definite time, and the proportion of cases in which crystallization begins is taken as a measure of the tendency of the glass to devitrify.

RESISTANCE TO ATTACK BY REAGENTS is most accurately measured by forming beakers of the glass and subjecting them to the solvent action of redistilled water on the steam bath. The temperature thus attained is about 80° and the usual time is 48 hours. The solution is evaporated in a small platinum dish and the residue weighed. Nonvolatile matter in the water used is determined and allowed for. Titration of the alkali dissolved instead of weighing is sometimes permissible but should be employed only for the comparison of similar glasses as the assumption is not always warranted that the alkali found is proportional to the total amount dissolved.

On the other hand, neither the alkali nor the total solids dissolved from the glass will in all cases answer as index to the serviceability for the reason that some glasses leave more opaque residue on dissolving than others do. The glass which is less soluble may become more cloudy when attacked by reagents than that which is more soluble. For comparison in this respect we find a steam digester useful with pressure at about 100 lbs.

A rapid method which has been very satisfactory consists in enclosing a short length of glass rod with 10 cc. distilled water in a steel tube provided with screw cap and maintaining at a temperature of 180° C. for 2 hrs. The alkali in the water is then titrated. Eight or ten of these tubes are run at one time.

An unexpected result when the glass baking dishes were put into service was the fact that baking took place more rapidly in them than in dishes of the ordinary materials.² Investigation developed a sufficient reason for the phenomenon but the fact was nevertheless very surprising. Metal reflects according to various authorities from 83 to 99 per cent of the radiant

heat which strikes it while glass reflects only 3 to 14 per cent. That radiation and not convection or conduction is the preponderant factor in baking was established by the following experiment:

The reflectivity of a glass baking dish was changed in part from that of glass to that of metal by silvering in a thin film on the outer surface in alternate quarters. A cake was baked in it in an ordinary kitchen oven heated by a gas flame. Where the cake had been protected by the metal coating, the bottom after baking was light-colored, sticky, and imperfectly baked, while in the other quarters it was brown and well done. As the cake was turned out bottom up the quartering was plainly visible on it.

CORNING GLASS WORKS
CORNING, N. Y.

A RAPID METHOD FOR THE DETERMINATION OF SOLUBLE NITROCELLULOSE IN GUNCOTTON

By H. C. MALLINSON

Received December 21, 1915

According to the British Government specifications the determination of soluble nitrocellulose in guncotton is conducted as follows:

"Four grams of dry guncotton are shaken up with 200 cc. of ether alcohol every 15 minutes for about 6 hours and then allowed to settle. When the solution above the guncotton is clear, 75 cc. are transferred to a small weighed flask, the solvent evaporated, and the residue dried until constant in weight, at a temperature not exceeding 65° C."

This method, which may be styled the evaporation method, is, to say the least, extremely tedious; and what is of more importance, it is not at all accurate owing to the occlusion of solvent which cannot be driven off. A step in the right direction is the method used by some analysts in which water is added to the solution before evaporating. This "indirect precipitation" method is as tedious and takes a little longer time than the regular evaporation method, although the results are lower, denoting greater accuracy, for it is obvious that if none of the ether alcohol-soluble matter is lost, the lower the results the greater the accuracy.

It is our practice at the laboratory of the smokeless plant of the American Powder Mills, to determine solubilities by what may be called the "direct precipitation" method, which is not only much quicker but gives more accurate results.

Some comparative data (percentages) on different samples show interesting results:

Sample No.	British Specification Evaporation Method	"Indirect Precipitation"	"Direct Precipitation"
1.....	7.30	7.20	7.00
2.....	9.30	8.56	8.40
3.....	20.00	19.22	18.82
4.....	25.05(a)	24.26	23.82

(a) Obviously the error in the evaporation method increases as the solubility rises. By applying a correction, solubilities may be found by precipitation and made to agree closely with results obtained by evaporation.

The following results show that repeated determinations are fully as satisfactory by the direct precipitation method as by the other methods, the same sample of cotton giving:

Direct Precipitation Method 2b	"Indirect Precipitation"	Evaporation Method
16.84	17.20	18.08
16.84	17.66	18.16
16.83	17.36	18.10

¹ *Loc. cit.*

² Sullivan and Taylor, *Loc. cit.*

The evaporations were all conducted at the same time and under identical conditions. I am of the opinion that if they were evaporated under different conditions of heat and humidity, these results would not check quite so well, while with our method there is no chance for conditions to play a part.

Another sample, treated according to each of the three methods quoted below, gave these results:

Method Number.....	1	2a	2b
Percentages.....	11.36	11.28	11.34

We carry out the direct precipitation method as follows:

A 5-gram sample (or if the solubility is known to be 25 per cent or higher, a 2-gram sample) is treated with 200 cc. of ether alcohol in a 200 cc. graduated cylinder. After settling, 50 cc. of the supernatant liquid are transferred to a porcelain dish of 650 or 700 cc. capacity. About 500 cc. of water at a temperature of 75 or 80° C. are slowly poured down the inside of the dish. This completely precipitates the dissolved cotton and the last traces of solvent are driven off by submerging with a glass rod the floating disk of cotton. The appearance of the precipitated mass determines the next step.

1—*Precipitate consists of one mass or disk (or one disk and a few small particles of cotton which may be added conveniently to the disk with forceps).* The disk is removed and laid as flat as possible on a piece of filter paper which has been marked with the sample number, and rests on a folded towel or some other absorbent material. The sample is now moistened with alcohol to shorten the time necessary for drying, covered with another filter paper, and the towel folded over all. By pressing with the hand the disk is dried to such an extent that drying in the oven occupies but a very short time, about 20 minutes at 160° F. if the sample is not large. The top filter paper is removed before drying, the lower one with the sample being placed in the oven until curling and crispness indicate dryness. The sample is then transferred to the balance and weighed directly. (*Wt. in grams* \times 80 = *Per cent solution.*)

2—*Precipitate does not hold together and (1) is impractical.* (a) Counterpoise two filter papers of convenient size, fold, and place one within the other, putting both in a funnel. The mixture of water and precipitate is poured onto the filter, any traces adhering to the sides of the dish being freed by a policeman. The dish is then rinsed with alcohol, and the alcohol poured onto the filter so that it washes the cotton down into the apex of the cone. The filters are removed from the funnel, flattened out by pressing between the folds of a clean towel, then removed to the oven. When dry, the sample is weighed by placing the outer filter paper on the weight side of the balance. Thus the weight is found directly.

(b) A quicker and very exact method is to use a tared metal or porcelain Gooch crucible. Ordinarily this will suffice to hold the precipitate without any trouble whatever, and the bulk of the water may be poured through first. But if this seems inadvisable in certain cases, the largest mass may be transferred

to the crucible, carefully covering the perforations; it then acts as an excellent filtering medium, retaining the smaller particles when the remainder is poured through. The filtrate should be caught in a clean beaker and examined to make sure that it is free from precipitate. The mass is moistened with alcohol, the crucible placed on a clean folded towel, and the cotton is pressed first against the side of the crucible with a glass rod, then down on the bottom, somewhat after the manner of making a Munroe crucible. In the case of an isolated sample, or when the cotton has been badly separated, a Munroe crucible may be used to good advantage.

Cotton treated by the direct precipitation method has much greater stability than when evaporated from an ether alcohol solution, and will stand a temperature of 170° F. without loss of weight long after it is dry.

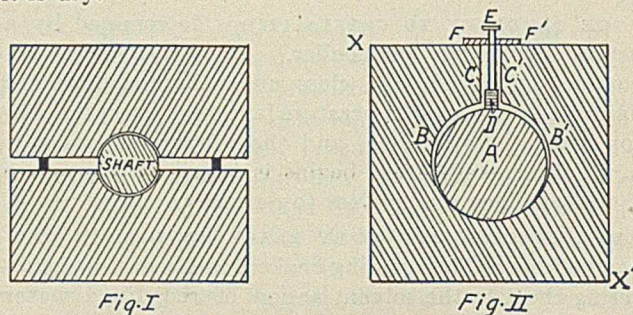


Fig. II: X, X'—Cross-section of bar. A—Cylinder-section in place.
B—Hole in the bar through which the cylinder is inserted.
C—A 1/2 in. hole at a right angle to B.
D—A loose-fitting rubber plunger.
E—Screw for forcing plunger against A.
F—Metal plate screwed to bar, threaded to fit screw E.

We usually have results in half an hour after drawing off the clear liquid, or in an hour and a half after the dry cotton is put into the cylinder and the solvent added. Complete solution of the soluble matter is effected in less than an hour by placing the flasks in a revolving apparatus, instead of taking 6 hours when shaken 4 times per hour by hand. A revolving shaking apparatus may be obtained from any chemical apparatus dealer (e. g., Eimer & Amend, No. 6148). If the revolutions are 6 per minute, then the flask is inverted 360 times in an hour, more agitation than it would get by hand-shaking in 6 hours.

We obtain the same results by attaching two box-like containers to the shaft of a water-wheel as in Fig. I. The cylinders are held in place with straps, and the wheel revolves five or six times per minute.

An excellent apparatus for the purpose may be made from a 3-in. diameter wooden bar. Holes slightly larger than the diameter of the cylinders are bored along the length of the bar, alternating at right angles to each other; if bearings are provided at the ends one may be furnished with a handle for hand turning, and the other with means for attaching to or connecting with a motor (small electric or water) arranged to give from five to ten revolutions per minute. Fig. II shows a way by which cylinders may be quickly inserted and held firmly in place. This can be easily made by any mechanic, and is quite as convenient and easy of operation as one obtained at greater expense.

OXYGEN DEMAND OF SEWAGES

By F. W. BRUCKMILLER

Received December 6, 1915

During a recent investigation¹ of the sewage disposal plants of the state, the nitrate method for oxygen demand was used in preference to the modified English dilution method, for the following reasons:

I—It is more easily manipulated.

II—It lends itself better to field work.

III—It is not open to any great errors in manipulation.

The modified English dilution method² consists in making dilutions of the sewage in question with aerated distilled water, incubating at 20° C. for 10 days, determining the residual oxygen, and, from that dilution in which between 30 to 60 per cent of the oxygen is used up, the oxygen required for the sewage is calculated. Since each sewage is different from every other one, that dilution which will work for one sewage will not always work for another. A preliminary series of dilutions must, therefore, be made on each sewage in order to determine the proper dilution. This requires time and considerable equipment, both of which were lacking in the work under discussion. Furthermore, considerable laboratory apparatus is required to make the dilutions as well as the oxygen determinations, all of which must be made in the field where the sample is collected.

The nitrate method³ on the other hand adapts itself to field work. No dilutions are necessary which, as has been previously shown, are a great source of error in the English method.⁴ In an unknown sewage, Lederer⁵ advocates that varying quantities of NaNO₃ (equivalent to 100, 130, 160, 190, 210 and 240, P. P. M. O.) be added to a constant quantity of sewage and that the sample which remains sweet and free from sediment be taken as the one containing the proper quantity of oxygen. From the residual nitrate and nitrite present, the oxygen equivalent can be readily calculated. At most, this procedure requires 6 bottles. Instead of adding varying quantities of NaNO₃, an excess can be added to one bottle and the presence of nitrate be indicated by methylene blue. This was the procedure adopted in our work, after we had satisfied ourselves that the excess NaNO₃ had no effect on the biological action during incubation. The results obtained were quite gratifying. No determinations need be made in the field. After incubation, the samples can be chloroformed and sent to the laboratory for examination. This in itself is a great feature in favor of the nitrate method for oxygen demand in field work.

Because of the manipulations through which the sewage must go in the English method, it is open to many grave errors. In the first place, in making the dilutions, aeration results unless great care is exercised. Oxygen is lost during incubation through leaky stoppers. Gases invariably collect under the glass stoppers and escape when the stopper is removed

to introduce reagents. That oxygen is lost in this way has been shown by a number of investigators.¹ Only when the dilution is such that the same percentage of oxygen is used up in each sample do the results coincide very well. To get this dilution each time is rather difficult and constitutes one of the greatest objections to the dilution method. Lastly, errors in the oxygen determinations are possible. Unless all the organic matters and nitrites are removed, accurate results are not possible.

The simplicity of the nitrate method eliminates any errors due to manipulations. Its great source of error lies in the determination of large quantities of nitrites and nitrates. An error in the determination of the latter is of more concern than in the former, since the former are seldom present in quantities greater than 5 P. P. M. An error of 1 P. P. M. in the nitrite would, therefore, not seriously affect the results, producing, as it were, in oxygen equivalent, an error of only 1.7 P. P. M. of oxygen which is well within limit of error on sewages that demand 300 P. P. M. of oxygen. By making the dilutions carefully with respect to the nitrates and using the phenol-disulfonic acid method for their determination, reasonable accuracy can be assured.

Because of these considerations, the nitrate method was used in all the oxygen demand determinations connected with our sewage investigations.

The sewages with which we worked were all domestic sewages from small towns. Partial analyses of a few typical sewages are given in Table I.

TABLE I—RESULTS EXPRESSED IN PARTS PER MILLION

No.	SOLIDS			NITROGEN		Oxygen consumed	Chlorine	Oxygen demand
	Total	Volatile	Suspended	Free NH ₃	Organic			
630	734	446	120	70	80	...	88	142
131	800	458	172	20	30	...	70	220
317	974	344	376	5	35	700	105	297
528	482	304	58	16	50	112	72	63
572	814	546	96	8	25	220	68	75
407	1638	992	476	16	35	650	230	89

A two weeks' stay was made at each town. A portable laboratory permitted the estimation of oxygen consumed, chlorine and oxygen demand, together with a number of engineering observations. Composite samples were sent to the laboratory at Lawrence, where the solids and the nitrogen content were determined. As only one man made the trips it was necessary to simplify the work as much as possible. This factor more than any other led us to use the nitrate method in preference to the dilution method for oxygen demand; not, however, until we convinced ourselves by experiments herewith related and also by those of others that the results from the nitrate method could be depended upon.

For nitrate procedure we filled a 250-cc. bottle through a funnel with settled sewage, overflowing half in order to get rid of all the air in the bottle. The nitrate solution was of such a strength that 2 cc. were equivalent to 500 P. P. M. of oxygen. The samples were incubated at 20° for 10 days. Such a quantity of sewage was taken for estimation of nitrates that a reading of about 30 on the colorimeter was always obtained.

¹ Lederer, *Am. J. Pub. Health*, 5, 355; also Lederer, *THIS JOURNAL*, 6 (1914), 887.

¹ Under the direction of the State Chemical Research Dept. and Sanitary Engineering Dept., of Kansas.

² *THIS JOURNAL*, 6 (1914), 884.

³ *J. Infect. Dis.*, 14, 482.

⁴ *THIS JOURNAL*, 6 (1914), 886.

⁵ *J. Infect. Dis.*, 14, 485.

In general, we secured consistent results. Once in a while anomalies would occur; that is, we would obtain results which were entirely out of harmony with the other values. These errors were mostly plus in character and were attributed to an ununiform mixing of the sample of sewage. Rarely was a determination lost and then only due to carelessness or technical errors. Some samples went foul the third or fourth day when experience had shown that they contained enough nitrate to keep them sweet at least 10 days. These "freak" results were also attributed to poor mixing of the sample, or the presence of an undue amount of organic matter in suspension. In general, however, the method worked quite smoothly and gave consistent results all through the work.

Before the investigation began, some preliminary work in the laboratory was done, the results of which strengthened the conclusions above noted. In connection with other collaborators of Dr. Lederer on the English method, we endeavored to find the best dilution and also a value at 5 days from which the absolute value of oxygen demand could be calculated. This we found not to be feasible. The results in Table II show no agreement whatsoever in the various dilutions. One would expect the error in a 1 per cent dilution not to be any more than twice as large as the error in a 2 per cent dilution. Our experience, as the table shows, has been contrary to this supposition. A method whose results vary so with each dilution employed requires, in our judgment, some further study in order to determine the reason for the deviations.

TABLE II—EFFECT OF VARYING DILUTIONS OF SEWAGE

Per cent Sewage in Mixture	Incubation at 20° C.		7.6 P. P. M. Oxygen at Start		Oxygen Absorbed (Basis of Sewage)	
	Incu- bation Days	Oxygen Absorbed in Diluted Sewage P. P. M. Per cent	Ratio of Oxygen Absorbed in 5 : 10 days	P. P. M.	Per cent	
0.36	1	0.4	5.55	..	111.1	5.25
	2	0.0	0.00	..	111.1	5.25
	3	0.6	7.90	..	166.6	7.89
	4	0.6	7.90	..	166.6	7.89
	5	1.1	14.42	68 Per cent	305.5	14.47
	6	1.4	18.40	..	511.1	24.20
	7	1.6	21.05	..	584.0	27.66
	8	1.6	21.05	..	584.0	27.66
	9	1.6	21.05	..	584.0	27.66
	10	1.6	21.05	..	584.0	27.66
1.00	1	1.6	21.05	..	222.2	10.54
	2	1.6	21.05	..	222.2	10.54
	3	1.6	21.05	..	222.2	10.54
	4	1.6	21.05	..	222.2	10.54
	5	1.6	21.05	51 Per cent	222.2	10.54
	6	2.2	28.94	..	305.8	14.47
	7	2.2	28.94	..	305.8	14.47
	8	2.6	34.21	..	361.3	17.20
	9	2.6	34.21	..	361.3	17.20
	10	3.1	40.79	..	431.0	20.40
2.00	1	3.8	50.00	..	211.0	10.00
	2	4.6	60.52	..	255.5	12.10
	3	5.1	67.10	..	283.2	13.43
	4	5.4	71.05	..	299.5	14.20
	5	5.6	73.68	93 Per cent	310.3	14.72
	6	5.8	76.31	..	322.2	15.56
	7	5.8	76.31	..	322.2	15.56
	8	5.8	78.34	..	322.2	15.56
	9	6.0	78.94	..	333.5	15.80
	10	6.0	78.94	..	333.5	15.80

Using a known sewage, comparisons of both methods of procedure of the nitrate method were made. The results contained in Table III confirm those published by Lederer.¹ Those in Method A were obtained by adding varying quantities of NaNO₃ to the sewage, and noting the one which just remained sweet. Those in Method B were obtained by adding an excess of NaNO₃ and 0.4 cc. methylene blue to just one bottle of sewage. All determinations were made after 10

days' incubation at 20° C. in 250 cc. glass stoppered bottles.

TABLE III—OXYGEN DEMAND (P. P. M.) BY NITRATE METHOD

Trial No.	A—By adding excess NaNO ₃ B—By adding 10 cc. NaNO ₃ (26.56 g. per liter)									
	1	2	3	4	5	6	7	8	9	10
Method A.....	300	265	250	310	287	326	297	269	307	278
Method B.....	310	270	248	308	290	320	300	265	310	275

The agreement in Table III shows that the excess of NaNO₃ does not affect the biologic process upon which the loss of oxygen depends. From this we decided that the addition of excess NaNO₃ to the sewage would give us as reliable results as the use of varying concentrations would.

In order to see whether the two methods, the excess nitrate and the dilution method, gave results of close agreement, the two were tried on a known sewage. For the dilutions, aerated distilled water with a temperature of 20° C. was used: 250 cc. bottles were filled to overflowing and 3 cc. of sewage added near the bottom of the bottle. After mixing they were incubated for 10 days at 20° C. The Rideal and Stewart¹ procedure was used. Thirty-five per cent of the oxygen was absorbed at the end of 10 days.

TABLE IV—COMPARISON OF OXYGEN DEMAND (P. P. M.) BY THE NITRATE AND THE DILUTION METHODS, INCUBATING AT 20° C.

Trial No.	Dilution Method	Nitrate Method	Trial No.	Dilution Method	Nitrate Method
1	305	301	11	293	298
2	298	285	12	298	296
3	301	299	13	307	303
4	310	312	14	290	285
5	302	304	15	310	306
6	285	283	16	288	295
7	297	294	17	296	300
8	289	285	18	298	293
9	300	298	19	302	299
10	294	291	20	289	294

Aside from the fact that the nitrate results are consistently lower than the dilution results, the two determinations agree fairly well. In fact, they agree well enough for all practical purposes, and strengthened us in our decision that the nitrate method would give satisfactory results in the field; also they are in strict accord with those obtained by Lederer.² Furthermore, our experience has confirmed this decision, and after a year's trial, we conclude that the nitrate method is far better adapted to field work than the modified English dilution method.

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A COMPARISON OF THE PERMANGANATE METHODS FOR THE DETERMINATION OF REQUIRED OXYGEN

By JOHN H. SACHS

Received December 3, 1915

As the determination of required oxygen is of very great³ importance in the examination of waters, it was thought that it would be well to look into the methods in use for the same and to choose from among them the one that seemed to give the best results. It was realized at the start that the method is not quantitative, and that the results obtained are only comparative. On the other hand, were a large number of waters examined in exactly the same way, the

¹ *Analyst*, 26 (1901), 141.

² *Loc. cit.*

³ Fleck, *Z. angew. Chem.*, 1889, 580.

results would surely show the relative quantities of oxidizable matter present.

As early as 1851, Förschammer¹ began using a dilute solution of potassium permanganate for the oxidation. He proceeded by simply adding this to one liter of the water under examination until a faint pink color persisted for one-half hour. From this method has sprung the many methods now in use. These methods may be divided into two classes: (1) *Oxidation in acid solution*; (2) *Oxidation in alkaline solution*. These methods have been further modified according to the time taken for the oxidation, the temperature at which the oxidation is carried out and the amount of permanganate used for the oxidation.

OXIDATION IN ACID SOLUTION

The KUBEL² method is as follows: To 200 cc. of the water to be examined there are added 10 cc. of dilute H₂SO₄ (1 : 3). To this, when heated to boiling, there is added from a burette a standard dilute solution of the permanganate until a decided red color remains. The boiling is continued ten minutes with the addition of more permanganate if the color tends to fade out. Standard oxalic acid solution is then added until the pink color has completely disappeared. The excess of oxalic acid is then titrated with the standard permanganate solution. The difference between the total amount of permanganate used and the permanganate equivalent to the oxalic acid added, gives the amount of permanganate reduced. Correction must be made for ferrous salts, nitrites or hydrogen sulfide, if they be present.

KOBRI³ recommends that the permanganate solution be made by dissolving 0.5 g. of the salt in one liter of water; after the addition of 150 cc. pure concentrated H₂SO₄, the whole is heated at 90° for 3 hrs. in a flask with a long neck. The solution is then standardized with oxalic acid. 100 cc. of the water to be tested are then mixed with 50 cc. of the permanganate solution and 15 cc. H₂SO₄. This is heated in the same kind of flask as was used above at 90° for 3 hrs. He points out that chlorides must be removed and corrections made for nitrites present.

TIDY'S⁴ process differs from the rest in that the oxidation is carried out at ordinary temperatures. He recommends the use of 250 cc. of the water; to this is added 10 cc. H₂SO₄ and 10 cc. KMnO₄. After standing in a stoppered bottle for 3 hrs. at ordinary room temperature an excess of KI solution is added, and the iodine liberated titrated with thiosulfate. A blank experiment in which recently distilled water is used is also made.

THRESH'S⁵ METHOD—250 cc. of the water to be examined are measured in a flask fitted with a stopper. To this are added 10 cc. H₂SO₄ and 10 cc. of a permanganate solution, of such strength that 1 cc. = 0.1 mg. available oxygen. The stopper is then inserted and the flask with its contents incubated for 3 hrs. at 37°. If the pink color tends to fade out, more of the permanganate solution is added. After 3 hrs. the flask is cooled, 1 cc. of a 5 per cent KI solution added and the iodine liberated is titrated with thiosulfate. While the water to be tested is incubating, a blank test is run. The ferrous salts, nitrites, etc., are at first determined by finding how much oxygen is consumed in 5 min. at 37°.

OXIDATION IN ALKALINE SOLUTION

SCHULZE'S⁶ PROCESS—100 cc. of the water are placed in a

flask of 300 cc. capacity. One-half cc. NaOH solution (2 : 1) is added and from a burette 10 cc. of standard permanganate. After boiling 10 min. the contents of the flask are cooled to 50–60°. 50 cc. H₂SO₄ (1 : 3) are then added and from a burette 10 cc. of a standard solution of oxalic acid. The procedure from this point is similar to that of the Kubel method.

EXPERIMENTAL

To choose from among these methods the following series of determinations were carried out, using water solutions of certain organic compounds. The solution of permanganate used was of such a strength that 1 cc. = 0.1 mg. available oxygen.

ACID SOLUTION—100 cc. water + 15 cc. KMnO ₄ + 10 cc. H ₂ SO ₄ (1 : 3)	
ALKALINE SOLUTION—100 cc. water + 15 cc. KMnO ₄ + 1 cc. NaOH (1 : 1)	
Acid	Alkaline
TREATMENTS	
I Boiled in Erlenmeyer beaker 10 minutes (Kubel).....	V
II Heated in Erlenmeyer beaker 85° for 1 hour.....	VI
III Incubated in closed flask 37° for 3 hours (Thresh).....	VII
IV Allowed to stand in closed flask at ordinary temperature for 3 hours (Tidy).....	VIII

After treating as above, the flasks were quickly cooled to 10–15°. The alkaline solutions were acidified with H₂SO₄. An excess of KI was added and the iodine liberated titrated with thiosulfate. Both the thiosulfate and the permanganate solutions were frequently standardized. The results, expressed in mg., of oxygen consumed by 100 cc. of the water are given in Table I.

TABLE I
Results in Mg. Oxygen Consumed per 100 cc. Water

Treatment:	ACID SOLUTIONS				ALKALINE SOLUTIONS			
	I	II	III	IV	V	VI	VII	VIII
1 Lactose.....	0.547	0.592	0.110	0.033	0.505	0.473	0.309	0.272
1 Glucose.....	0.641	0.652	0.054	0.027	0.587	0.641	0.543	0.415
1 Sucrose.....	0.783	0.739	0.096	0.020	0.620	0.636	0.488	0.317
1 Urea.....	0.086	0.092	0.023	0.017	0.081	0.083	0.038	0.040
1 Dried Egg Alb.....	0.400	0.483	0.156	0.173	0.415	0.461	0.254	0.161
1 Starch.....	0.571	0.334	0.027	0.016	0.415	0.312	0.178	0.108
1 Agar.....	0.613	0.505	0.046	0.035	0.397	0.402	0.161	0.127
1 Gelatine.....	0.119	0.178	0.037	0.033	0.359	0.312	0.175	0.119
1 Dried Milk.....	0.600	0.537	0.072	0.028	0.524	0.520	0.236	0.212
5 Dried Egg Alb.....	0.908	1.100	0.577	0.484	0.923	0.953	0.496	0.358
5 Gelatine.....	0.242	0.552	0.100	0.077	0.808	0.729	0.407	0.442
5 Lactose.....	1.500	1.500	0.138	0.033	1.183	1.131	1.050	0.888

It is at once seen that at the high temperatures the most oxygen is consumed. It will also be noticed that there is little difference in the results at 85° and 100°. At the lower temperatures, especially in the acid solutions, the consumption of oxygen is much smaller. In almost every case the oxygen consumed at ordinary temperatures is less than that consumed at 37°. In Methods VII and VIII the solution usually took on a green color, due to the formation of K₂MnO₄. These methods were, therefore, discarded. In Methods V and VI there was usually a larger quantity of the MnO₂ separated than in any other method. This¹ acts catalytically to reduce more KMnO₄. Grünhut² has shown that the presence of Mn in water introduces quite an error by these methods. For these reasons the alkaline methods were discarded.

Another set of experiments was then arranged in which the oxidation of 100 cc. of water was carried out in Erlenmeyer flasks two ways: (1) heating for 1 hr. at 85°, and (2) incubating for 3 hrs. at 37°. Here the amount of KMnO₄ was varied. The results of these experiments are shown in Table II.

From these results, it can be seen that at the higher temperatures the more KMnO₄ used for the oxidation, the more oxygen is consumed. At 37° there is little

¹ Noll, *Z. angew. Chem.*, **24** (1911), 1509.

² Grünhut, *Z. anal. Chem.*, **52** (1913), 36.

¹ Fresenius, *Z. anal. Chem.*, **2** (1863), 425.

² Braun, *Ibid.*, **6** (1867), 253.

³ Kobrich, *Chem.-Ztg.*, **11**, 4.

⁴ Tidy, *J. Chem. Soc.*, **35** (1879), 66.

⁵ Thresh, "Examination of Water and Water Supplies," **1913**, 309.

⁶ Trommsdorff, *Z. anal. Chem.*, **8** (1869), 350.

TABLE II
Results in Mg. Oxygen Consumed per 100 cc. Water

1 Hour—85°	15 cc.	20 cc.	25 cc.	30 cc.	40 cc.
KMnO ₄ Solution:					
5 Gelatine.....	0.552	0.697	0.821	0.872	0.952
5 Dried Egg Alb.....	1.100	1.293	1.425	1.526	1.790
5 Dried Milk.....	1.500	1.850	2.142	2.336	2.706
Sewage No. 1.....	1.252	1.452	1.588	1.786	2.094
Sewage No. 2.....	1.228	1.415	1.530	1.655	1.730
Sewage No. 3.....	1.082	1.280	1.422	1.605	1.675
City tap water.....	0.372	0.440	0.461	0.482	0.527
3 Hours—37°					
5 Gelatine.....	0.100	0.103	0.108	0.123	0.140
5 Dried Egg Alb.....	0.549	0.539	0.565	0.618	0.670
5 Dried Milk.....	0.460	0.475	0.490	0.494	0.477
Sewage No. 1.....	0.426	0.452	0.444	0.459	0.431
Sewage No. 2.....	0.435	0.460	0.440	0.473	0.455
Sewage No. 3.....	0.455	0.633	0.490	0.482	0.473
City tap water.....	0.155	0.160	0.162	0.178	0.182

difference in this respect. This makes it quite clear that in comparing results of oxygen consumed at high temperatures, only those results can be compared that are obtained by a method in which the same amount of permanganate is used for the oxidation. This is a very important point. However, at 37°, the amount of KMnO₄ used for the oxidation plays no large part and hence such results can be compared no matter whether or not the same amount of permanganate is used.

Although the presence of chlorides interferes with the determination of oxygen required in acid solution, the 37° acid solution method of Thresh seems best. The chlorides can be readily removed by Ag₂O and hence offer no great difficulty.

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ESTER GUMS OR ARTIFICIAL RESIN ESTERS

By CARLETON ELLIS AND LOUIS RABINOVITZ

Received February 2, 1916

The neutralization of acid resins for use in varnishes where the acid character of the resin is detrimental to the quality of the varnish is a problem that has engaged the varnish chemist for a long time. The tendency of acid resin varnishes to "liver" or thicken is a phenomenon that frequently occurs in the case of the so-called enamels or varnishes containing metallic oxides and is one of the greatest difficulties encountered by varnish chemists in the preparation of colors ground in a varnish vehicle. In order to obviate this difficulty it has been the practice among the manufacturers of varnishes to use gums relatively low in free acid such as Kauri and others, which, however, cannot be employed in the cheaper enamels and other similar coating compositions, owing to the comparatively high cost of these gums.

The hard varnish gums for years past have been growing scarcer and more expensive, and the only really abundant source of resin is common rosin. The latter is too soft for use in high-grade varnishes, while in grinding varnishes the acid of the rosin combines with the pigment and makes the product thick or even solid after it has stood a considerable time. Grinding varnishes constitute one-fourth to one-third of the total volume of business of many varnish houses; hence the preparation of a varnish which is stable to basic pigments is an important matter.

LIME TREATMENT—One method of treating rosin is to heat it with lime which neutralizes some of the acidity and has a hardening effect. It is not feasible

to use enough lime to make a neutral product as the material would be insoluble in oil and turpentine. Highly limed varnishes do not stand outside exposure satisfactorily.

This condition of the resin market has led to the careful scrutiny of the products known as rosin esters or ester gums which are prepared by esterifying ordinary rosin or similar resin with glycerine and the like. These rosin esters are soluble in oil and turpentine and have been found fairly free from the objection of "livering" or thickening with basic pigments. For a time the consumption of such esters was small but as their value came to be appreciated by the varnish manufacturer the demand increased and has now grown to very substantial proportions. Up to the present time in this country rosin esters have not been made for general sale but a few varnish manufacturers for some time past have been preparing esters for their own consumption. A considerable quantity of ester gum made in Germany and England has been imported. These products vary considerably in quality and the acid numbers range from 10 or 12 to about 50.

At the present time, owing to the lack of consumption abroad of copal and other hard gum, a great reduction in the price of this raw material has been made and in consequence the making of medium-priced grinding varnishes with hard gums is more feasible than it was a few years ago. On the other hand, glycerine, which enters into the manufacture of ester gums, is now extraordinarily high in price and these conditions may tend to diminish temporarily the consumption of rosin esters. Such a condition is, however, only temporary, for at the close of the present European war a large demand will spring up for hard varnish gums, and rosin esters will be again restored to the place which they attained in the resin market prior to the opening of the war.

Before reviewing the previous work on the neutralization of resins it will be rather instructive to present the views held by various investigators regarding the cause of the phenomenon of "livering" or thickening.

Rosicki¹ holds that the thickening of the varnish is due to the formation of salts difficultly soluble in the varnish formed by the reaction of the free resin acids and the metallic oxide present. In support of this theory he cites the fact that copals like Congo and Manila when melted in the normal way do not yield varnishes which stand the addition of basic pigments; they do so, however, when melted or "run" with a loss of 30–35 per cent. This result he claims is due to the large drop in the acid number of the copal during the melting process. In some cases the acid number falls from 150 to about 25. The tendency of varnishes towards thickening decreases proportionately with the decrease in acid number.

Muehle² is of the opinion that the thickening phenomenon is due to the coagulation of the high molecular copal particles rather than to the formation of in-

¹ *Farben-Ztg.*, 1913, 1194.

² *Ibid.*, 1913, 1119, 1944, 2058, 2178.

soluble salts. Through extensive experiments which he carried out he claims to have found that neither neutralization of the copal acid by basic substances, such as lime and magnesia, nor their esterification, nor any other method tending towards the saturation of the free acids were of use in preventing the coagulation of the varnish. Muehle¹ states that neither he nor his associate, Hammelmann, succeeded, through combining the carboxyl group of resin acids by all possible methods (esterification, acetylation, forming anhydrides, etc.), in producing varnishes from Congo and Manila copals, which would stand the addition of pigments. They were able to bring the acid number down to a very low figure, but the danger of thickening was by no means eliminated.

Megerle,² commenting on the controversy between Rosicki and Muehle, states that according to his observations during his experience extending over a period of more than twenty years, he is of the opinion that the gelatinizing of varnishes in the presence of zinc or lead basic pigments is due to not one but to both the reactions claimed by Rosicki and Muehle.

NEUTRALIZATION OF ROSIN WITH METALLIC OXIDES

The hardening of resins by treatment with lime has long been known. In 1884 Kissel observed that the melting point of natural acid resin could be increased considerably by neutralizing it with lime, magnesia, or zinc oxide, and that the hardness increased proportionately with the amount of material introduced into the resin.³ Later⁴ he improved his method by removing the last traces of the free rosin acid that invariably occurred in the hardened rosin by washing the powdered compound with ammonia water. In this way he claims to have obtained a neutral product.

Melvin⁵ describes a method of preparation of zinc resins according to which zinc oxide is added to rosin at 230° F., in the proportion of 2½ to 25 parts of zinc oxide to 100 parts of rosin. The preparation of the resins of calcium, magnesium and zinc is described by Prager.⁶ Zinc resinate is stated to be less affected by water than the corresponding compound of calcium.

Pirschl⁷ claims an improvement in the method of preparing metallic resins by introducing a flux causing a greater percentage of the metallic oxide to combine with the acid resin. The flux that he generally employed was rosin oil. According to him the temperature should differ with the metallic oxide employed. The hydroxides he claims are to be preferred to the oxides as more complete neutralization can be effected with the former. He found that rosin is capable of taking up 16 per cent of manganese dioxide, 10 per cent of barium oxide, 40 per cent of lead oxide and 8 per cent of calcium oxide.⁸

¹ For details of a controversy between Rosicki and Muehle see Stevens and Armitage's "Treatise on the Technology of Wood Oil."

² *Farben-Ztg.*, 1913, 2230.

³ See D. R. P. 30,000, March 5, 1884; U. S. Patent Reissue No. 10,714, April 20, 1886; U. S. Patent No. 303,436, August 12, 1884.

⁴ U. S. Patent No. 414,366, Nov. 25, 1890.

⁵ U. S. Patent No. 370,640, Sept. 27, 1887.

⁶ *Seifen-Zig.*, 1915, 705.

⁷ U. S. Patent No. 521,270, June 12, 1894.

See also Gentsch, U. S. Patent No. 657,696, Sept. 11, 1900.

The practice of liming rosin and other acid resins has been in vogue in most varnish works for a great many years and the cheaper grade of varnishes containing largely rosin as the resinous stock almost invariably carries a considerable percentage of lime or other base for hardening purposes. The acidity, however, can be only partly neutralized as the use of a sufficient amount of base to furnish a neutral product would yield a resinous body insoluble or very difficultly soluble in the usual varnish thinners. Thus it is not feasible to rely upon liming to prepare a grinding varnish sufficiently neutral to be free from tendency of livering.

According to Prager¹ rosin may be hardened by the addition of 5-10 per cent of sulfur at 140-150° C. The cooled product is dark green in color, possesses a sulfur-like odor, and is quite resistant to the action of weather and chemical reagents.

NEUTRALIZATION OF RESINS WITH ORGANIC SUBSTANCES

In order to prepare ordinary esters of soft resins, such as rosin, the softer constituents of the raw resin are removed by distillation in a vacuum in the presence of superheated steam or a current of indifferent gas up to 300-350° C., or sometimes by extracting the raw resin by means of solvents such as dilute alcohol. The residue is then heated with equivalent proportions of glycerine, phenol, naphthol, or carbohydrate at a high temperature with or without the addition of the dehydrating agents and with or without pressure. For example, rosin is heated in a vacuum at 350° C. to remove the volatile materials, the residue is treated with resorcin in the proportion of 100 parts of rosin to 17 parts of resorcin and the vapors which are formed are allowed to escape by opening a valve of the autoclave. The operation of blowing off the generated steam is continued until esterification is substantially complete. This can be roughly determined by shaking an ether or benzene solution of the ester with a dilute aqueous solution of caustic soda and noting the degree of action of the alkali.

Glycerine esters which can be immediately employed in the varnish industry are prepared according to Bottler² by heating abietic acid to 180-210° and adding to it 10 to 16 parts of glycerine under constant stirring while subjecting to a vacuum of 10 cm. After the addition of the glycerine the temperature is gradually raised to 280° C., while the vacuum is maintained constant. The operation is continued until the esterification is complete. In order to impart to the ester a greater degree of hardness, the softer portions are distilled off under reduced pressure or in an atmosphere of an indifferent gas at ordinary pressure. If the product becomes very thick toward the end of the operation some linseed oil may be added. Finally, the residue is treated with ½ to 2 per cent of manganese peroxide or red lead and the heating is continued until the solution is complete. The varnish stock thus obtained is of a light color and is readily soluble in benzene and turpentine.

¹ *Seifen-Zig.*, 1915, 706.

² "Harze und Harzeindustrie," Hanover, 1907.

Suter¹ claims that he was able to bring about combination between dehydrated molasses and rosin in the presence of asphalt oil dissolved in a vehicle such as alcohol or turpentine. For example, 30 lbs. of copal and 20 lbs. of rosin are supposedly combined with 25 lbs. of molasses and 5 lbs. of asphalt distillate.

Schaal² has described various methods of producing resin esters and for separating the soft and hard constituents. He observes that resin acids combine freely with carbohydrates as well as the lower and higher alcohols, phenols, naphthols and similar aromatic hydroxy bodies to form resin acid esters. These products are partly soft and partly very hard resinous substances. The esters may be made (1) by heating equivalent proportions of the materials to a high temperature with or without pressure and with or without the addition of substances capable of absorbing water such as acids or acid salts; (2) by passing through the mixture heated neutral gases so as to expel the water thus formed; (3) by heating the metallic salts of the resin acids with haloid or sulfo combinations of the phenols and their homologues. In an example given by Schaal, colophony is distilled in vacuum at a temperature up to 350° C. in order to remove volatile constituents and the residue, which consists chiefly of a hard resinous substance, is mixed with 10 per cent by weight of dehydrated glycerine. The mixture is heated with agitation and under a pressure of several atmospheres to 250° C. After some time the pressure rises, due to the formation of steam, and the latter is blown off from time to time. When the formation of water ceases the resin esters which have been formed are subjected to distillation for the purpose of separating the softer from the harder portions.

By the foregoing process it will be noted that the reaction of the resin acid with the hydroxy body takes place under a pressure of several atmospheres, while in the method described below Schaal maintains a vacuum in the chamber in which the resin acid and hydroxy body are heated.

The formation of mixed esters of Manila copal and rosin is described by Schaal.³ According to a procedure given by him, 50 lbs. of Manila copal are melted and an equal amount of rosin added. The temperature is raised to about 180–210° C. and a mixture of 6 lbs. each of fruit sugar and glycerine is gradually added. The mixture is constantly agitated and the temperature is slowly raised to 280° C.; at the same time a vacuum of about 100 mm. is maintained in order to remove the aqueous vapors which are formed. While the temperature is being raised to 280° C., such portion of the hydroxy body as distills off is replaced by fresh material until the formation of the ester is completed. In place of the mixture of fruit sugar and glycerine a mixture of 16 lbs. of phenol with 4 lbs. of cane sugar or mannite and 4 to 5 lbs. of glycerine may be used. The addition of boric acid is regarded as favoring the reaction.

¹ U. S. Patent No. 905,384, Dec. 1, 1908.

² U. S. Patent No. 335,485, Feb. 2, 1886; Reissue No. 10,823, March 29, 1887.

³ U. S. Patent No. 501,446, July 11, 1893.

An apparatus used by Schaal in the manufacture of rosin esters is shown in Fig. I. The kettle *A* is equipped with a charging funnel and stirring device and a gooseneck connects this vessel to a receiver, *B*. The outlet pipe *d* is connected with an air pump so that a partial vacuum can be maintained in the apparatus. The rosin acids are placed in the kettle *A* and heated to 180–240° C. when the glycerine or other hydroxy body is added under constant agitation. A vacuum of 100 mm. is maintained in the apparatus. The temperature is then gradually raised to about 280° C. while the agitation is continued and the heating operation progresses until a portion taken from the kettle *A* and dissolved in benzine, or ether, or ground fine in water, does not give up any soluble matter when mixed with an aqueous solution of sodium carbonate.

A further suggestion by Schaal¹ is that of oxidizing the resinous product before esterification. For example, the rosin is reduced to a fine powder and is subjected to the action of oxygen, which is stated to have the effect of raising the melting point of the rosin to a point where it approaches that of the copals. This product may then be esterified with glycerine, glucose, levulose or cane sugar.

Terrisse² has esterified a variety of varnish gums

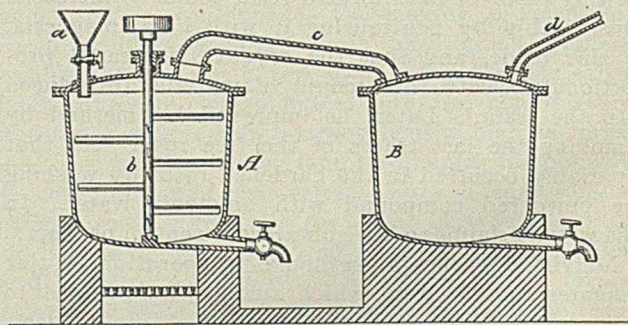


FIG. I

with glycerine. Fossil resins (including Congo copal, Zanzibar and Madagascar anime, kauri, Benguela copal, pontianak, Manila and others) are "solubilised"³ by heating them, preferably under pressure in an autoclave at a suitable temperature (240–360° C.), with or without the addition of naphthalene or phenol. The naphthalene or phenol is removed by distillation or otherwise, the acid value of the fused resin is determined, and an excess of high-boiling alcohol such as glycerine is added. The mixture is then heated until the uncombined alcohol is distilled off, the product consisting substantially of a neutral resin acid ester, readily soluble in linseed oil. For example: (1) 100 g. of ground Zanzibar gum are heated with 350 g. of naphthalene at 280° C. and 4 atmospheres for 4 hrs., or until a test portion is soluble in linseed oil. The acid value is determined, and some excess above the calculated amount of glycerine is added. The mass is then heated in a still or open vessel at 280–320° C. until a test on glass remains transparent on cooling. (2) 100 kilos of Congo copal are fused by the

¹ U. S. Patent No. 698,741, April 29, 1902.

² *J. Soc. Chem. Ind.*, 1916, 57; British Patent No. 23,055, Nov. 25, 1914

³ *J. Soc. Chem. Ind.*, 1904, 552; 1908, 457.

open-kettle method; its acid value is then determined and the calculated amount of glycerine is added. 15 kilos of copal oil, redistilled under reduced pressure to the state of a greenish yellow viscous liquid, are added, and the mixture is heated in a still, or open vessel, to 280° C.; 5 to 6 kilos of glycerine are then added and heating continued until a test gives a clear bead.

EXPERIMENTAL

Investigations were carried out with the object of finding a simple and at the same time an efficient method for producing substantially neutral rosin or other resinous compounds that would resist the action of basic pigments, such as white lead and zinc oxide. To be of commercial value the products are required to possess not only a low acid number but good color and hardness as well. This offers difficulties as it is not easy, for instance, to obtain an ester possessing both a low acid number and a good color. Either one or the other property has to be sacrificed in a measure unless special and expensive precautions are taken. To some extent the same is true of color and hardness.

Partial esterification of rosin by means of glycerine readily took place by bubbling gases through a mixture of rosin and glycerine in slight excess, at 280–300° C. Hydrochloric acid gas, carbon dioxide, hydrogen, air and oxygen were successively tested. In no case, however, was an ester obtained of sufficiently low acid number to warrant their use except, possibly, in special cases. A difficulty encountered in the use of these gases was the considerable loss of glycerine carried over by the gaseous current. A rosin ester obtained by the use of hydrochloric acid was of almost a semifluid consistency, while the esters prepared by the use of air or oxygen were generally dark in color. This method gave esters having acid numbers of 30 to 40. The use of bodies expected to aid the reaction by catalytic or dehydrating effect, such as sulfuric acid, zinc chloride, sodium acid sulfate and others in the presence of gas, did not materially assist the ester formation. With the exception of hydrochloric acid gas the action of the gases in bringing about partial esterification of the rosin is probably largely a mechanical one. On bubbling through the melted rosin and glycerine the gas brings these two substances into intimate contact with one another. On the other hand, as already stated, the passing gas also causes considerable loss of glycerine. This accounts for the fact that only partial esterification takes place when using approximately equivalent amounts of rosin and glycerine under these conditions.

A considerable improvement in the preparation of rosin esters was made by the introduction of a mechanical stirring device. This afforded the agitating effect of the gases without the drawback of excessive volatilization of glycerine. To reduce further the loss of glycerine a reflux condenser was used. Products were obtained in some of the tests having an acid number as low as 6 or 7. It may be stated, however, that the products having such a low acid number were generally darker in color.

In each of the following runs 60 parts by weight of rosin and 8 parts of glycerine were employed. The yield in each case was about 60 parts of ester. The acid number of the rosin employed was 156.

EXPERIMENT I				EXPERIMENT II			
Time	Temp.	Acid		Time	Temp.	Acid	
Hrs. Min.	° F. ° C.	No.		Hrs. Min.	° F. ° C.	No.	
	10 240	118			0 240	116	
	20 250	121			20 365	185	
	30 300	149			30 400	204	
	60 400	204			45 415	213	
1	15 425	218			50 450	232	
1	30 460	238		1	5 465	241	
1	45 475	246		1	25 490	254	
2	10 500	260		2	500	260	
2	35 500	260	45.0	2	30 500	260	32.0
3	500	260		2	55 500	260	
3	30 525	274	36.0	3	15 520	271	20.2
4	5 520	271		3	30 520	271	
4	15 520	271	13.5	3	45 520	271	12.9

EXPERIMENTAL RESULTS		CALCULATED	
Wt. of Rosin (C ₂₀ H ₃₀ O ₂) (a)	60.0		60.0
Wt. of Glycerine	8.0		6.1
Wt. of Ester	60.0		62.5

(a) W. Fahrion, Bischoff and Nastvogel. See Allen's "Commercial Organic Analysis," Vol. II, Part 3 (1907), p. 159.

It was found that under ordinary conditions ethyl alcohol, phenol, cresol, aniline and alpha and beta naphthylamine, sugar, starch and glucose did not react with the rosin to form neutral products. Experiments carried out with sugar, glycerine and starch under pressure in the presence of a water-absorbing adjacent layer of unslaked lime similarly gave negative results. For example, 100 parts of rosin and 15 parts of crystallized dextrose reduced to a fine powder and intimately mixed were placed in an open container surrounded by unslaked lime and heated in an autoclave at 253° C., for 3 hrs. The pressure did not rise above 3 atmospheres. The final product consisted of unchanged rosin, the acid number of which was 145.6, while the dextrose was completely converted into a carbonaceous mass. Aniline and alpha and beta naphthylamine when heated with rosin under pressure likewise gave negative results.

According to Hibbert¹ the condensation of polyhydric alcohols is facilitated by the presence of iodine. Tests carried out on the rate of formation of rosin ester of glycerine in the presence of small quantities of iodine did not disclose any beneficial result.

COLOR OF THE ESTER—The production of rosin esters meeting the requirements of varnish manufacture as regards lightness of color is a matter of some difficulty, as the resin discolors rather rapidly when exposed to air or oxygen at the high temperature required for esterification. In consequence it is desirable to maintain an atmosphere of an inert gas over the esterifying material during the progress of the reaction and while cooling. Once an ester has become discolored by oxidation it is extremely difficult to better the color by bleaching operations. Small scale experiments carried out to determine the effect of various bleaching agents such as bone-black, fuller's earth and sulfur dioxide showed the coloring matter of the ester to be practically unaffected by these agents.

In some of our experimental work we used apparatus as shown in Fig. II. This consisted of a kettle fitted with a tight cover and stirrer mounted on a varnish kettle truck carrying a countershaft. The

¹ *J. Am. Chem. Soc.*, 1915, 1748; U. S. Patent No. 1,126,467, Jan. 26, 1915.

stirring device was operated by a motor. The kettle could be readily moved on and off the fire without affecting the operation of the stirrer. This apparatus proved very convenient to handle.

DETERMINATION OF THE ACID NUMBER OF ROSIN ESTERS—One gram of the ester is dissolved in 25 cc. of benzol or ether and the solution is titrated with *N/10* alcoholic caustic potash, using phenolphthalein as an indicator.

ROSIN ANHYDRIDES—What appears to be the anhydride of rosin acids is readily obtained by passing an inert gas through the rosin at 300° C. The anhydride is soluble in organic solvents such as alcohol, ether, benzol, but it differs from ordinary rosin in its behavior towards aqueous alkali. Rosin dissolved in benzol or ether shaken with a cold aqueous solution of caustic alkali readily reacts with the latter with a formation of rosin soap. The anhydride of rosin under the same conditions remains unaffected or but slowly affected. This gives a simple rough method for the determination of the "anhydride content" of rosin. The procedure consists in dissolving a definite quantity of the materials in benzol or ether and titrating the solution with aqueous caustic potash or soda solution, stirring the mixture vigorously after each addition of alkali and using phenolphthalein as an

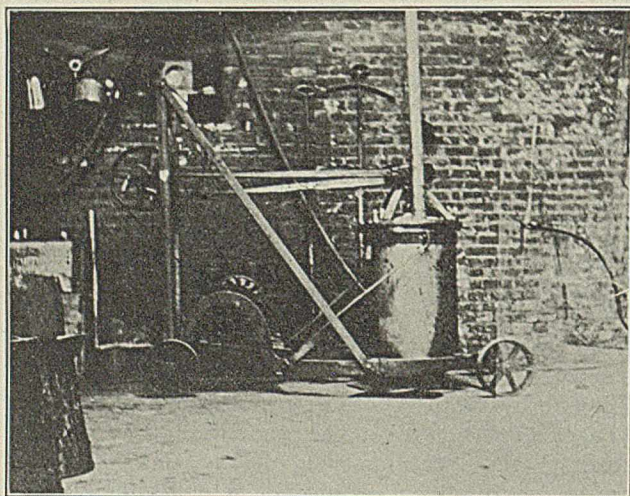


FIG. II

indicator. Toward caustic potash dissolved in alcohol, rosin and the anhydride of rosin behave alike.

EFFECT OF TEMPERATURE ON THE ACID NUMBER OF THE ANHYDRIDE DETERMINED BY AQUEOUS ALKALI

Time (Hrs.)...	1	2	3	4	5	6	7
Temp. (° C.)...	155	200	245	290	320	340	357
Acid No.	44	34	30	20	19	18	18.5

Common rosin of normal acid number was heated at about 300° C. until its acid number, determined by titration with *aqueous caustic potash* solution, was found to be reduced to approximately 20. However, on titration with *alcoholic potash solution* the acid number was found to be but slightly reduced. As the anhydride thus appears to have a greater degree of resistance to alkalis than the original resin acids, a series of "livering" tests were carried out with a considerable number of basic pigments. The results showed

the anhydride to be capable of combination with such pigments causing thickening of the mixtures.

PROPERTIES OF ESTER GUM—An ester gum made from a good grade of rosin and glycerine when properly prepared should have a light amber color or pale straw color, should be bright and clear, with freedom from tackiness. It should not contain an excess of glycerine, and should dissolve readily in benzene or turpentine. A solution of equal parts of the latter and the ester gum should remain clear on standing. Rosin ester is practically insoluble in 80 per cent alcohol and should be substantially unaffected by a 10 per cent solution of sodium carbonate. Even boiling aqueous solutions of sodium carbonate should have little or no immediate effect. The ester gum should be free from burnt or tarry odor.

DAMMAR GUM—A mixture of 50 parts dammar gum and 5 parts of glycerine was heated for one-half hour under agitation at 250° C. The acid number of the gum dammar fell from 39 to 12.5. The final product was dark in color.

COPAL GUMS—The esterification of the copals is a far more difficult problem than that involved in producing the esters of rosin. The copals normally are insoluble in the ordinary solvents of the varnish industry and require to be cracked by protracted heating at high temperatures until they become soluble. It is possible to esterify the raw resin or to crack it and esterify the cracked product. It is commonly thought by varnish makers that after an ester of glycerine has been formed it should not be subjected to protracted heating because of the tendency of decomposition with loss of glycerine. Our observations have shown that a number of the esters are very stable at high temperatures, and contrary to the prevailing idea that glycerine is not lost by heating in this manner. The esterification of copal gum with glycerine and subsequent treatment at a cracking heat is, however, sometimes prejudicial to the color of the preformed ester and usually it is desirable to crack the product first and then esterify the soluble resin so formed. Great care, however, has to be taken in esterifying this product to regulate the temperature properly, as infusible products may be formed. For example, Congo gum was run at 327° C. (620° F.) until soluble in turpentine, and was then treated with glycerine. Reaction took place readily, yielding a spongy product which could not be fused even on heating to over 360° C. (700° F.). On cooling, a porous resinous mass was obtained.

PONTIANAK COPAL—92 parts by weight of fused gum and 8 parts of glycerine were heated for 5 hrs. at 260–280° C. under constant agitation. The acid number fell from 74 to 34.

CONGO GUM—100 parts of fused or cracked Congo gum and 5 parts of glycerine were heated for 4 hrs. at 250–260° C. with stirring. The acid number fell from 72 to 16.

SUMMARY

1—The method of preparing rosin esters was reduced to simplest terms. Esters were prepared from

rosin and glycerine having an acid number as low as 6 or 7, which were as a rule darker in color than the rosin employed. Esters were prepared whose acid numbers lay between 13 and 13.5 which were good in color.

2—Ethyl alcohol, phenol, cresol, aniline, alpha and beta naphthylamine, sugar, starch and dextrose did not combine with the rosin to form neutral substances under ordinary conditions. Aromatic amino compounds did not combine with the rosin in presence of dehydrating agents even under considerable pressure.

3—Bone-black, fuller's earth and sulfur dioxide had no beneficial effect on the color of rosin esters.

4—A qualitative and quantitative method for determining rosin anhydrides in the presence of rosin acids and rosin esters was studied.

5—Congo gum, pontianak gum and dammar gum were esterified with glycerine to a greater or lesser degree. Copal gums which had been cracked and rendered soluble in varnish makers' solvents were found to esterify readily.

MONTCLAIR, NEW JERSEY

CEANOTHUS VELUTINUS (SNOW BRUSH) AS A SOURCE OF WAX AND TANNIN

By CHAS. C. SCALIONE AND HERBERT S. BLAKEMORE

Received November 4, 1915

The study of this shrub was undertaken with the hope of being able to utilize a material that at present is both a fire menace and a nuisance in California forests. This study, though not complete, will show that this plant contains easily available products of high commercial value.

BOTANICAL

Ceanothus velutinus (Douglas),¹ commonly known as "Snow Brush," is a widely branching shrub, two to six feet, and sometimes more, in height. The leaves are alternately petioled, roundish or broadly ovate, about three inches in length and have polished resinous upper surfaces, but are somewhat pubescent beneath.

The area inhabited by this plant is bounded roughly by the Coast Range of California on the west, the Columbia river on the north, Colorado on the east, and San Francisco Bay on the south. It is especially plentiful in the Shasta National Forest in the neighborhood of Sisson, California, where it has been estimated² that 30,000 tons could be gathered within 5 miles of the railroad and three times this amount could be gathered within 15 miles.

We are indebted to the United States Forest Service for 500 lbs. of leaves and twig ends used in this investigation. This material was gathered at Sisson, California, and shipped to Berkeley.

EXAMINATION FOR ESSENTIAL OILS

An attempt was made to distill about 50 lbs. of leaves and twigs for essential oils. The distillate was slightly opalescent and by redistillation and extrac-

tion of the distillate a minute quantity of a pungent-smelling oil was isolated. This quantity was not sufficient for examination. Probably if the leaves had been distilled as soon as cut, sufficient oil would have been isolated to study, but the yield would not be of commercial importance.

EXTRACTION OF WAX

The remainder of the twig ends, after drying on a steam radiator, were separated from the leaves by threshing. The leaves were ground in a coffee mill and sifted through a twenty-mesh screen. They were next thoroughly extracted with dry 86° Bé. gasoline in a specially designed Soxhlet extractor of 10 lb. capacity. The average yield of wax was 7.3 per cent of the weight of leaves.

The wax had a greenish appearance, due to a little chlorophyll. At first it was of pasty-like consistency,



FIG. I

but on standing on the steam bath and driving off more solvent it became brittle, breaking with a conchoidal fracture. The crude wax had the following constants:

Free acid.....	20.3	Reichert-Meissl No.	7.5
Saponification number.....	93.4	Sp. gr. at 15°.....	0.988
Iodine value.....	19.5	Melting point.....	78-79° C.

CHEMICAL EXAMINATION OF WAX

In order to separate the wax into some of its components, a well-dried portion was extracted with alcohol in a Soxhlet extractor. The material remaining in the cartridge when dried was a dark brown paraffin-like mass. When boiled with alcoholic potash a portion saponified. The unsaponified material was separated from the soap liquors. On examination, this portion proved to be a hydrocarbon. It could not

¹ Parson's "Wild Flowers of California."

² Personal communication from Acting Forester of Fifth District.

be obtained in a purified state and appeared to be composed of a number or homologous hydrocarbons, having a melting point between 50–57° C. Upon cooling, the potash soap became a mucilaginous mass. On acidifying, filtering and recrystallizing from alcohol solution, an acid crystallizing in straight needles, having a melting point of 76–76.5°, was isolated. Creotic acid melts at 77.8°. When titrated in an alcoholic solution with caustic potash its acid number was 140.5. The acid number of creotic acid ranges from 136–146.¹

On cooling, crystals separated out of the original alcoholic extract. Water was added to this alcoholic extract and the fats separating out were filtered. They were washed entirely free of chlorophyll with dilute alcohol solution. The fats were saponified in fairly concentrated potash solution, the solution diluted and the unsaponified portion filtered off. The soap liquids were evaporated to a small volume on the steam bath and acidified. The fatty acids separating out were filtered, washed and dried. They melted at 65–67°.

A fractional crystallization was made of these fatty acids with magnesium acetate in hot alcohol.² This fractionation was repeated three times and two acids of fair purity were isolated. One melted at 61–62°, the other at 68–69°. The silver salt of the former when ignited yielded 28.85 per cent of silver, the latter 27.56 per cent of silver. Palmitic acid melts at 62° and combines with 29.55 per cent silver. Stearic acid melts at 71–72° and combines with 27.43 per cent silver. The alcohols liberated in the saponifica-

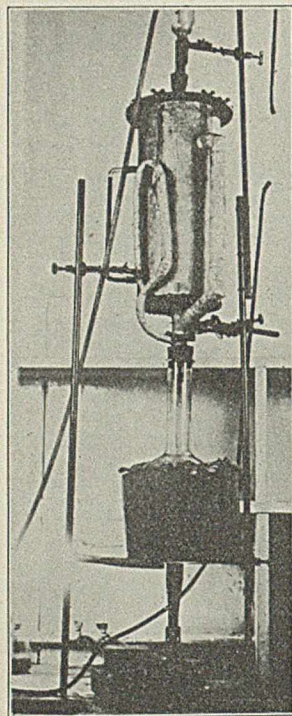


FIG. II

tion of the palmitic and stearic acids were washed with dilute ethyl alcohol and dried. The melting point was between 78 and 80°. When heated with soda lime³ and the resulting acids separated, an acid showing the properties of creotic acid as previously described was isolated. This would indicate ceryl alcohol. A higher acid with properties corresponding to melissic acid was isolated, indicating myricyl alcohol. Some traces of a lower acid were present but not sufficient to identify it. The original wax is probably composed of creotic acid in the free condition, a hydrocarbon, and palmitic and stearic acids in combination with ceryl and myricyl alcohols. A faint acrolein test seemed to point to the presence of a small quantity of glycerides.

¹ Lewkowitsch's "Oils, Fats and Waxes," 1898, 51.

² Leathe's "Monograph on Fats," p. 79.

³ Lewkowitsch's "Oils, Fats and Waxes," p. 74.

EXAMINATION OF LEAVES

TANNING—The extract from these leaves responded to the following qualitative tests for tannins: hydrogen ion gave a brown precipitate; salt gelatine solution, a heavy white precipitate; iron alum, a green coloration; and bromine water, an immediate precipitation. These tests would indicate the presence of catechol tannins.

An examination for mixed tannins was made as directed by Procter.¹ [The separation of the catechol from the other tannins by this method depending on the insolubility of the catecholic tannin compound with formaldehyde in the presence of hydrochloric acid.] In this case it was found that the tannins were exclusively of the catecholic variety, for on filtering the precipitate and testing the filtrate with salt-gelatine solution, no more tannins were detected.

A portion of the tannin that had been separated by adding dilute acid² was thoroughly dried, and distilled in a retort. The distillate recrystallized from alcohol had a melting point of 110°, was soluble in water and ether and with iron alum gave a deep green coloration. An empirical formula calculated from combustion and molecular weight data could be represented as C₆H₄(OH)₂. This corresponds to catechol.³

Glucose was identified partially free but to a greater extent combined, as a glucoside. A water extract of the leaves was taken and divided into two samples. The first sample was treated with lead subacetate and polarized. The second sample was treated with dilute hydrochloric acid, clarified and polarized. The polarization was dextro in both cases, but in the second sample was greatly increased. The presence of glucose was confirmed by preparing the glucosazone and microscopically studying the crystal form and determining the melting point.

A weighed sample of leaves was extracted with a Procter sand filter. The extract analyzed by the official method of the American Leather Chemists' Association⁴ showed 17.3 per cent tannins.⁵

INORGANIC ELEMENTS—In order to determine whether or not these leaves contained inorganic salts that in any way would injure hides in tanning, an ash determination was made with the following results:

	Per cent
Moisture in leaves.....	11.2
Total ash.....	5.53
SiO ₂	0.65
CaO.....	1.30
FeO.....	0.15

TANNERY TESTS

Through the courtesy of Mr. David Bloom, of Samuel Bloom & Sons, tanners in San Francisco, a practical test of ceanothus leaves was conducted on hides under tannery conditions.

Samples of hides from the "lime," "pickle" and "bate" were treated in water with these leaves ground.

¹ Procter's "Leather Chemists' Pocketbook," p. 51.

² Trimbell's "Tannins."

³ Trottmann's "Leather Trades Chemistry," p. 98.

⁴ Procter's "Leather Chemists' Handbook," pp. 94–96.

⁵ This material compares very favorably with other sources of leaf tans. According to Trottmann pistacia contains 14–16 per cent tannins; tammari, 9–10 per cent; quebracho, 17–20 per cent; oak bark, 12 per cent; sumac (crude), 19 per cent.

to pass a twenty-mesh screen. The hides tanned quickly, the grain being completely struck through in a short time. It was found that this material did not plump the hides properly. The hides were in all three cases completely tanned without harmful discoloration. A side of hide that had been prepared for the one-bath chrome, one-bath vegetable tan, was submitted to these leaves for the vegetable tan. Here, too, the hide was well tanned but not properly plumped. Another objection raised was the bulkiness of the leaf residue in the tanning vats. To do away with this nuisance it would be necessary to make this material up into an extract. To this extract suitable plumping organic acids could be added.

The preliminary data above described would indicate that these leaves are an extremely satisfactory source of tannin for tannery purposes. Work along this line is progressing in the tannery.

SUMMARY

Ceanothus velutinus, a widely distributed plant, has been found to contain 7.3 per cent and 17.3 per cent tannins. The wax was composed of free hydrocarbons, free creotic acid and in a great part of palmitic and stearic acids in combination with ceryl and myricyl alcohols. A trace of glycerides appeared to be present.

The tannin was found to be of the catecholic variety. Tests in the tannery have led the authors to believe that a suitable extract for tanning purposes could be made from these leaves. From the quantity of this shrub available, its objectionable presence in the forests and the value of the products obtainable from it, this material should become of considerable economic importance.

In concluding, we would wish to thank Mr. Carl A. Kupper and Mr. C. S. Smith, of the United States Forest Service, for obtaining the material for the investigation and for the survey of its occurrence; Professors W. C. Blasdale and H. C. Biddle, of the Chemistry Department of the University of California, for valuable suggestions given during the progress of the work; and Mr. David Bloom, for permitting the experimental work in the tannery.

UNIVERSITY OF CALIFORNIA, BERKELEY

SOME QUALITATIVE TESTS FOR GUM ARABIC AND ITS QUANTITATIVE DETERMINATION¹

By C. E. WATERS AND J. B. TUTTLE

Received December 16, 1915

INTRODUCTION

The group of polysaccharides includes such diverse substances as the starches, cellulose, the dextrans, the true gums and the plant mucilages. They possess in common the property of being decomposable hydrolytically into one or more sugars, usually pentoses or hexoses. By oxidation the acids corresponding to these sugars are formed, but the first step toward this reaction appears to be hydrolysis.

The true gums, of which gum arabic is typical, dissolve in cold water, yielding clear solutions which,

¹ Published by permission of the Director of the Bureau of Standards. Copies of the complete paper, from which this is abridged, can be obtained by application to the Director, Bureau of Standards, Washington, D. C.

though viscous and adhesive, can be filtered. The closely related and quite similar mucilages, such as gum tragacanth and cherry-tree gum, simply swell up and form more or less homogeneous suspensions that cannot be filtered. Perhaps most of the so-called gums are mixtures of one or more representatives of the above classes.

As might be expected from their chemical nature, the gums do not readily lend themselves to reactions of a definite qualitative or quantitative value. One of us learned how unsatisfactory some of the qualitative tests are when samples of mucilage first came to the Bureau of Standards for examination. This led to an extended study of the literature and of the various qualitative reactions that have been published, and finally to a comparatively accurate quantitative method. In the last part of this work the two of us joined forces, hoping to carry on a much more extended investigation than was found later to be possible.

The object of this paper is to discuss briefly some of the more important qualitative and quantitative methods and give references showing, as far as possible, what other methods have been published.

QUALITATIVE TESTS

In nearly all cases a 2 per cent solution of gum arabic was used. Similar solutions of dextrin and of gum ghatti, a substitute for arabic, were subjected to the same tests.

(1) FERRIC CHLORIDE AND ALCOHOL—A mixture of 2.5 volumes of 50 per cent alcohol and 1 volume of neutral ferric chloride solution containing 25 g. of the salt in 100 cc., precipitates gum arabic, though often only on long standing.¹ Gum ghatti gives no precipitate, and dextrin a very slight one.

(2) POTASSIUM HYDROXIDE—According to Liebermann,² solutions of gum arabic and of dextrin become amber-yellow when warmed with potassium hydroxide, while the closely related gum senegal gives at most a faint yellow color. Sollman³ stated that dextrin when so treated turns more or less brown, while some sugars and gums other than arabic, behave similarly. Rideal and Youle⁴ came to the conclusion that this test is of no value. Two samples of gum arabic, among a number tested by them, gave a green color; a solution of ghatti turned pink, and dextrin a very dark red or almost black. Nevertheless this test is among those recommended in the latest edition of "Lunge."⁵ Our own experiments amply confirm the statements that this test is of no value.

(3) COLOR REACTIONS WITH PHENOLS—Reiche⁶ found that gum arabic gives a flocculent blue precipitate when boiled with orcinol and concentrated hydrochloric acid. Other carbohydrates gave yellow or brown colors. Other investigators obtained reactions

¹ Roussin, *J. Pharm. Chim.*, [4] 7 (1868), 251. See also Allen's "Com. Org. Anal.," 4th Ed., Vol. III, p. 443.

² *Chem.-Ztg.*, 14 (1890), 665.

³ *Am. J. Pharm.*, 83, 176; *Chem. Zentr.*, 82, I (1911), 1560.

⁴ *J. Soc. Chem. Ind.*, 10 (1891), 610.

⁵ "Chem.-Tech. Untersuchungsmeth.," 6th Ed., Vol. III (1911), pp. 167-8.

⁶ *Ber. Ges. Förder. Chem. Ind.*, 1879, 74; *Chem.-Ztg.*, 4 (1880), 191.

with other phenols.¹ In our work, nine different phenolic compounds were used in alcoholic hydrochloric acid solution. Quite a wide range of colors was obtained, but the test was found to be unreliable for the carbohydrates which were studied.

(4) BASIC LEAD ACETATE—An aqueous solution of neutral lead acetate precipitates neither dextrin nor gums arabic and ghatti. An alcoholic solution of the salt does, however, slowly precipitate gum arabic.²

As might be expected from its employment in clarifying sugar solutions before polarization, basic lead acetate is an excellent precipitant for many gums. The solution may be made basic by adding ammonia³ or by boiling with litharge. The precipitate formed when gum arabic solution is added, is of a peculiar curdy consistency, and of such characteristic appearance that it is hardly necessary to make any confirmatory tests. Allen⁴ speaks of this precipitate as a "white jelly." Dextrin solutions are, at most, made slightly cloudy by the reagent, while gum ghatti yields a very small amount of precipitate, most of which remains suspended in the liquid.

The basic acetate solution used in this work was made by long continued boiling of 40 g. of crystallized

(6) MISCELLANEOUS QUALITATIVE TESTS—Many other reagents for gum arabic have been suggested, but they need only be referred to as follows:

(a) Oxidase reaction for distinguishing between gums arabic and tragacanth.¹

(b) Warming with hydrofluoric acid as a test for gum arabic, glue and dextrin.²

(c) Color reaction with alkali and diazobenzene-sulfonic acid.³

(d) Reaction with acidified egg albumen as a test for gum arabic and dextrin.⁴

(e) Nessler's reagent to detect gelatin in gum arabic solutions.⁵

(f) Reduction of mercuric acetate in the presence of sodium chloride.⁶

(g) Reduction of molybdic acid.⁷

(h) Color reaction with cobalt nitrate and alkali.⁸

(i) Color reaction with colloidal gold solution.⁹

Other reagents for gum arabic, such as sodium or potassium silicate, borax or ammonium oxalate,¹⁰ would seem to depend largely upon the natural calcium content of the gum, though some of the reagents are said to cause gelatinization. In our work numerous other reagents were tried, but even such promising

TABLE I—CHIEF QUALITATIVE TESTS FOR GUMS AND DEXTRIN

REAGENT	GUM ARABIC	GUM GHATTI	GUM GEDDA	DEXTRIN
Ferric chloride and alcohol	Precipitate	Nearly clear	Slight precipitate	Slightly cloudy
Basic lead acetate	Dense precipitate	Cloudy	Less precipitate than arabic	Slightly cloudy
Copper sulfate and sodium hydroxide, cold	Blue precipitate, colorless solution	Dark blue solution, often cloudy	Light blue precipitate, dark blue solution	Dark blue solution
Copper sulfate and sodium hydroxide, boiled	Precipitate darker, pale blue solution	Slight reduction	Precipitate darker	Complete reduction
Iodine solution	No characteristic color reactions			Reddish purple solution

lead acetate, dissolved in 250 cc. of water, with an excess of litharge. It was filtered, after which it remained clear for a long time.

Basic lead acetate has been recommended probably more frequently than any other reagent as a qualitative test for gum arabic, as well as for removing this and other gums from wines, liqueurs, etc., in which other constituents are to be determined.⁵

(5) COPPER SULFATE AND SODIUM HYDROXIDE—Jettel⁶ does not mention the basic lead acetate test, but relies chiefly upon the behavior of dextrin, gum arabic, etc., towards copper sulfate and sodium hydroxide. The test was devised by Liebermann⁷ for detecting dextrin and gum senegal in the presence of gum arabic. The details are given quite fully by Jettel. We need only say that gum arabic gives a blue precipitate, the supernatant liquid being colorless. Ghatti gives a dark blue solution which is sometimes turbid, but which clears up on warming gently; there is a little reduction on boiling. Dextrin gives a precipitate which dissolves on warming; at the same time there is considerable reduction to cuprous oxide.

¹ Ihl, *Chem.-Ztg.*, **9** (1885), 231; Clermont and Chautard, *Compt. rend.*, **94**, 1254; *Jahresber.*, **1882**, 684.

² Chauvin, *Mon. Sci.*, [5] **1** (1911), 317-8; *Chem. Zentr.*, **82**, I (1911), 1656.

³ v. Lippmann, "Chemie der Zuckerarten," 3rd Ed., p. 1616.

⁴ *Op. cit.*, p. 441.

⁵ Rideal and Youle, *J. Soc. Chem. Ind.*, **10** (1891), 610; Fromm, *Z. anal. Chem.*, **40** (1901), 143; Papasogli, *L'Orosi*, **21** (1898), 263-5; Scheibler, *Z. Ver. Zuckerind.*, **23**, 288; Battut, *Sucr. Indig. et Colon.*, **32**, 285; v. Lippmann, "Chemie der Zuckerarten," p. 1616.

⁶ "Zündwaren" in Lunge's "Chem.-Tech. Untersuchungsmeth.," 6th Ed., Vol. III, pp. 167-8.

⁷ *Chem.-Ztg.*, **14** (1890), 635.

ones as basic zinc salts and sodium zincate were found to be useless.

In Table I is given a comparison of the more reliable reactions for the identification of dextrin, gums ghatti and gedda, and for gum arabic from different sources. Some of these samples were obtained after most of the work described above had been completed, and only the tests tabulated were applied. All samples of gum arabic behaved alike.

QUANTITATIVE METHODS

Since the chemical nature of the gums is such as to render most of the qualitative tests of at least doubtful value, it is not surprising that there are difficulties involved in their quantitative separation and determination. Some of the methods that have been proposed will be mentioned below, after which our own procedure will be described.

(I) FERRIC CHLORIDE AND CALCIUM CARBONATE—The details of this method, which was proposed by Roussin,¹¹ are given by Allen.¹¹

¹ Payet, *Apolh.-Ztg.*, **25**, 116; *Z. anal. Chem.*, **44** (1905), 453.

² Bornträger, *Oesterr. Chem.-Ztg.*, **3**, 1888; *Z. anal. Chem.*, **40** (1901), 131.

³ Petri, *Z. physiol. Chem.*, **8**, 291; *Jahresber.*, **1884**, 1328.

⁴ Günsberg, *J. prakt. Chem.*, **88**, 239; *Z. anal. Chem.*, **2** (1863), 218.

⁵ Vamvakas, *Ann. chim. anal. appl.*, **12** (1907), 12, 139; *Analyst*, **32** (1907), 193, 226.

⁶ Hager, *Pharm. Centr.*, **18**, 313; *Z. anal. Chem.*, **17** (1878), 380.

⁷ Hager, "Commentar zur ersten deutschen Pharmakopöe," Vol. II, p. 116; cf. Stohmann in "Muspratt," 4th Ed., Vol. III (1891), p. 1917.

⁸ Papasogli, *L'Orosi*, **21** (1898), 263-5.

⁹ Zsigmondy, *Z. anal. Chem.*, **40** (1901), 697.

¹⁰ Allen, *Op. cit.*, p. 441.

¹¹ *Op. cit.*; also, Auguet, *Ann. Fals.*, **2**, 136-8; *Chem. Abs.*, **5** (1911), 538.

(2) FERRIC CHLORIDE AND SODIUM CARBONATE—This method was employed by Landwehr¹ for the determination of glycogen and, incidentally, of gum arabic. In connection with this he determined the percentages of water held by ferric hydroxide when dried to constant weight at different temperatures.

(3) LEAD ACETATE—The use of this salt, dissolved in alcohol, was proposed by Chauvin² and recommended by Rocques and Sellier.³ As far as we know, the basic salt has not been used quantitatively. Various formulas have been ascribed to the precipitate, and it is not unlikely that it varies in composition.⁴

(4) ALCOHOL—Chauvin employed alcohol acidified with hydrochloric acid to precipitate gum. The acid is unnecessary, for strong alcohol has often been used to precipitate gum from plant extracts, wines, etc.⁶

(5) MISCELLANEOUS METHODS—Methods depending upon hydrolysis,⁷ followed by estimation of hexoses or pentoses, and those by which the gum is oxidized to mucic acid,⁸ are of no value because samples of gum from different sources yield different percentages of the products. Wide variations in the iodine absorption, acidity, and the amount of alkali taken up from alcoholic potash, are also found.⁹

(6) COPPER SULFATE AND ALKALI—Madsen⁵ estimated the gum in licorice juice (*Succus liquiritiae*) by throwing it out with strong alcohol, dissolving in water, and precipitating with copper sulfate and sodium carbonate. The gum is not identical with gum arabic, but for botanical reasons may well be quite similar to it.

During the course of our work, while still unaware of the work of Madsen, it was attempted to use the same reagents, together with alcohol, to precipitate gum arabic quantitatively. The filtrates were always cloudy. Slightly better, but still far too low, results were obtained when sodium hydroxide instead of carbonate was used, and having the combined solutions contain 60 per cent of alcohol. Since any excess of copper over the gum present would be thrown down as hydroxide, thus increasing the difficulty of washing and drying the precipitate, some modifications of Fehling's solution were next tried. The best results were obtained with a reagent made up with copper acetate, sodium potassium tartrate and sodium hydroxide. When this was added to a solution containing about 0.25 g. of gum arabic in 40 cc. of water, there was no precipitation, or at most a slight turbidity. An amount of 95 per cent alcohol equal to the volume of the mixed solutions was then added, with vigorous stirring. This resulted in the formation of a fine-grained precipitate that could be filtered off and washed

with comparative ease. It was dried, weighed, ignited and the ash weighed. The results by this method varied a few per cent below and above 100.

Copper acetate was chosen for making up the reagent because no sodium sulfate or other salt insoluble in alcohol of the strength used could be formed. Even this reagent is not ideal, and the final step taken is described below.

(7) METHOD FINALLY ADOPTED—Copper acetate dissolved in ammonia possesses certain advantages over all the other solutions employed. In order to ascertain the best conditions for precipitation, a few preliminary tests were made. One-quarter gram of gum arabic was dissolved in 50 cc. of water, 25 cc. of ammoniacal copper acetate solution (see below) added, and then enough alcohol to give the required percentage of the total volume of the mixture. Thirty per cent of alcohol gave no precipitate. With 40 per cent there was a faint precipitate, so finely divided that it was practically impossible to filter. With 50, 60, and 70 per cent of alcohol, respectively, dense and easily filtered precipitates were formed. The addition of more alcohol to the filtrates from these three caused no further precipitation. These precipitates gave on ignition the following amounts of ash, practically all cupric oxide:

Percentage of Alcohol Employed:	50	60	70
Ash, gram.....	0.0412	0.0436	0.0544
	0.0402	0.0446	0.0564
	0.0398	0.0452	0.0548
Averages.....	0.0404	0.0445	0.0552

From this it will be seen that in the presence of 50 per cent of alcohol, the gum is precipitated quantitatively and carries down with it less occluded matter than when the mixture contains more alcohol.

The following procedure was finally adopted for the determination of gum arabic: Fifty grams of copper acetate were dissolved in water, an excess of ammonia added, and the solution diluted to 1000 cc., using water and alcohol in such proportions that the final solution contained 50 per cent of alcohol. For each determination a 50-cc. portion of a gum arabic solution, representing 0.25 g. of gum, was pipetted into a 250-cc. beaker, an equal volume of alcohol added, and then 25 cc. of the copper reagent, with constant stirring. The precipitate was allowed to settle, was filtered on a tared paper, washed with 50 per cent alcohol containing ammonia, then with 75 per cent, and finally with 95 per cent alcohol. It was dried to constant weight at 105°, ignited in a porcelain crucible and the ash weighed. The amount of ash was deducted from the weight of the original precipitate and the difference called "net gum arabic." The amount of moisture in the gum originally taken for analysis must be allowed for. This is determined by drying in a current of hydrogen at 105°. No allowance is made for the potassium and calcium which form an integral part of the gum. These may be to some extent retained in the precipitate and, therefore, be included in the ash. Any error that may be introduced by neglecting this is small and very much less than the error inherent in the method.

In some of the preliminary work the gum-copper

¹ *Z. physiol. Chem.*, **9** (1884), 164.

² See footnote 9; also *Ann. Fals.*, **5**, 27-30; *Chem. Zentr.*, **83**, I (1912), 756.

³ *Ann. chim. anal. appl.*, **16** (1911), 218-20; *Chem. Zentr.*, **82**, II (1911), 394.

⁴ Riegel, *Arch. Pharm.*, [2] **54**, 155; *Jahresber.*, **1** (1847-8), 795; Battut, *Sucr. Indig. et Colon.*, **32**, 285; Scheibler, *Z. Ver. d. Zuckerind.*, **23**, 288.

⁵ *Loc. cit.*

⁶ Diehl, *Pharm. Rundschau*, **1**, 31; *Z. anal. Chem.*, **22** (1883), 622; Madsen, *Pharm. Centr.*, **20**, 144; *Z. anal. Chem.*, **22** (1883), 134.

⁷ v. Lippmann, *Loc. cit.*

⁸ Kiliani, *Ber.*, **15** (1882), 34-7.

⁹ Williams, *Chem. News*, **58**, 224; *Z. anal. Chem.*, **28** (1889), 732.

precipitate was dried at 95° and then at 105°. The additional loss in weight at the higher temperature was usually about 3 or 4 mg., or 1.5 per cent. The following results were obtained with 0.25-g. portions of gum:

RESULTS OBTAINED BY THE AMMONIA COPPER SULFATE METHOD				
SERIES	A	B	C	D
Percentage of gum found.....	96.6	100.1	100.4	101.6
	98.0	99.0	101.2	102.8
	96.9	98.3	99.1	103.3
	98.4	99.3	99.7	...
	96.7	100.7	98.8	...
Averages.....	97.3	99.5	99.9	102.6
General average.....	99.5			

It is evident from an inspection of the figures that the method as finally modified is capable of giving results as accurate as could be expected. It is realized, however, that much work could yet be done upon mixtures of gum arabic with ghatti, dextrin, etc., as well as upon mucilages of known composition. A few preliminary determinations, made while Fehling's solution was still being experimented with, indicate that dextrin and ghatti tend to be carried down with gum arabic. At the same time a sample of mucilage was prepared according to the formula in the U. S. Pharmacopoeia; from this the gum was precipitated with strong alcohol, dried and analyzed. The net gum found in four determinations was about 91 per cent. This low result may be due to a fault of the method or to partial hydrolysis of the gum.

The publication of the results so far obtained has been so long delayed, and the opportunity to complete the work seems so remote, that it has been decided to present this paper without further postponement.

SUMMARY

The most characteristic qualitative test for gum arabic is the precipitate formed with basic lead acetate. Mixtures of copper sulfate and sodium hydroxide, and of neutral ferric chloride and alcohol are of value as confirmatory tests. A summary of the more important methods that have been proposed for the estimation of gum arabic is followed by a description of the steps that led the authors to the use of alcoholic copper acetate-ammonia solution for this determination.

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THE OCCURRENCE OF AZELAIC ACID AS A PRODUCT OF THE SPONTANEOUS OXIDATION OF FATS

By BEN H. NICOLET AND LEONARD M. LIDDLE

Received October 13, 1915

It is very well known that azelaic acid, $\text{COOH}(\text{CH}_2)_7\text{COOH}$, is a normal product of the artificial oxidation of various unsaturated fatty acids. All of the common eighteen-carbon unsaturated fatty acids (oleic, linolic, linolenic) very probably have a double bond located between the ninth and tenth carbons, that is, in the center of the carbon chain. It is further pretty well established that neither linolic nor linolenic acid has a double bond between this position and the carboxyl group. Consequently it was to be expected, and it has been found, that azelaic acid results from the oxidation of these acids with alkaline permanganate, from the decomposition of their ozonides, and from the breaking down of their nitrogen peroxide addition products.

It seemed probable to us that the difference between artificial and natural oxidation would be one of degree, or perhaps only one of time, rather than a complete difference in kind. In this case azelaic acid should be a product, and perhaps an important product, in the development of rancidity, and particularly in its more advanced stages.

Gröger¹ exposed some oils to air on filter paper and examined them after four years. One of the products isolated was an impure azelaic acid, supposed to be mixed with some suberic acid.

Scala² isolated from rancid material a number of fatty acids ranging from formic to pelargonic, and also most of the corresponding aldehydes. He obtained one fraction of nonvolatile, water-soluble acids, which yielded crystals that he suspected of being azelaic acid.

Here apparently the matter rests to-day. It is the purpose of the present note to call attention to the occurrence in very highly rancid cottonseed oils of amounts as high as 10 per cent of azelaic acid or a glyceride of this acid. The glyceride, whose presence is indicated, would belong to a type heretofore unknown.

Certain grades of fuller's earth are largely used in the bleaching of refined cottonseed oil. The oil remaining absorbed in the earth after filtering and pressing, is in an ideal condition for oxidation by air. In fact the oil-soaked clay, in large scale work, frequently becomes heated to the ignition point by simply standing in contact with air. The oil from a specimen of earth that had been used to bleach cottonseed oil, and had since been kept for a year and a half without any effort to protect it from the air, was extracted for examination.

From 100 g. of clay, low-boiling petroleum ether extracted only 4 g. of oil. Hot alcohol extracted 25 g. The characteristics of the oils from these two extracts are given below.

EXTRACT	Ether	Alcohol
Amount of Extract (grams).....	4.0	25.0
Acid No. (mg. KOH per g. oil).....	145.4	144.8
Saponification No. (mg. KOH per g. oil saponified).....	282.0	260.0
Volatile Acids (mg. KOH to titrate steam-volatile acids from 1 g.).....	46.0	35.0
Azelaic Acid (after saponification).....	3%	10%

In spite of its high acid number, the fraction extracted by alcohol gave very little azelaic acid when extracted with hot water. It was accordingly saponified, and the liberated fatty acids extracted with hot water. The water solution thus obtained was concentrated and gave in various fractions crystals of crude azelaic acid amounting to about 10 per cent of the fat saponified. This crude acid, after two or three recrystallizations from water, showed the constants of pure azelaic acid.

	Found	Pure azelaic acid
Melting point.....	105°	106°
Equivalent weight (by titration).....	95.9	94.0

Another sample of clay was extracted wholly with alcohol, and azelaic acid determined in the hot water extract both from the original material and from the acids obtained on saponification.

¹ *Z. angew. Chem.*, **1889**, 62; *J. Soc. Chem. Ind.*, **1889**, 202.

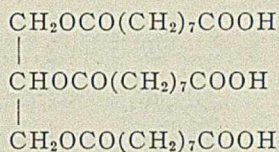
² *Staz. sper. agr. ital.*, **30** (1897), 613; *Gazz. chim. ital.*, **38**, I (1908), 307; abstract *Chem. Zentr.*, **1908**, I, 2085.

AZELAIC ACID FOUND		TOTAL
Before saponification	After saponification	
0.6 per cent	9.8 per cent	10.4 per cent

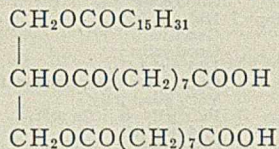
The crude acid had an equivalent weight of 112 (calc. 94).

A "shredded" (laundry) soap, which had developed 2 per cent of free acid on storage, was also worked up for azelaic acid. About 0.5 per cent was found.

The most remarkable thing about the oxidized cottonseed oil described is, however, not so much its abnormally high content of azelaic acid, as the form in which it was evidently present. Only about one-eighteenth of the total amount was present as free acid. The rest was in a form that was insoluble in hot water, and became soluble only after saponification. The simplest assumption to explain this behavior is that the oxidation proceeded practically independently of hydrolysis, and thus gave rise to the formation of glycerides of a hitherto unknown type, the semiglycerides of dibasic acids. The simplest one that might be present here may be called trisemiazelain,



The formation of mixed glycerides is of course not excluded. For instance, α -palmito diolein might be expected to give α -palmito disemiazelain,



These results tend also to justify the modern tendency to regard rancidity of fats and oils as due not simply to hydrolysis of the glycerides present, but at least equally to oxidation phenomena which are not necessarily dependent on such hydrolysis. In the case described, it is evident that the oxidation and hydrolysis were entirely independent processes.

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JELLY INVESTIGATIONS

By W. V. CRUESS AND J. B. MCNAIR

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A great deal of work has been done upon the chemistry of pectin and related bodies from both the purely scientific and practical standpoints. One of the best pieces of work has been done by Th. von Fellenberg,¹ who seems to have obtained more definite information upon the derivation of pectin from more complex compounds and upon its composition and chemical behavior than any of the other investigators. Bigelow and Gore in *Bull.* 94 of the U. S. Dept. of Agric., Bureau of Chemistry, gave a very good summary of the literature at that date. Miss N. E. Goldthwaite² studied jelly making largely from the practical side and dealt with such factors as effect of acid concen-

tration, character of acid, sugar concentration, character of sugar, temperature, pectin concentration and source of pectin, on quality of jelly.

The experiments discussed in the following paper were undertaken to throw light upon some of the practical phases of jelly making, rather than to add anything to the knowledge of the chemical composition of pectin. The main points investigated were: (1) Suitability of various fruits and vegetables for jelly making; (2) yields of jelly from various fruits; (3) clarification of jelly stock;¹ (4) loss of fresh fruit flavor in jelly making by hydrolysis and evaporation and production of jellies without application of heat; and (5) effect of sugar and acid concentrations on jelly. These topics will be discussed in the order given.

SUITABILITY OF VARIOUS FRUITS AND VEGETABLES FOR JELLY MAKING

To produce a jelly of the proper consistency when the liquid, obtained from the fruit by cooking with or without addition of water, is mixed with sugar in the proper proportion and cooked, the fruit must contain a good supply of both pectin and acid, or if not a large supply of pectin, a large amount of compounds that break down into pectin at the temperature of boiling water. Some fruits were found to contain sufficient acid and pectin while others lacked one or the other of these necessary constituents. Where the fruits were low in acid, attempts were made to produce jelly without addition of acid and also with addition of citric acid or lemon juice. In most cases the pectin was extracted in the usual way by cutting the fruit into small pieces, adding water to cover, boiling slowly until tender and expressing the hot juice by pressing in a small fruit press or by straining through a coarse cloth with gentle pressure.

The solution so obtained was analyzed for Balling or Brix degree (per cent dissolved solids) and acidity, and if much more dilute than the juice of the fresh fruit itself, was concentrated before being made into jelly. In making jelly, sugar was added in most cases at the rate of 1 $\frac{1}{4}$ volumes of sugar to 1 of solution. The mixture was then heated to boiling and boiled down to a boiling point of 104-105° C. or to a concentration of 65-70 per cent dissolved solids. At these concentrations, a jelly will form if the fruit is suited to the purpose.

The tests enumerated in Table I show that cull blackberries, loganberries, Isabella grapes, Tokay grapes, oranges, lemons, and pomelos can be used as jelly stock without addition of acid. These fruits are produced in from moderate to very large quantities in California. The culls resulting during picking and packing are in many instances a total loss. Of those noted, only the loganberry is used to any great extent as jelly stock. Commercially, this fruit is boiled with a small amount of water, pressed and the juice is sterilized in 5-gal. cans. It is stored in these cans until needed. The liquid settles in the cans so that when

¹ By "jelly stock" is meant the pectin-containing solution obtained from fruit or vegetables by heating the material with or without addition of water, and pressing or straining to separate liquid from pulp.

¹ Th. von Fellenberg, *Mitt. Lebensm. Hyg.*, 1914, 226-256.

² N. E. Goldthwaite, *THIS JOURNAL*, 1 (1909) 333; 2 (1910), 457.

the can is opened and the juice is decanted from the sediment, only a small amount of the total need be filtered. The other fruits noted above can be treated similarly with good results, as small scale tests have shown. Oranges do not always contain sufficient acid for jelly making, while lemons are too high in acid to make a palatable jelly. A mixture of the two fruits in the ratio of two oranges to one lemon gives more uniform and satisfactory results. Tokay grapes give a jelly of neutral flavor and should, therefore, be mixed with highly flavored grapes such as Muscat, Isabella or Concord. Muscat and Tokay culls are obtainable in great quantities in California for \$3 to \$10 per ton.

Cull apples, apple cores, and peels, are, of course, used in large quantities for jelly stock, both for apple jelly and blended jellies. By one of the most common methods, the waste apples are dried, baled, and sold to bakeries and jelly manufacturers. The manufacturer then boils the dried fruit with water as the

extracts were kept separate and tested individually for their jelly making properties. They were also combined in various amounts to ascertain maximum amounts of pectin solutions from the last extractions that could be blended with the first two extracts and still give a jelly. Oranges and lemons mixed in the ratio of two oranges to one lemon gave a maximum yield of 1585 cc. jelly per 1000 g. of fruit, or approximately 392 gals. of jelly per ton of fruit, or 8363 6-oz. glasses of jelly per ton. Yields of 300 gals. of jelly from the mixed fruits have been obtained often in the laboratory. Red loganberries gave a maximum yield of 1890 cc. jelly per 1000 g. fruit or approximately 467 gals., or 9962 6-oz. glasses per ton. Similarly, Mammoth blackberries gave 290 gals. jelly per ton. With addition of acid, these yields were considerably increased so that the yields were limited rather by lack of acid than lack of pectin.

CLARIFICATION—A jelly to be most attractive should be clear. Two methods of clarification are in general

TABLE I—COMPOSITION OF JELLY STOCKS FROM VARIOUS FRUITS, AND SUITABILITY OF VARIOUS FRUITS FOR JELLY MAKING

FRUIT OR VEGETABLE	PECTIN SOLUTION Balling (a)	Acidity (b)	Citric Acid Added	Final Acidity	CHARACTER OF RESULTING JELLY
Apple, Yellow Newtown, Smith Cider, Gravenstein Winesap	.....	.....	.....	.....	Good jelly in all cases except where fruit was overripe
Apricot	.....	.....	0	.....	Good jelly in some cases. Does not always jell
Cherry Black Tartarian	23.2	0.55	0.30	0.80	Very soft jelly. Not satisfactory
Citron Melon	7.1	0.32	0	0.32	Did not jell
Citron Melon	7.1	0.32	0.68	1.00	Soft jelly, but fairly satisfactory
Citron Melon	7.1	0.32	2.68	3.00	Stiff jelly
Cranberry	.....	.....	.....	.....	Stiff jelly
Currant	7.0	1.86	0	1.86	Good jelly
Currant (2nd boiling of pulp)	1.3	0.28	1.22	1.50	Good jelly
Blackberry, Mammoth Variety	7.6	1.18	0	1.18	Good jelly
Blackberry, Himalaya Variety	.....	.....	.....	.....	Good jelly
Fig, Mission Variety	13.1	0.2 (app.)	0.3 (app.)	0.5	Good jelly
Fig, Mission Variety	13.1	0.2 (app.)	0	0.2 (app.)	Did not jell
Grape, Isabella	20.0	0.8	0	0.8	Good jelly
Grape, Tokay	20.0	0.7	0	0.7	Good jelly
Huckleberries	.....	.....	.....	.....	Did not jell
Lemons	4.0 (app.)	3.0	0	3.0	Good jelly (this represents dilution of one-half)
Loganberry	13.5	1.85	0	1.85	Very good jelly
Loganberry (2nd boiling)	7.0	0.96	0	0.96	Fair jelly, a little soft
Loganberry (3rd boiling)	3.0	0.40	0	0.40	Did not jell
Orange, Navel	8.0	0.65	0	0.65	Good jelly
Orange (2nd boiling)	2.0	0.27	0.5	0.77	Good jelly
Orange (3rd boiling)	1.0	0.10	0.5	0.65	Did not jell
Orange (Valencia) + Lemons in ratio 7 : 1 by wt.	7.0	0.64	0	0.64	Good jelly
Peach, Muir	.....	.....	.....	.....	Did not jell
Pear, Bartlett	.....	.....	.....	.....	Did not jell
Pomegranate	6.3	0.61	0	0.61	Did not jell
Pomegranate	12.6	1.60	0	1.60	Did not jell
Pomelo	.....	.....	.....	.....	Good jelly
Pomelo plus Lemons in ratio 6 : 1 by wt.	8.0	0.65	0	0.65	Good jelly
Strawberry	5.8	0.76	0	0.76	Did not jell

(a) Balling degree equals per cent dissolved solids, principally sugars.

(b) Acidity as citric or malic.

fruit is needed for jelly making. Loganberries and citrus fruits have been treated similarly in this laboratory with good results.

Citron melons were found to be high in pectin, but low in acid. They could possibly be mixed with acid fruits when used for jelly.

The suitability of cranberries and currants for jelly is so well known that they need not be dwelt upon.

Peaches, pears, pomegranates and strawberries were found to be too low in pectin for jelly.

Mission figs contain sufficient pectin, but are too low in acid to make jelly. The localities that produce figs often produce lemons; thus the two fruits could be mixed to advantage.

YIELDS—The amount of jelly obtainable from any fruit without addition of acid will depend on the pectin and acid content of that fruit. Maximum yields from several fruits were obtained by making from four to six successive extractions of pectin by boiling the fruit with water and pressing. The several

commercial use. The most common practice is to filter the hot pectin solution. Often the boiled fruit and liquid are thrown together into some form of cloth or felt bag filter. This process is slow and troublesome and does not ordinarily give a brilliantly clear filtrate.

The second method consists in sterilizing the hot juice from the press in 5-gal. cans. These are stored until the sediment deposits. This will ordinarily be a period of several months. The settled juice is then decanted or siphoned off from the sediment directly into the cooking kettles. The process is often modified to the extent of giving the hot juice a bag filtration before canning.

Laboratory tests were made to ascertain the effect of Spanish clay and infusorial earth on the rate of filtration. These substances were added in powdered form to the hot juice and the rates of filtration and clearness of filtrates compared with those of the untreated juice. The Spanish clay, when added dry,

gave an "earthy" taste and did not appreciably hasten filtration. Infusorial earth, when added at the rate of 5 g. per 100 cc., greatly increased the rate of filtration and gave a clearer filtrate with one filtration than could be obtained without the addition of this substance. It was also found that the filtration through short fiber asbestos pulp in the Seitz type of filter was very much more rapid and resulted in a clearer filtrate than was obtained with the bag filter. A mixture of Seitz asbestos No. 5 and Seitz "Brilliant" asbestos added to and mixed with juice to give a filtering layer about $\frac{3}{8}$ in. thick gave good results. The flavor of the juice is not impaired. Filtration in all cases is made before any sugar is added to the juice.

Jelly stocks from loganberries, currants, and a mixture of oranges and lemons were prepared by boiling the fruits with a small amount of water until soft and pressing through a coarse cloth. The oranges and lemons were mixed in the ratio of two oranges to one lemon before boiling. The juices were divided into small portions. To these portions were added casein from a 2 per cent solution in dilute NH_4OH at the rate of 20, 40, 60 and 100 g. per hectoliter, respectively. To other portions were added egg albumen in the same amounts as noted for casein. To others were added 250, 500, 1000, 1500 and 2000 g. Spanish clay per hectoliter from a 10 per cent suspension of this substance in water. Untreated checks were also prepared. The various lots were bottled and sterilized one-half an hour at 100°C . It was found that the lemon-orange jelly stock settled very satisfactorily in 24 hrs. after sterilization without the addition of any clarifying material. The untreated loganberry and currant checks did not settle very satisfactorily in 24 hrs., but after several weeks' storage did settle fairly well. Currant juice prepared by heating the crushed fruit to 85°C ., pressing and sterilizing at 85°C ., settled better than the juice from the same fruit heated to 100°C . The casein and egg-albumen findings gave poor results in all cases and resulted in making the liquids more cloudy than the untreated checks. Spanish clay at 250 g. per hectoliter did not aid in clearing; 500 g. per hectoliter seemed to aid considerably in clearing. In some cases, 1000 g. per hectoliter gave a perfect clarification in 24 hrs.; in other cases, 1500 to 2000 g. of Spanish clay per hectoliter were needed to effect clearing of the juice. This was especially true of loganberry juice. In applying this method in practice, preliminary tests on a few hundred cc. of the material should be made before clarifying any large amount.

The Spanish clay was prepared by soaking it in a small amount of water until soft. It was then worked up with the water into a finely divided, thin "mud" or suspension. This can be made to a definite concentration; e. g., 20 per cent or 10 per cent mixtures were found satisfactory. The flavor of the juice is not impaired by the use of the clay in this form.

Preliminary tests with fire clay indicate that this substance can probably be used in a way similar to that employed with Spanish clay.

AROMA AND FLAVOR CHANGES IN JELLY MAKING

Fruit jellies when made in the ordinary way usually have a different aroma and flavor than those of the fresh fruits from which they are made. Ordinarily, jellies are made by extracting the pectin by boiling, followed by addition of sugar and boiling until the mixture boils at about 220°F ., or until the mixture jells, or until a Balling or Brix degree of 65° (corrected for temperature) is obtained. The high temperatures resulted in marked changes in flavor, giving a so-called "cooked" taste to the resulting jelly.

It was thought that this change in flavor and aroma might be due in part to hydrolysis and in part to loss by volatilization. To throw light on loss by evaporation, attempts were made to make jelly from currants, loganberries, blackberries, and a mixture of orange and lemons, at temperatures of room temperature, 60° , 70° , 80° , 90° and 100°C . The fruits were crushed and heated in water-jacketed aluminum pots to the temperatures indicated and pressed. Cane sugar was added to increase the Brix degree to 65° and the juices were heated to the temperatures indicated to dissolve the sugar.

To note whether loss of flavor was also due to hydrolysis, a second series at the same temperatures indicated above was carried out in a 500-cc. flask fitted with a long water-cooled reflux condenser.

The jellies made by the two methods were compared shortly after they were made. The jellies made in the open kettle at the lower temperatures were superior to those made at the higher temperatures as regards amount of fresh fruit flavor and aroma retained. The same applied to the jellies made under the reflux condenser. After two to three months' storage, the differences in flavor and aroma were not so pronounced. The orange jelly, after long storage, developed a "turpentine"-like taste, probably due to oxidation of the orange oil.

The jellies made at room temperature were especially close to the flavor of the fresh fruits from which they were made. Loganberry and in one or two cases blackberry and orange jelly were made without application of heat, but strawberries did not yield a jelly in any case. Loganberries very readily give a highly flavored aromatic and firm jelly in this way. So far as known, this method has not been described in the literature before.

The jellies made under the reflux condenser were superior in flavor and aroma to those made at the corresponding temperatures in the open kettle.

The facts that jellies made at high temperatures (85 – 105°C .) were poorer in fresh fruit flavor than those made at room temperature and 60 – 75°C ., and that jellies made under the reflux condenser were stronger in fresh fruit aroma and flavor than jellies made at the same temperatures in an open kettle, indicate that loss of flavor and aroma is due both to volatilization and to decomposition of flavoring and aromatic bodies.

EXPERIMENTS ON RÔLE OF SUGAR IN JELLY MAKING

The addition of sugar in jelly making is necessary to raise the concentration of dissolved solids sufficiently

to cause jelling of the pectin. The amount of sugar necessary to cause jelling will depend upon the pectin and acid concentrations, but the amount used normally is controlled by the concentration of sugar necessary to prevent fermentation or molding. Tests with loganberry and orange jellies showed that jellies could be obtained at 60° Brix or lower, but that in such cases molding or fermentation took place unless jellies were sterilized in sealed containers. Jellies with varying amounts of sugar were inoculated with mold and yeast and caps were placed on the glasses. It was found that 65° Brix prevented spoilage but that much below this concentration, mold growth took place. Where the sugar concentration was increased from 72° to 75° Brix crystallization of sugar often took place. This crystallization depends on the amount of cane sugar present. The tendency to crystallize was most noticeable in jellies of low acid content and in which little hydrolysis of the cane sugar had probably taken place. Where glucose is used for jelly making, the concentration may be considerably above 70° Brix without crystallization.

In the ordinary household method of jelly making, equal parts of volume of juice and sugar are used. The mixture is then boiled down until it jells. This results in prolonged boiling at temperatures above 100° C. and consequently in considerable loss in flavor and aroma. Jellies were made by this method and compared with jellies from the same fruits made by adding enough sugar to bring the juice to the proper concentration (65° Brix) at once and only heating enough to dissolve the sugar. The latter method gave jellies of better flavor and aroma than the former.

A simple method for calculating the amount of sugar to add to a juice of a given degree Brix to bring the liquid to 65° Brix is as follows:

Let a = Brix of juice.
 V = Volume of juice.
 S = Grams sugar necessary to bring to 65° Brix.
 Then $(65 - a)V/35 = S$.
 Example:
 $V = 250$ cc. $a = 5$ ° Brix.
 $(65 - 5) 250/35 = S = 428.5$ g. sugar.

For practical purposes, a little more than $1\frac{1}{2}$ of sugar to one of juice by weight will be found satisfactory.

If this method is used, the fruit juice cannot be so dilute as where a mixture of one of sugar to one of juice is used and where the pectin is concentrated by boiling off excess water. The juice must contain enough pectin to give a jelly without concentration of the juice.

Sugar added to the crushed fruit before pectin extraction seemed to help retain the flavor and the jelly so made appeared to be superior in this respect to jelly made by the usual methods.

A solution of 65° Brix will boil at 103.9° C. or 219.02° F. at sea level. This point can be used to determine the proper density of the boiling jelly if the proper allowance is made for elevation of locality in which the jelly is made. The boiling point of water for any given locality may be determined and then the boiling point of jelly at the proper concentration will be 3.9° C. or 7.02° F. above the boiling point of water.

TESTS ON EFFECT OF ACID IN JELLY MAKING

It was found that pectin solutions made by boiling and pressing fruit and containing less than 0.5 per cent acid as citric or tartaric usually did not jell, but it was also found that if the acid were increased to 0.7 or 0.8 in such cases, it almost invariably gave a jelly. This was noticed especially with citron melon and fig solutions, both naturally deficient in acid, but containing sufficient pectin for jelly making. Tests made with a 1 per cent solution of pure orange pectin¹ in distilled water indicated that a concentration of 0.3 per cent acid in the final jelly was necessary to give a firm jelly. Increase of acid in the final jelly to 1.0 per cent acid resulted in softening of the jelly; 1 per cent acid in the final jelly gave good results and corresponds to about 1.5 acid in a fruit juice before addition of sugar. 0.3 per cent acid in the final jelly would similarly correspond to about 0.5 per cent acid in the fruit juice before addition of sugar. This would indicate a range of 0.5 to 1.5 per cent acid in the original fruit juice for the proper concentration of acid calculated as citric acid. This corresponds very well with results obtained with pectin-containing orange juices made by boiling this fruit and pressing. In this case an acidity of 1.5 per cent in the juice gave a finished jelly that set quickly but which finally softened, while 0.5 per cent gave a fairly good jelly, and less than 0.5 per cent did not give a jelly or resulted in a very soft jelly.

Working with purified pectin and different amounts of pure citric acid, it was found that for the same treatment as regards amounts of sugar added, time of boiling, etc., the color of the resulting jelly was darkened in direct proportion to the amount of acid used. The colors were compared by means of a Dubosq colorimeter. This darkening is probably due to caramelization of the sugar.

SUMMARY

I—It was found that of the fruits produced in any great quantity in California, namely, grapes, apples, loganberries, blackberries, lemons and pomelos in all cases contained sufficient acid and pectin to give satisfactory jellies. Oranges always contained enough pectin, but were found to give better results if mixed with lemons to increase the acidity. Apricots and cherries occasionally gave jellies, but in general were not satisfactory because of deficiency in pectin. Pomegranates and strawberries did not have enough pectin to give jellies, although the acidity was sufficient. Peaches, pears, and the huckleberries lacked sufficient pectin and acid. Figs and citron melon gave satisfactory jellies when acidified with citric acid or lemon juice.

II—Maximum yields of 392 gals. jelly per ton of oranges and lemons mixed in ratio of two oranges to

¹ This pectin was prepared by boiling the sliced oranges under a reflux condenser with 95 per cent alcohol three successive times with three different lots of alcohol. This removes most of the sugars, acid, etc. The residual pulp was then heated with distilled water under pressure. The hot liquid was pressed out and filtered. The pectin was precipitated with 95 per cent alcohol and purified by redissolving in water and precipitating with 95 per cent alcohol. This purification was twice repeated. The resulting pectin was white and friable.

one lemon, 467 gals. per ton of loganberries and 290 gals. per ton of blackberries were obtained in this laboratory.

III—Orange jelly stock was found to clear satisfactorily by settling twenty-four hours; other juices required a longer time and did not settle so completely as the orange jelly stock did. All juices tested were clarified satisfactorily by the addition of 1000–2000 g. Spanish clay per hectoliter (from a 10 or 20 per cent suspension of the clay in water), followed by heating to 100° C. and settling.

IV—Changes in and loss of fruit flavors and aromas in jelly making were found to be due to decomposition by heat and to direct loss by volatilization.

V—Jellies with practically all of the aroma and flavor of the fresh fruit were made by crushing fruits high in pectin, pressing out the juice, and adding sufficient sugar to increase the Brix degree to 65°. Loganberries and currants were especially adapted to this procedure.

VI—An acidity between 0.5 and 1.5 per cent for fruit juices to be made into jelly seemed to be the optimum range for production of satisfactory jellies.

VII—A Brix degree of 65° was necessary to prevent spoilage by mold and yeasts where jellies were inoculated with these organisms.

UNIVERSITY OF CALIFORNIA EXPERIMENT STATION
BERKELEY

THE ANALYSIS OF NON-ALCOHOLIC LEMON AND ORANGE EXTRACTS

By E. L. REDFERN

Received November 29, 1915

During the last year there have appeared on the market various flavoring extracts containing no alcohol but made up with gum tragacanth and glycerine in which the essential oils are held in suspension. It is obvious that the amount of oil present cannot be determined by the ordinary methods and an attempt was made to devise some method by which the oils could be determined quantitatively to see if this class of extracts was up to the legal standard. These extracts are quite viscous and unless warmed slightly, pour with difficulty, but, by warming for a few minutes they can be measured in an accurately graduated cylindrical graduate. The use of a pipette for measuring is not satisfactory, as a considerable amount of the mixture adheres to the inside of the pipette and is difficult to remove, while with a graduate it can be removed by letting the graduate drain for a few minutes into the flask to be used in the analysis and then rinsing with a little alcohol. A standard extract containing 5 per cent of lemon oil was made up as follows: 150 cc. gum tragacanth, which had been soaked in water and reduced to the proper consistency, 40 cc. glycerine and 10 cc. pure lemon oil.

First an attempt was made to extract the oil in a separatory funnel with ether but an emulsion was formed which could be only partly broken up by running in the centrifuge. The ether was drawn off through a small dry filter into a tared flask, evaporated off spontaneously and dried for a few hours in a

desiccator. The final weight of oil obtained from 10 cc. of the 5 per cent extract was 0.2664 and 0.2246 g. in duplicate determinations. Ten grams of extract were then mixed with anhydrous CuSO_4 to apparent dryness and extracted in a Soxhlet extractor with anhydrous ether but only 17 per cent of the oil was recovered. Distillation with steam gave 24 per cent recovery of oil. The fact that gums are precipitated with alcohol suggested a possible solution of the difficulty: 25 cc. of the standard extract were measured out and transferred to a 200-cc. Erlenmeyer flask, 25 cc. of 95 per cent alcohol were added and the flask was then shaken vigorously. The alcohol was filtered on a Gooch crucible and collected in a 100-cc. graduated flask, care being taken to prevent any of the precipitated gum from running into the crucible. The precipitate was washed several times with 95 per cent alcohol and the filtrate made up to 100 cc. The precipitation method using 50 cc. of this solution did not give uniform results, owing to the fact that with this high strength of alcohol a considerable quantity of the oil was held in solution. The method suggested by Howard¹ was then used which gave 4.96 and 5 per cent oil in duplicate tests on the 5 per cent standard.

An orange extract was made up as in the case of lemon, using orange oil, and gave in duplicate tests with Howard's method 4.80 per cent of oil.

Duplicate tests of an unknown extract gave 5.2 and 5.04 per cent. In these tests a Babcock milk bottle graduated to 1 per cent was used to insure more accurate reading as the amount of oil in the dilutions is small. Especially is this true in substandard extracts. If the analysis of an extract shows that it is much below standard, the author has found it advisable to repeat the analysis using a skim milk bottle graduated to 0.01 per cent, which makes it possible to read very small amounts of oil. The supernatant liquid in the skim milk bottle can be easily drawn off by attaching a suction tube to the filling tube on the bottle and decanting off the remaining small amount through the capillary tube as the chloroform carries the oil present and remains on the bottom. The method has been used in this laboratory for several months and has given uniform results.

IOWA DAIRY AND FOOD COMMISSION
DES MOINES

THE ANALYSIS OF MAPLE PRODUCTS, VIII

The Application of the Conductivity and Volumetric Lead Subacetate Tests to Maple Sugar

By J. F. SNELL AND G. J. VAN ZOEREN

Received August 27, 1915

In Papers I² and VII³ of this series a conductivity test and in Paper VI⁴ a volumetric lead subacetate test for purity of maple syrup have been described. The question remained how these tests could best be applied to sugars. Two methods of procedure suggested themselves: (1) A quantity of sugar sufficient

¹ *J. Am. Chem. Soc.*, 1908, 608.

² *THIS JOURNAL*, 5 (1913), 740.

³ *Ibid.*, 8 (1916), 331.

⁴ *Ibid.*, 8 (1916), 241.

for the test could be weighed out and dissolved in a definite quantity of water; (2) a larger quantity of sugar could be dissolved and the solution boiled down to a syrup, which could then be tested as a syrup.

Under the direction of the senior author, Mr. J. M. Scott in 1913 determined the conductivity values of some twenty pure sugars by both of these methods of procedure. For the first, 15 g. of sugar were dissolved in hot water and made up to 50 cc. at 250° C. For the second method a solution of the sugar was boiled until the temperature reached 219° F. The values obtained were seldom identical; in some instances the former method, in other instances the latter method, gave the higher result. This indicated variation in sampling, and as material suitable for a study of the question of sampling was not immediately available the investigation was laid aside. It has now been resumed with reference to the volumetric lead test as well as to the conductivity test.

Ten of the syrups of the season of 1915 used in the work reported in Papers VI and VII were used in these new experiments. About 200 cc. of each were boiled to 243–245° F., poured into moulds, and allowed to stand for a day or two. The sugars thus obtained were redissolved, boiled to 219° F. and filtered through cotton wool. The conductivity values and the volumetric lead numbers were then redetermined on the regained syrups and compared with those found in the original syrups. The results are given in Table I. They show no material difference between the original syrup and that obtained by redissolving the sugar. This method of applying the tests to maple sugar is, therefore, satisfactory.

TABLE I—COMPARISON OF VALUES IN ORIGINAL AND REGAINED SYRUPS

No.	10	13	14	16	18	19	22	27	29	43	Av.
CONDUCTIVITY VALUE:											
Original Syrup.....	107	119	99	106	97	108	112	109	117	125	109.9
Syrup from Sugar....	106	119	99	106	98	106	112	110	113	125	109.4
VOLUMETRIC LEAD No.											
Original Syrup.....	5.3	5.3	5.1	5.3	5.8	6.0	5.7	5.1	5.6	5.2	5.44
Syrup from Sugar....	5.4	5.6	5.3	5.4	5.4	6.2	5.6	5.0	5.5	5.8	5.52

The tests have been applied in the same manner to 16 sugars of the season of 1913, which were collected from the makers with the syrups reported in Paper III.¹ 75–100 g. of sugar were dissolved, the solution boiled to 219° F. and filtered through cotton wool.

The conductivity values found vary from 97 to 148 and the volumetric lead numbers from 5.1 to 6.5. These results are all within the limits found in pure maple syrups.² The conductivity values obtained by Mr. Scott by this same method (22 pure sugars) are also within the limits found in pure maple syrups.

Three sugars collected from grocers in the western provinces of Canada in 1912, tested in like manner, gave the following results:

No.	Conductivity Value	Volumetric Lead No.
1.....	16	0
2.....	146	5.6
3.....	79	0

Nos. 1 and 3 are condemned by the tests, while No. 2 appears to be a genuine maple sugar.

METHOD—Dissolve a fairly large representative sample (say 100 g.) of the sugar in hot water. Boil

to 219° F. (103.9° C.). Filter through cotton wool. Test the resulting syrup as directed in Papers VI and VII.

SUMMARY

Pure maple sugars converted into syrups give conductivity values and volumetric lead numbers within the limits found in genuine maple syrups.

MACDONALD COLLEGE, PROVINCE OF QUEBEC

DETERMINATION OF TARTARIC ACID

By B. G. HARTMANN, J. R. EOFF AND M. J. INGLE

Received December 30, 1915

The determination of tartaric acid in numerous soda fountain beverages, grape juices, wines and other food products, has necessitated a modification of the Halenke and Möslinger method, the provisional method of the Association of Official Agricultural Chemists.¹ Since modifications of this method presented as reports of the Associate Referee on Wine of the above Association have not thus far been available to many chemists who may be doing work of this nature, it is considered desirable to review briefly the recent methods for the determination of tartaric acid² and to give the results of a successful search for the cause of the discrepancies noted in the determination of this acid. These variations in results, even of the same analyst, were noted especially on wines containing free acid and alcohol.³

Most of the earlier methods depended on the precipitation of potassium acid tartrate, the original method being that of Berthelot and Fleurieu⁴ published in 1889. This method was modified by Halenke and Möslinger⁵ in 1895. Of the numerous methods which have been described for the quantitative determination of total tartaric acid in wines, this method may be considered as deserving first mention as to simplicity of manipulation, accuracy and adaptability to varying conditions. This is the method which the authors have still further modified.

Magnier de la Source⁶ was perhaps one of the first to note the fact that when free tartaric acid was present the cream of tartar precipitate did not represent the total tartaric acid content. He, however, suggested the neutralization of one-fifth of the total acidity by adding standard alkali. This procedure did not give satisfactory results on wines containing much free tartaric acid, such as Catawba and Scuppernong. The Goldenberg method⁷ for the estimation of the tartaric acid content of argols or crude tartar, consisted in dissolving the argols in hydrochloric acid and, after completely neutralizing with potassium carbonate, adding acetic acid to transform the neutral salt to the insoluble acid tartrate. This procedure, however, was open to criticism, since (as noted by Lampert and by Ordonneau⁸) iron

¹ U. S. Bureau of Chemistry, *Bull.* **107** (1912), 86.

² E. P. Haüssler, *Schweiz. Apoth. Zeit.*, **52** (1914), 525–7, 537–40, 553–6, 569–72.

³ B. G. Hartmann, *Proc. A. O. A. C.*, **1914**.

⁴ M. Berthelot, *Chimie Végétale et Agricole*, **4** (1889), 423, in collaboration with M. de Fleurieu.

⁵ A. Halenke and W. Möslinger, *Z. anal. Chem.*, **34** (1895), 263.

⁶ M. L. Magnier de la Source, *Ann. chim. anal.*, **1** (1896), 205–6.

⁷ *Zeit. anal. Chem.*, **47** (1908), 57–59 (from *Chemischen Fabrik*).

⁸ M. C. Ordonneau, *Bull. soc. chim.*, **7** (1910), 1034–41.

¹ THIS JOURNAL, **6** (1914), 216.

² See Papers VI and VII.

and aluminum, commonly present in argols, tend to lower the result. Heczko¹ calls attention to the fact that the freshly precipitated calcium carbonate tends to react with the neutral potassium tartrate. The Marseille method² was used as an approximate method for the determination of tartaric acid in argols and depended on the precipitation of neutral calcium tartrate from an ammoniacal solution.

The most recent precipitation method is that developed by A. Kling.³ This is an extremely satisfactory procedure and, as tried out at the Enological Laboratory of the Bureau of Chemistry, gave the best yield of any method tried. The principle of the method is the formation of the very insoluble calcium racemate under conditions which give a theoretical yield from synthetic solutions. When applied to two authentic wines representing the extremes in ratio between cream of tartar and free tartaric acid, it gave results which were all that could be desired.⁴ As the tartaric acid present in the grape and the commercial article derived from it is always the dextro form, the addition of an excess of laevo salt would form the racemate, so that by forming the calcium salt under the favorable conditions prescribed, a most efficient method is developed. This is accomplished by adding calcium acetate and alkaline laevo-tartrate of ammonia in excess, and titrating the calcium racemate precipitate with a standardized potassium permanganate solution.

Iron and aluminum introduce a source of error in this determination which has been corrected by a modification, using an ammonium citrate solution.⁵ The presence of esters of tartaric acid is also allowed for by saponification as detailed by Kling and Gelin.⁶ The present prohibitive price of laevo-tartrate of ammonia, the instability of a tartrate solution, which requires a preservative, and the need of a microscope, are all factors tending to inhibit a general use of this method in commercial laboratories.

Other investigators have made use of the reducing action of the tartaric acid radical; thus Chapman and Whitteridge⁷ oxidize a bismuth tartrate precipitate; Mestrezat⁸ and Kling also finally titrate with potassium permanganate. Pozzi-Escot⁹ oxidizes barium tartrate, while Ferentzy¹⁰ ignites magnesium tartrate and weighs the resultant MgO, but Gowing-Scopes¹¹ modifies this method and titrates the magnesium tartrate with permanganate.

Evaporation, with a subsequent addition of alcohol, or alcohol and ether, has been advanced by Pasteur, Reboul, Magnier de la Source, and Malvezin. The addition of potassium bromide brings the free

tartaric acid into the reaction, so that on the addition of the alcohol-ether mixture all the tartaric acid is precipitated as tartar. These methods are not considered satisfactory as the evaporation is productive of losses through volatilization of esters and possible decomposition, and acid malates are titrated as tartrates¹ as are also other acid-reacting substances. This method as given by Malvezin was also tried out in the Enological Laboratory, and gave concordant but uniformly high results.

It has been demonstrated in routine work by the authors that the Halenke and Möslinger method is unreliable when employed on wines and fruit juices containing a considerable amount of free tartaric acid, such as Catawba, Iona, or Scuppernong grape juices or wines. This is due to the failure of the method to precipitate the free tartaric acid quantitatively as potassium acid tartrate and is attributable to the reversibility of the main reaction ($H_2T + KCl \rightleftharpoons HKT + HCl$). It has been noted by the authors that the addition of potassium acetate for the purpose of offsetting the disturbing influence of the hydrochloric acid formed ($KAc + HCl \rightleftharpoons KCl + HAc$) does not altogether correct this fault, one-fifth to one-third of the free tartaric acid being lost.² Furthermore, the addition of the potassium acetate to wines not containing free tartaric acid has a tendency to decrease the yield by dissolving the potassium acid tartrate.³

Having thus recognized that the value of the Halenke-Möslinger method was in the main dependent upon the elimination of the disturbing influence of the hydrochloric acid liberated, the authors decided that the best preventive for the formation of hydrochloric acid was to completely neutralize the acidity of the wine and to add the molecular equivalent of tartaric acid for the alkali added in order to convert the neutral tartrates into acid tartrates, and from this point on to proceed as prescribed in the Halenke-Möslinger method, omitting the potassium acetate addition altogether. By this procedure no intermediate products which might possibly interfere with or redissolve the potassium acid tartrate were to be expected, thus forming favorable conditions for a quantitative separation of the total tartaric acid as potassium acid tartrate. Trials of the procedure upon various synthetic solutions of tartaric acid and its salts proved its superiority to the older method.

Unfortunately, these experiments are not final since they were for the greater part undertaken on aqueous solutions, but it is quite possible that the behavior of a wine containing various other ingredients, such as phosphates and sulfates, may augment the usefulness of the method.

This modification has the decided advantage over the Halenke-Möslinger method in that, where there is a small amount of tartaric acid present in a wine (as in ports, sheries, and other fortified wines), the

¹ Arnold Heczko, *Z. anal. Chem.*, **50** (1911), 73-82.

² M. d'Hector de Rochefontaine, *Ann. chim. anal.*, **1** (1896), 25.

³ Andre Kling and L. Gobert, *Ann. fals.*, **4** (1911), 185.

⁴ *J. Assoc. of Offic. Agr. Chem.*, **1** (1915), 136.

⁵ M. Andre Kling and D. Florentin, *Proc. 8th Intern. Cong. Appl. Chem.*, **1** (1912), 237-9.

⁶ M. Andre Kling and E. Gelin, *Ibid.*, **1** (1912), 251-6.

⁷ Alfred C. Chapman and Percy Whitteridge, *Analyst*, **32** (1907), 163-6.

⁸ Note of M. W. Mestrezat presented by M. Müntz, *Compt. rend.*, **143** (1906), 185.

⁹ Em Pozzi-Escot, *Ann. chim. anal.*, **13** (1908), 266-9.

¹⁰ Josef V. Ferentzy, *Chem. Zeit.*, **31** (1907), 1118.

¹¹ L. Gowing-Scopes, *Analyst*, **33** (1908), 315-19.

¹ M. L. Magnier de la Source, *Ann. chim. anal.*, **2** (1897), 281-3.

² B. G. Hartman, Bureau of Chemistry, *Bull.* **162** (1913), 71.

³ *Ann. chim. anal.*, **1** (1896), 205-6.

addition of the tartaric acid insures a precipitation that otherwise might not occur.

HARTMANN AND EOFF METHOD

FOR WINES—Neutralize 100 cc. of wine with normal sodium hydroxide. The amount of alkali necessary for neutralizing may be calculated from the acidity of the wine previously determined. To the neutralized wine add the molecular equivalent in grams, of powdered tartaric acid,¹ corresponding to the amount of alkali required for neutralization. After the tartaric acid has dissolved add 2 cc. glacial acetic acid and 15 g. potassium chloride and after solution add 15 cc. alcohol (95 per cent). Stir until precipitation has started, then allow to stand over night at a temperature not above 15° C. After this interval filter the solution through either a Gooch crucible prepared with filter paper pulp or a Buchner funnel of 7 cm. diameter, into which is fitted exactly

TABLE I—DETERMINATIONS OF TARTARIC ACID BY HARTMANN-EOFF METHOD

SUBSTANCE	Results in Grams Tartaric Acid per 100 cc. Liquid			
	Actual Content	Hand Stirred	MECHANICALLY STIRRED 30 min.	15 min.
Tartaric Acid Solution...	0.481	...	0.482	...
	0.481	...	0.483	...
	0.241	...	...	0.238
	0.241	...	...	0.236
	0.241	...	...	0.238
	0.120	...	...	0.110
California Hock Wine...	0.048	0.042	0.025	...
	0.048	0.042	0.012(a)	...
California Sauterne Wine...	0.254(b)	0.240	0.255	...
California Zinfandel Wine...	0.221(b)	0.215	0.217	...
California Sherry Wine...	0.233(b)	0.211	0.243	...
California Sherry Wine...	...	0.088	0.099	...
California Port Wine...	...	0.113	0.120	...
California Sherry No. 2...	...	0.101	0.100	...
California Port No. 2...	...	0.120	0.120	...

(a) Stirred one hour.

(b) Content determined by method given on p. 86 of U. S. Dept. Agr., Bureau of Chemistry, Bull. 107 (Rev.).

a strong filter paper; use gentle suction and wash three times with 7 cc. of a solution composed of 100 cc. of water, 15 g. potassium chloride and 20 cc. of 95 per cent alcohol. Transfer the precipitate and paper to the original beaker with 50 cc. hot water, bring to a boil and immediately titrate with *N*/10 sodium hydroxide, using phenolphthalein as indicator. Increase the burette reading by 1.5 cc. as a correction for solubility, multiply by 0.015 and subtract the tartaric acid added. This will give the total tartaric acid in the wine in terms of grams per 100 cc.

OTHER MODIFICATIONS

STIRRING—It was noted that stirring until a precipitate actually formed was essential to the accuracy of the method. By means of the mechanical stirring of solutions the time factor was lessened and it was found practicable by this expedient to determine correctly the tartaric acid content of a synthetic solution in 15 to 30 minutes.

HALF-NEUTRALIZATION METHOD.—An attempt to neutralize one-half of the acidity of wine proceeding according to the Halenke-Möslinger method, omitting

TABLE II—DETERMINATION OF TARTARIC ACID IN WINES IN WHICH THE ACIDITY WAS HALF NEUTRALIZED

Experiment No.	1	2	3	4	5	6	7
Hartmann-Eoff Method...	0.74	0.54	0.99	0.76	0.72	0.78	0.80
Half-Neutralization Method...	0.68	0.50	0.96	0.71	0.63	0.71	0.77

the potassium acetate addition, gave less accurate results than complete neutralization, from 3 to 9 per cent less acid being found than was present.

¹ The acid used should be pure and well dried.

TEMPERATURE—The authors also find that the temperature at which the reaction mixture of the Halenke-Möslinger method is held for 15 hrs. influences the precipitation, there being a decided increase in yield of tartrate at low temperatures.

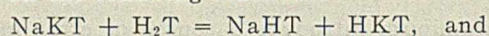
TABLE III—EFFECT OF CHILLING ON PRECIPITATION WHEN UNMODIFIED METHOD WAS USED

No.	Temperature C.	GRAM TARTARIC ACID Actual	Found	Per cent Acid Recovered
1	5	0.994	0.774	77.9
2	5	0.994	0.792	79.7
3	5	0.497	0.401	80.7
4	5	0.497	0.405	81.5
5	17	0.994	0.698	70.2
6	17	0.994	0.698	70.2
7	17	0.497	0.354	71.3
8	17	0.497	0.357	71.8

Before entering upon the final description of the methods resulting from these experiments it should be remarked that although other investigators have attempted to avoid the disturbing influence of mineral acids by neutralizing a part of the acidity of the wine, the authors have been unable to find records showing that this has been done with any marked degree of success and that the addition of tartaric acid to the neutralized solution for the purpose of precipitating potassium acid tartrate has evidently not been previously tried.

ROCHELLE SALT METHOD

The tartaric acid required may be efficiently added as Rochelle salt. In that case the method is based on the following reactions:



As Rochelle salt contains exactly four molecules of water of crystallization, it may be used without drying. For every cc. of normal alkali required for neutralization, add 0.141 g. of the salt. As only 53.17 per cent of the salt is normally tartaric acid, weighing errors are minimized. If this salt is ground or unduly exposed to the air it may lose some of its water of crystallization. It is, therefore, necessary to obtain the actual acid content at the time used. This may be done by dissolving 1 g. of the salt in 100 cc. of water, adding 2 cc. acetic acid, 15 g. KCl, and 20 cc. of 95 per cent alcohol, stirring until precipitation starts, and allowing to stand in an ice box with a maximum temperature of 15° C. The addition of alkali may, therefore, be dispensed with.

The following results were obtained on five samples of grape juice, using the proposed method and the Rochelle salt method:

TABLE IV

No.	Grams Rochelle Salt Added	Grams Tartaric Acid in Salt	TARTARIC ACID IN JUICE USING Rochelle Salt	Tartaric Acid H.-E. Method
1	0.776	0.031	0.624	0.627
2	1.297	0.720	1.170	1.205
3	0.874	0.485	0.624	0.636
4	1.199	0.665	0.620	0.638
5	0.677	0.372	0.640	0.637
Rochelle Salt	1.000	0.555	...	...

FOR GRAPE JUICE—Take 50 cc. of the filtered juice and neutralize with *N* NaOH. After neutralizing make to 100 cc. volume with distilled water. From this point on, the H.-E. procedure as described under wine is followed, using 20 cc. instead of 15 cc. of

95 per cent alcohol. The occlusion of other organic acids with precipitated pectin bodies and cream of tartar makes the use of only 50 cc. of grape juice advisable for the determination.

In case of syrups, fermentation of sugar or a separation of the acid therefrom as the lead salt¹ is advisable. It may be of interest to mention that Halenke and Möslinger advise a double precipitation in the case of grape juices.

FOR ARTIFICIAL PRODUCTS CONTAINING FREE PHOSPHORIC ACID AND ALCOHOL—While experimenting with synthetic solutions, containing tartaric acid, free phosphoric acid and alcohol, it was found that neither the Halenke-Möslinger method nor the Hartmann and Eoff method gave satisfactory results. Further, it developed that these two methods became less reliable as the solutions under discussion aged. This condition was found to be brought about by the formation of ethyl esters of tartaric acid, the amount of ester formed increasing with the time allowed for the reaction. This was shown by saponifying the solution with an excess of alkali before determining the tartaric acid, a complete recovery of the theoretical amount of acid being thereby obtained. It was also observed that in cases where much free phosphoric acid was present the Halenke and Möslinger method failed to give any precipitate of potassium acid tartrate whatever, notwithstanding the presence of considerable tartaric acid in the solution. These two points, the loss of tartaric acid through esterification and the failure of the Halenke-Möslinger method to give even approximate results in presence of free phosphoric acid, were made the subject of investigation in 1914 by the Associate Referee on Wines of the Association of Official Agricultural Chemists. The heretofore unpublished work of five collaborators was very satisfactory and fully substantiates the findings recorded above.

The behavior of alcohol and tartaric acid in the presence of other free organic acids (formation of esters) is a well-known phenomenon and was pointed out by Berthelot and Fleurieu in their original paper describing the alcohol-ether method. Esterification in part may explain why very old wines, when employing the customary methods for determining the total tartaric acid, very often show an exceedingly small amount of this constituent.

It is very important to know the extent of esterification in artificial products containing free phosphoric acid, alcohol, and tartaric acid, since the ordinary methods may not reveal the tartaric acid that is present even in amounts as high as 3 g. per 100 cc. of solution.

It was found that by adding 5 cc. *N* NaOH in excess of neutralization to 50 cc. of the solution under examination, bringing to a boil and allowing to stand over night, a complete saponification could be obtained. The addition of the required amount of tartaric acid, dilution to 100 cc. with water and then proceeding as detailed for wines, yielded quantitative results for total tartaric acid.

¹ C. Schmitt and C. Hiepe, *Z. anal. Chem.*, **21** (1882), 534-41.

Solutions indicated in Table V were analyzed by different analysts on different dates with the results given.

TABLE V—(Results in Grams per 100 cc.)

DETERMINATION	HALENKE AND	HARTMANN-EOFF METHOD	Completely Neutralized
	MÖSLINGER METHOD	Half Neutralized	
Acidity as Tartaric.....	4.92	2.52	1.96
Total Tartaric Acid.....	2.00	1.80	1.89
Phosphoric Acid.....	1.91	0.48	0.048
Caramel.....	1.20	1.20	1.20
Amaranth.....	0.024	0.024	0.024
Cane Sugar.....	5.00	5.00	5.00
Alcohol.....	5.00	5.00	5.00

Table VI presents results obtained on three synthetic solutions, on the dates indicated.

TABLE VI—RESULTS (G. per 100 cc.) ON THREE SYNTHETIC SOLUTIONS

Solution Number	DATE 1914	HALENKE AND	HARTMANN AND EOFF METHOD	Preliminary Saponification	
		MÖSLINGER	Neutralization Complete		
I.....	7/20	0.74	1.88	1.90	..
	8/12	0.64	1.69	1.84	..
	8/24	0.06	1.54	1.76	..
	8/26	0.63	1.66	1.67	2.00
	10/30	0.00	1.61	1.65	..
II.....	7/20	1.03	1.76	1.76	..
	8/12	0.90	1.62	1.68	..
	8/24	0.67	1.51	1.62	..
	8/26	0.91	1.57	1.58	1.79
	10/30	0.65	1.51	1.63	..
III.....	7/20	1.23	1.87	1.87	..
	8/12	1.18	1.77	1.77	..
	8/24	1.00	1.68	1.77	..
	8/26	1.22	1.72	1.71	1.89
	10/30	0.92	1.63	1.67	..

The low results obtained by the Halenke and Möslinger method show the necessity of starting the precipitation by stirring as illustrated by the results obtained on August 24th, and October 30th. The gradual esterification of the free tartaric acid is shown by the lower results obtained as the solutions aged.

BUREAU OF CHEMISTRY, WASHINGTON

THE DECOMPOSITION OF THE ORGANIC MATTER OF KELP IN THE SOIL¹

By A. W. CHRISTIE

Received November 15, 1915

Considerable interest has been evinced of late in the possible use of kelp as a commercial fertilizer. Burd² has shown that probably the most practical and profitable way of utilizing kelp would consist in drying at a low temperature and grinding. The resulting product, in addition to the valuable potash (11.45 per cent K_2O in air-dried kelp (*Macrocystis*)), contains all the nitrogen and organic matter. Stewart³ has shown that the nitrogen (1.18 per cent N in air-dried kelp (*Macrocystis*)) becomes slowly available in the soil. In connection with the probable use of dried and ground kelp as a commercial fertilizer or as a filler for mixed fertilizers, it becomes of interest to learn the fate of the organic matter and whether any agricultural value may be assigned to it. The extent and rate of decomposition of kelp in soil were compared with the following materials which are common sources of organic matter in the soil, *viz.*, manure, straw and alfalfa.

PLAN OF EXPERIMENT

In each of 14 glass jars were placed 300 g. of air-dried soil (fine sandy loam from Anaheim, California),

¹ See also work of U. S. Department of Agriculture on Kelp. [Error's NOTE.]

² "Economic Value of Pacific Coast Kelps," *Bull.* **248**, California Agricultural Experiment Station.

³ "Availability of Nitrogen in Pacific Coast Kelps," *J. Agr. Research*, **4**, No. 1 (1915), 21.

and to each jar were added 15 g. of the organic material to be tested. The two samples of kelp used were *Macrocystis pyrifera* and *Nereocystis leutkeana*, the varieties of greatest commercial importance on the Pacific Coast. These samples were oven-dried and finely ground and then allowed to come to constant moisture content by exposure to the air at room temperature. The manure, alfalfa and straw were also finely ground and thoroughly air-dried. Jars 11 and 12, in addition to the 15 g. *Macrocystis*, were inoculated with a few cc. of a solution from a jar of decomposing kelp, to ascertain if the partial sterilization due to oven-drying would have any effect on the subsequent decomposition in the soil. All jars were loosely stoppered to prevent excessive evaporation, yet allowing easy access of air, and were kept at an average temperature of 30° C. for 5 mos. The moisture content was maintained at 18 per cent (optimum for the soil) by frequent additions of sterile water, accompanied by cultivation of the soil.

At the end of 5 mos. the contents of each jar were removed, thoroughly air-dried and ground for analysis. A 10-g. portion from each jar was analyzed for humus and humus nitrogen, using the method of Grandeau, as modified by Hilgard.¹ Table I gives the results obtained.

This table shows that dried and ground kelp in this experiment was decomposed to form humus to approxi-

TABLE I—RESULTS OF 5-MONTH TESTS

Jars	MATERIAL ADDED	PER CENT HUMUS IN SOIL				% N in Humus	% ORGANIC MATTER		% Pentosans in Originals	% PENTOSANS RECOVERED		PER CENT ORIGINAL PENTOSANS DECOMPOSED	
		Duplicates	Av.	GAIN			Original	Humified		Duplicates	Av.		
1 & 2	Alfalfa	0.98	1.08	1.03	0.37	10.15	89.00	8.81	12.18	3.17	2.47	2.82	77
3 & 4	Straw	1.14	1.24	1.19	0.53	8.25	96.50	11.49	27.75	4.34	6.88	5.61	80
5 & 6	Manure	1.08	1.11	1.10	0.44	9.54	65.50	13.98	11.57	2.45	2.49	2.47	79
7 & 8	<i>Nereocystis</i>	1.03	1.16	1.10	0.44	10.50	43.60	21.00	6.16	1.46	1.64	1.55	77
9 & 10	<i>Macrocystis</i>	0.96	1.03	1.00	0.34	11.55	59.60	11.85	7.11	1.72	1.81	1.76	75
11 & 12	Mac. (inoc.)	0.98	1.06	1.02	0.36	9.95	59.60	12.65	7.11	1.62	1.64	1.63	77
13 & 14	[Blanks]	0.65	0.66	0.66	....	13.82	....	....	....	....	....	....	..

mately the same degree as the substances ordinarily employed for that purpose. On a basis of equal weights of original material, the *Nereocystis* is surpassed only by straw, is equal to manure and superior to alfalfa. The *Macrocystis* is somewhat inferior but nearly equal to alfalfa. The inoculation of the *Macrocystis* slightly increased its humification but not sufficiently to cause it to surpass any of the other materials. The variations in the percentage of nitrogen in the humus are slight and no great importance is attached to them.

Since the various materials used contain very different amounts of organic matter which might be humified, the percentage of the organic matter humified during the period of incubation is important. The per cent of organic matter in the original materials and the average per cent of this organic matter which humified appear in Table I. On the basis of a unit amount of organic matter, the *Nereocystis* is by far the best humus producer and even the *Macrocystis* is surpassed only by the manure. The conditions under which this experiment was carried out, *viz.*, constant moisture content of 18 per cent and constant temperature of 30° C. for 5 mos., would certainly be equivalent to a considerably longer period under field conditions. Furthermore, the form and manner

in which these materials were added to the soil are not the same as would obtain in field practice. None of the materials would be finely ground, with the possible exception of the kelp, if it were part of a complete fertilizer. The alfalfa would ordinarily be plowed under green and the manure moist and fresh: these conditions accelerate their decomposition in the soil. The kelp used in this experiment, as has already been pointed out, was heated to a much greater temperature than would be the case in commercial practice and hence was probably less readily decomposed. The conditions in the laboratory may favor the decomposition of one substance more than another.

The per cent of humus is not necessarily a definite index of the value of the organic matter in the soil. Therefore, it is not desired to convey the impression that the organic matter of kelp is proven by this experiment to be as valuable as the other materials used. The experiment does prove, however, that kelp is not an inert substance in the soil and that its organic matter has some fertilizing value. Final judgment upon these points would require data obtained from field experiments.

PENTOSAN DECOMPOSITION

Hoagland¹ has shown that kelp contains considerable amounts of pentosans and since the other materials used are also high in pentosans, it is desirable to study the fate of this group in the soil. The materials were

analyzed for pentosans according to the Official method,² which is empirical and depends upon the production of furfural from whatever source derived; hence, conclusions regarding the decomposition of pentosan materials must be based simply upon comparative data. The samples of soil and organic materials were the same as those previously described. After 5 mos. incubation the soils were analyzed and the percentages of pentosans found calculated to the original weight of materials added to the soil. Tests on untreated soil showed only very small amounts of furfural-yielding substances, and corrections were made for the blanks. The extent of decomposition in each case is given in Table I. It is evident that the pentosans in the different materials are all decomposed to about the same extent, since in all cases between 75 and 80 per cent of the total amount has been decomposed regardless of the original source or amount. Some slight differences which are evident can be reconciled with previously established facts, *e. g.*, it is known that *Nereocystis* is more easily decomposed than *Macrocystis*; inoculation slightly increased the decomposition of *Macrocystis*. These data also indicate that from the standpoint of pentosan decomposition, kelp may be ranked with the other materials tested.

¹ "Organic Constituents of Pacific Coast Kelps," *J. Agr. Res.*, **4**, No. 1 (1915), 39.

² Bureau of Chemistry, U. S. Dept. Agr., *Bull.* **107**, 54.

¹ Hilgard, "Soils," p. 132.

SUMMARY

Dried and ground kelp decomposes in the soil under laboratory conditions, increasing the humus content to an extent comparable with alfalfa, manure and straw. Of the pentosans present, 75 to 80 per cent was decomposed in all the materials.

Acknowledgment is made to Professor D. R. Hoagland, at whose suggestion the above work was performed.

AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF CALIFORNIA, BERKELEY

ESTIMATION OF CARBON DIOXIDE AS BARIUM CARBONATE APPLIED TO THE MARR METHOD FOR DETERMINATION OF CARBONATES IN SOIL

By C. J. SCHOLLENBERGER

Received December 27, 1915

Closely following the publication by Marr¹ of a method for soil carbonates, a modification embodying its essential features, which are evolution of carbon dioxide by boiling with dilute acid under reduced pressure and absorption of the evolved carbon dioxide in a solution of sodium hydroxide, the carbonate therein being subsequently estimated by the well-known double titration method of Brown and Escombe,² was extensively studied in this laboratory and a form of apparatus adapted to it subsequently described by E. W. Gaither.³

Extended experience with this method, both in every-day use on routine samples and with the special samples furnished by the Referee on Soils for the Association of Official Agricultural Chemists' work in 1914 and 1915, has served to establish the fact that the decomposition of soil at a moderate temperature *in vacuo* by dilute hydrochloric acid is undoubtedly the most accurate of all procedures so far proposed for this determination, as it reduces to a minimum the activity of acid on organic material. When the soil is treated with acid in the cold there will be for some samples, depending on the nature of the carbonates present, an incomplete decomposition of carbonate. If the soil be boiled at atmospheric pressure with acid there will be an excessive action on the organic matter with consequent liberation of carbon dioxide not derived from carbonates, necessitating a blank determination on an extracted sample and the application of a correction for carbon from organic sources which involves considerable uncertainty.

There is, however, a source of error in the Marr method if the double titration procedure is used for determining the evolved carbon dioxide. This is indicated by the fact that the results by the Marr method, although showing excellent agreement with those obtained by boiling with stronger acid, the proper correction being applied and the double titration procedure used in each case, do not show such good agreement when compared with results obtained by boiling at atmospheric pressure and measuring the carbon dioxide gas, the corresponding correction

for action of acid on organic matter being applied. Nor is it usually found possible to recover by the double titration method all the carbon dioxide from samples of pure carbonates.

As the result of work done in this laboratory, and having for its object the improvement of the Marr method and at the same time the retention of its essential feature, which is decomposition of soil carbonates by dilute acid at reduced pressure and temperature, involving the least possible attack upon soil organic matter which is compatible with complete decomposition of carbonates and complete evolution of the gaseous carbon dioxide in the minimum period of time, it has been found possible to do away with the objectionable double titration. This is accomplished by effecting the absorption of the carbon dioxide evolved from the sample in barium hydroxide solution contained in a Meyer bulb tube. The precipitated barium carbonate is filtered off and determined as described by Cain.¹ The method is essentially the same as that recommended for adoption as a tentative method by the Referee on Soils of the Association of Official Agricultural Chemists in 1915.

E. Truog² has described a method for the determination of carbon dioxide by absorption in a measured excess of barium hydroxide solution and titration of the excess of barium hydroxide, using phenolphthalein as indicator. A trial was made of this method also, but effecting the absorption in a Meyer bulb tube, which seemed to be better adapted to the purpose in this instance than did the ingenious bead tower described by Truog. The results were satisfactory when the acid used for the titration was standardized by the use of a sample of known carbonate content, as pointed out by Brady.³ If the theoretical strength of the acid had been employed in making the calculations, a considerable minus error might have been introduced. The method offers important advantages over the double titration procedure, and will probably give better results in the hands of operators not thoroughly familiar with the latter method, but it must not be forgotten that it is subject to the same great source of error, *viz.*, the presence of substances supposedly neutral to phenolphthalein, but through hydrolysis, alkaline to that indicator—sodium bicarbonate in the one case and barium carbonate in the other.

For the reasons enumerated above, it is evident that absorption in barium hydroxide solution and titration of the residual hydroxide offers only a slight advantage over the older scheme of absorption in sodium hydroxide and double titration on the score of accuracy of results, although it does offer some advantages in the points of speed and convenience. By careful standardization of the method, it would doubtless give satisfactory results for routine work. The filtration method proposed by Cain is not subject to the above sources of error, and should give

¹ *Jour. Agr. Science*, [2] 3, 155.

² *Phil. Trans. (B)*, 193 (1900), 289.

³ *THIS JOURNAL*, 4 (1912), 611.

¹ *Technological Paper 33*, Bureau of Standards; also *THIS JOURNAL*, 6 (1914), 465.

² *THIS JOURNAL*, 7 (1915), 1045.

³ *Ibid.*, 6 (1914), 843.

very accurate results when properly carried out. While not so speedy as the simple titration, its freedom from the usual sources of error entitle it to the preference for all exact work.

In Table I are presented results obtained by several methods on a series of six soils, identical with those supplied by the Referee on Soils of the Association of Official Agricultural Chemists for coöperative work in 1915. The figures in parenthesis following sample No. 1 serve as an approximate measure of the extent to which organic matter has been attacked by the reagents in each case, and these percentages have been deducted in the cases of the next three samples in order to afford a better comparison between methods. A similar blank for Nos. 5 and 6 was obtained by extracting a sample of No. 5 with cold dilute hydrochloric acid (1 volume concentrated acid diluted to 10, the same as used for those methods requiring boiling at atmospheric pressure), then washing thoroughly with CO₂-free water. 0.0099 per cent carbon was obtained from the extracted soil by boiling and estimation by double titration, while none whatever was obtained by the Marr method in either of two

TABLE I—PERCENTAGES CARBON BY VARIOUS METHODS

SAMPLES ANALYZED					
1—Silt Loam, deficient in Organic Matter and supposedly free from Carbonates					
2—No. 1 + a small amount of 100 mesh Limestone					
3—No. 1 + 100 mesh Dolomite					
4—No. 1 + 100 mesh Dolomite					
5—Black Clay Loam, containing Carbonates and much Grit (preventing fine grinding)					
6—No. 5 + 100 mesh Dolomite					
No.	RESULTS BY MARR METHOD (MODIFIED)				
	Boiled at Atmospheric Pressure with 1 : 10 HCl	Gasometric	(Cain's) BaCO ₂ Titrated	Residual Ba(OH) ₂ Titrated	(Brown-Escombe) Double Titration
1	(0.0096)	(0.0093)	(0.0015)	(0.0018)	(0.0007)
2	0.0276	0.0276	0.0274	0.0276	0.0291
3	0.0276	0.0280	0.0279	0.0270	0.0289
4	0.2133	0.2220	0.2237	0.2204	0.2194
5	0.1485	0.1508	0.1498	0.1462	0.1454
6	0.2835	0.2880	0.2868	0.2750	0.2759

samples. In this connection it is but fair to state that only one other analyst reported no carbon by the Marr method from No. 5 after extraction, but, on the other hand, only one reported more from No. 5 after extraction than from No. 1, although No. 5 contains by far the larger amount of organic matter. The explanation may be either that No. 1 actually contains a trace of carbon dioxide, or that extraction with cold dilute acid removes or causes the decomposition of the most readily attacked part of the organic matter. It was noted that the acid extract from No. 5 was very dark in color.

In conclusion, the writer wishes to express his obligations to Mr. J. W. Ames, chief of the Department of Chemistry at this Station, for helpful suggestions and permission to publish this article.

OHIO AGRICULTURAL EXPERIMENT STATION
WOOSTER, OHIO

SOME NOTES ON SANDALWOOD, ITS ASSAY, YIELD OF OIL, AND CHANGES IN THE OIL DURING DISTILLATION¹

By C. H. BRIGGS

Received September 13, 1915

The data set forth in this paper have been collected at various times during the last few years, and as

¹ Presented at the 51st Meeting of the American Chemical Society, Seattle, Aug. 31–Sept. 3, 1915.

similar results have not been noted elsewhere in the literature, it was thought it might be of interest to others.

A few years ago twelve samples of various grades of sandalwood were obtained from the Mysore Province, India. These samples consisted of small pieces of the unground wood representing certain types or classes of sandalwood which could be bought from the Mysore government. The samples varied in weight from a few ounces to a pound, and as there was a considerable range of prices, we were naturally much interested in the content of santal oil in the different grades.

A search of the literature failed to reveal any method of assay for the amount of santal oil in sandalwood that could be applied to these small samples. At first it was thought that this problem was hopeless, but after considerable experimentation a method of assay was evolved which proved to be quite satisfactory. It is as follows:

Place 100 g. of the finely powdered drug in a Soxhlet extractor and extract with sulfuric ether for one day or until completely extracted. Transfer the ether extract to a 200-cc. side neck distillation flask and evaporate off the ether on a steam bath with the aid of a stream of air. Add 35 cc. of glycerine and distill in a vacuum until about 25 cc. of the glycerine have distilled over. Add 25 cc. of water to the distillate and extract with chloroform, using three portions of about 25 cc. each. Evaporate the combined chloroform extracts in a tared dish on a water bath with the aid of a stream of air until the chloroform has all been removed, dry in a vacuum desiccator over sulfuric acid and weigh.

Sandalwood contains a large amount of fixed oils as well as the essential oil and both are extracted by ether. The essential oil cannot be separated quantitatively from this extract by distillation in a vacuum unless glycerine is also added to help carry over the last traces of the essential oil. The essential oil can be separated from the glycerine in the distillate by extracting with chloroform. A 5-g. sample of santal oil was dissolved in ether and assayed by the above method as a check: practically all of the oil was recovered.

The twelve samples of sandalwood obtained from the Mysore government and representing as many different grades assayed as follows:

No.	% OIL	No.	% OIL	No.	% OIL
1	3.7	5	3.7	9	3.84
2	7.44	6	6.5	10	3.53
3	5.9	7	4.7	11	3.66
4	8.3	8	4.73	12	3.8

SAMPLE FROM STOCK, 6.0% OIL

It will be noted that these samples varied from 3.7 to 8.3 per cent. It would be of much value to distillers of santal oil if the cost of the wood could be based on the content of oil, but the commercial conditions governing the sale of sandalwood are such that this cannot be carried out successfully. However, the assay is of value in checking the yield of santal oil from the wood when distilled on a large scale.

CHANGES IN THE OIL DURING DISTILLATION

During the course of this work, it was noted that oil obtained from sandalwood by this method of assay had an optical rotation of -18° or above, whereas

the same wood when distilled with steam in an ordinary essential-oil still yielded an oil having an optical rotation of -14° or less. It was also noted that the oil obtained by the assay method was readily soluble in 5 volumes of 70 per cent alcohol at 25°C ., whereas the oil obtained by the ordinary steam distillation required more than 5 volumes of 70 per cent alcohol to dissolve it. Thus a sandalwood which was known to contain an oil which would meet the U. S. P. requirements, would yield by ordinary steam distillation an oil which would no longer meet these requirements. There must, therefore, be some decided change in the oil during distillation with steam.

To study this condition, 500 lbs. of sandalwood were distilled with steam and samples of each day's run collected and the physical properties determined. The results were as follows:

Day	Sp. Gr.	Ref. Ind.	Opt. Rot.	Solubility at 25°C . in 5 parts 70% alcohol
1st	0.969	1.5017	$-12^\circ 34'$	O. K. at 40° to 50°C .
2nd	0.970	1.5020	$-12^\circ 22'$	O. K. at 25°C .
3rd	0.972	1.5027	$-12^\circ 46'$	O. K. at 25°C .
4th	0.974	1.5030	$-12^\circ 54'$	O. K. at 25°C .
5th	0.976	1.5035	$-14^\circ 10'$	O. K. at 25°C .
6th	0.978	1.5037	$-12^\circ 30'$	O. K. at 25°C .
7th	0.978	1.5045	$-11^\circ 8'$	O. K. at 25°C .
8th	0.9795	1.5046	$-10^\circ 4'$	O. K. at 26.5°C .
9th	0.981	1.5046	$-9^\circ 10'$	O. K. at 29°C .
10th	0.9815	1.5046	$-8^\circ 20'$	O. K. at 32°C .
11th	0.9820	1.5045	$-7^\circ 45'$	O. K. at 35°C .
12th	0.983	1.5045	$-7^\circ 8'$	O. K. at 38°C .
13th	0.982	1.5046	$-6^\circ 34'$	O. K. at 44°C .

It will be noted that there was a gradual increase in specific gravity with each day's run from 0.969 to 0.982. Also that the refractive index steadily increased from 1.5017 to 1.5046. The optical rotation was fairly constant for 5 days at -12° to -13° and then steadily decreased to $-6^\circ 34'$. With the exception of the first day's run, the oil was soluble in 5 parts of 70 per cent alcohol at 25°C . for the first 7 days, but the eighth day's run was no longer soluble at 25°C . and the solubility grew gradually less up to the end of the distillation.

To determine if this change in the optical rotation of santal oil during distillation was due to prolonged exposure of the oil to boiling water, a sample of oil having an optical rotation of $-20^\circ 40'$ was boiled continuously for several weeks in a glass flask with a reflux condenser. The same experiment was also carried out by boiling with a 10 per cent solution of sodium chloride.

OBSERVATION	EXPERIMENT I		EXPERIMENT II	
	Water	10% NaCl	Water	10% NaCl
At beginning of experiment	$-20^\circ 40'$	$-20^\circ 40'$	$-20^\circ 40'$	$-20^\circ 40'$
After boiling 1 week	$-18^\circ 50'$	$-19^\circ 42'$		
After boiling 2 weeks			$-16^\circ 10'$	$-19^\circ 40'$
After boiling $2\frac{1}{4}$ weeks	$-15^\circ 40'$	$-19^\circ 45'$		
After boiling 3 weeks	Flask broke	$-19^\circ 30'$		
After boiling $3\frac{1}{2}$ weeks			$-13^\circ 16'$	$-16^\circ 40'$
After boiling 6 weeks		$-17^\circ 30'$		

It will be noted that there was a very decided change in the optical rotation of the santal oil by boiling with water, the rotation decreasing from $-20^\circ 40'$ to $-13^\circ 16'$ in $3\frac{1}{2}$ weeks. The change by boiling with the 10 per cent salt solution was much less, being reduced to $-16^\circ 40'$ in the same length of time.

We must conclude then that under certain conditions prolonged contact with boiling water brings about decided changes in the composition of santal oil and greatly reduces the optical rotation. These

same changes take place in the oil to a greater or less extent during the distillation of the oil from the wood with steam and probably accounts for much of the santal oil on the market having a low optical rotation and poor solubility.

The writer wishes to express his thanks to Mr. S. T. McCallum for his assistance during this work.

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NOTE ON AMERICAN CHARLOCK OIL

By H. S. BAILEY AND L. B. BURNETT

Received December 21, 1915

During the course of an investigation into the "Production, Botanical Composition and Volatile Oil Strength of American Wild Mustard Seed," Winton and Bornmann¹ separated from northwestern wheat screenings several samples of fairly pure charlock (*Brassica arvensis*) seed. These we combined and further purified in the laboratory until our material was 98-99 per cent charlock, the remainder being nearly all brown mustard (*Brassica juncea*).

After taking out a sample for analysis, the seed was ground in a drug mill and pressed cold in a small hydraulic press, the material remaining under pressure over night. The press cake was then reground and divided into two portions, one of which was extracted with petroleum ether (b. p. $35-60^\circ$) and the other with ethyl ether in a Soxhlet apparatus.

The original seed contained 4.1 per cent moisture, as determined in an atmosphere of CO_2 at 100°C ., 30.0 per cent ether extract and 29.6 per cent petroleum ether extract. The chemical and physical factors of the expressed and extracted oils together with an analysis by Grimme² of oil of charlock, probably the ether extract of *Sinapis arvensis*, are given in the accompanying table.

PHYSICAL AND CHEMICAL FACTORS OF CHARLOCK OILS

	Expressed Oil	Ether Extract	Petroleum Ether Extract	Grimme's Analysis
Specific Gravity, 15/15	0.9221	0.9272	0.9212	0.9228
Refractive Index, 25°	1.4734	1.4739	1.4729	1.4720(a)
Saponification No.	182.9	183.1	181.0	179.4
Iodine No., Hanus	121.1	119.8	119.3	102.6(b)
Insoluble Acids and Unsaponifiable	95.3	95.4	95.2	94.21
Soluble Acids	0.0	0.0	0.0	
Mean Mol. Wt. of Ins. Acids	339.1	338.1	334.8	312.4
LIQUID ACIDS:				
Per cent	89.3	90.0	90.0	
Iodine No.	126.0	122.3	125.0	
SOLID ACIDS:				
Per cent	3.1	1.6	2.0	
Iodine No.		62.0	61.0	

(a) Calculated to 25° from Grimme's value 1.4738 at 20° .
(b) Probably not by Hanus' Method.

As has been pointed out by Winton and Bornmann, there are large quantities of so-called "Wild Mustard" which contain varying proportions of charlock and brown mustard separated from American grains. Some of this is already being utilized as an oil material. Whether or not this oil can be sufficiently refined to make it suitable for food purposes remains to be seen, but undoubtedly it can be used in soap making and possibly in cheap paints.

BUREAU OF CHEMISTRY, WASHINGTON

¹ THIS JOURNAL, 7 (1915), 684.

² Lewkowitsch's "Chem. Tech. and Anal. of Oils, Fats and Waxes," 5th Ed., Vol. II, p. 271.

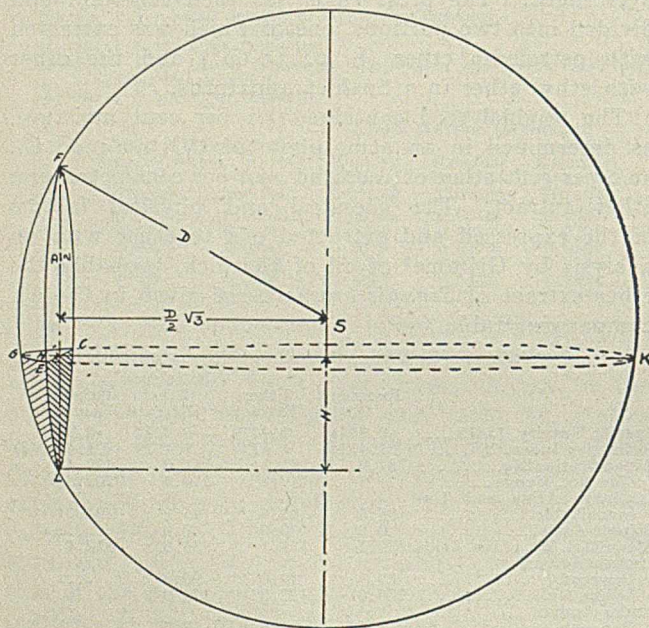
LABORATORY AND PLANT

GAUGING OF STORAGE TANKS—METHOD OF ACCURATELY AND RAPIDLY DETERMINING THE VOLUME CONTENT OF MATERIAL IN HORIZONTAL CYLINDRICAL TANKS WITH BUMPED HEADS

By K. B. HOWELL

Received January 19, 1916

Many horizontal cylindrical tanks find employment in industrial operations of the present day. Some of these serve for storage or transportation of liquid materials, others for purposes of distillation, still others for purposes of admixture or agitation of liquid materials. In connection with these tanks, there often arise occasions where it becomes extremely desirable to know the quantity of liquid material which is contained in them. There have been published from time to time various formulas, charts and mathematical tables which aim to calculate the volume of material contained in these tanks from a knowledge of the vertical height of the material in the tank and the dimensions of the tank. These formulas and methods of calculation, however, are prac-



tically without exception based on the assumption that the tank is a true cylinder. They, therefore, become applicable with accuracy only to those cases where the tank or still has flat heads. In the majority of cases met with in practice, however, the mechanical advantages to be gained have required that the heads of the tanks be bumped. To such tanks it is impossible to apply the aforementioned method of calculation without the introduction of a considerable error. In the case of the average 8,000-gal. tank car, the volume content of the two bumped heads is about 277 gals., or about 3.5 per cent of the total contents of the car. Since, therefore, the percentage content contained in the heads varies from 0, when the tank is empty, to 3.5 per cent, when it is one-half full, it becomes necessary for

us in many cases to employ methods of measurement which take account of this varying volume content.

Probably the only relatively accurate method is by a direct empirical calibration of the tank filling the same with measured quantities of water. This method is quite slow and laborious.

It has, therefore, seemed to the writer advisable that a method of calculation be worked out for the determination of the volume content of the liquid material contained in a horizontal tank containing bumped heads which shall eliminate the necessity of a laborious calibration of the tank and at the same time permit the calculation to be of a reasonable degree of accuracy. In other words, the method of calculation should possess the following features:

- 1—Simplicity of Calculation
- 2—General Applicability
- 3—Accuracy Commensurate with the Possible Accuracy of Measurement

Expressing the proposition in a somewhat more mathematical form, our problem then resolves itself

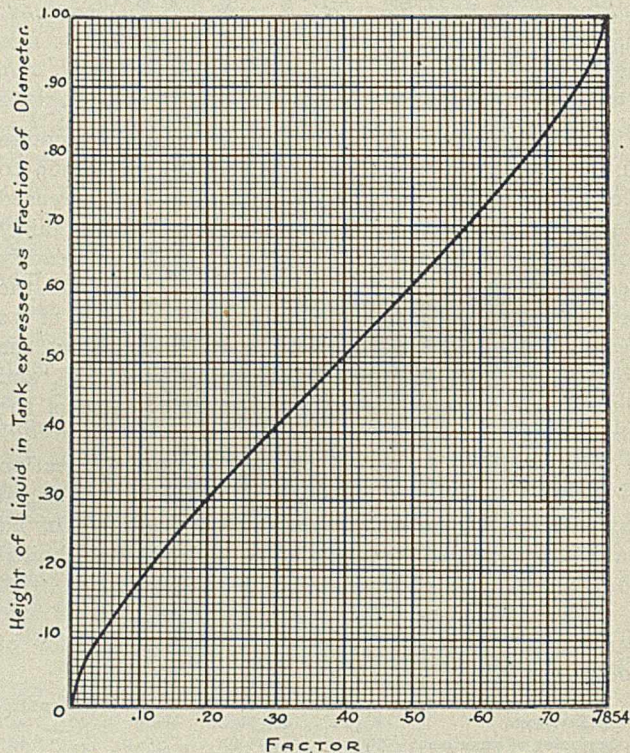


FIG. 1—FOR DETERMINATION OF LIQUID CONTENTS OF BUMPED TANKS IN HORIZONTAL POSITION

Liquid Contents of Tanks (Exclusive of Bumped Heads) is equal to Factor \times Diameter² \times Length of Tank in ft.

into a determination of a method of calculating the volume of the figure formed by the sides and heads of a "bumped" tank and a horizontal plane at any height, H , from the bottom of the tank. This volume we have represented by V . It may be considered as consisting of two parts, the volume V_c contained in the true cylindrical portion of the tank which is exclusive of the bumps, and the volume V_b contained in each bumped head. The relationship between these values is expressed by the following equation:

$$V = V_c + 2V_b$$

METHOD OF DETERMINING V_c

This volume is the segment of a true cylinder. Its volume can, therefore, be readily determined by any of the methods, charts or tables recognized in general engineering practice and referred to previously in this article. Fig. I is a graphical adaptation of one of these tables from Kent's "Mechanical Engineers' Handbook," page 121. It is used in connection with the following formula:

$$V_c = 7.48 \times (F. No. 1) \times D^3 L$$

where L = length of tank in ft.
 D = diameter of tank in ft.
 7.48 = conversion factor for cu. ft. to gals.
 F. No. 1 = factor obtained from Fig. I

F. No. 1 is obtained as follows: Express the height H as a fraction of the diameter D . Locate the resultant value on the vertical axis of the chart. From

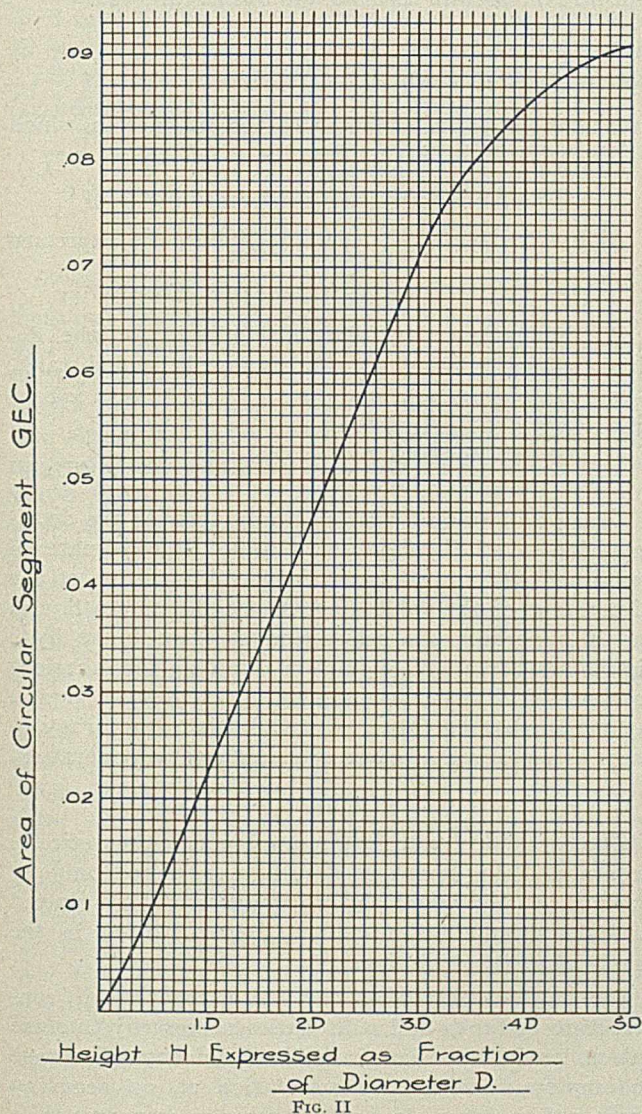


FIG. II

this point, move horizontally across the chart until intersection with the curve occurs. From the point of intersection, drop down to the vertical axis. The point of intersection with the latter represents the desired factor F. No. 1.

METHOD OF DETERMINING V_b

This proposition is considerably more complex. It consists essentially in the determination of the volume

of a complex figure formed by the surface of a sphere, a fixed vertical plane and a horizontal plane at varying height, H , from the lowest point, L , of intersection of the vertical plane and sphere. This may be otherwise expressed as the volume of a portion of a spherical segment cut off by a plane at vertical height, H , from the point L .

The development of any general formula or method of determining this volume is rendered simpler and of somewhat more general application by reason of the very general practice of tank design by which the radius of the bump of the tank head is made equal to the diameter of the tank. While it is quite possible to design and determine upon a method of calculation which applies to a different radius of "bump" yet the

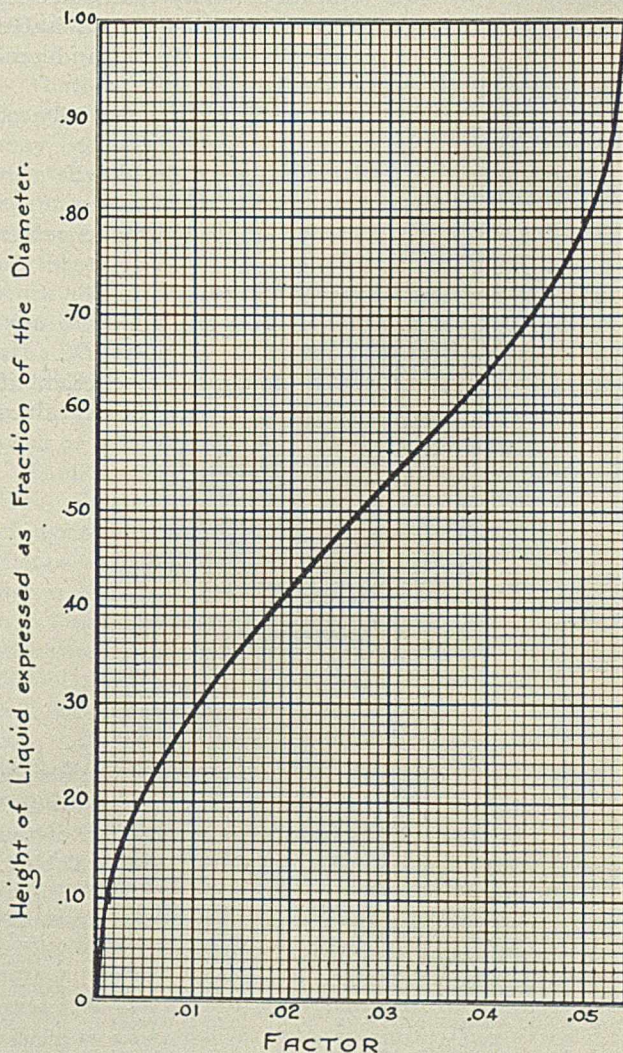


FIG. III—FOR DETERMINATION OF LIQUID CONTENTS OF BUMPED TANKS IN HORIZONTAL POSITION

almost universal acceptance of the above formula has led us to confine our proposition to the above condition. In our subsequent calculations, therefore, we shall take advantage of this condition which results in making the diameter of the base of our segment equal to the radius of our sphere.

Expressed in terms of mathematical symbols, our problem is as follows:

METHOD OF CALCULATION

Given:

SPHERE S : Diameter = $2D$ SPHERICAL SEGMENT : Diameter = D ; Height = $D - \frac{D'\sqrt{3}}{2}$ CIRCULAR AREA LEFC : Diameter = D CIRCULAR SEGMENT CEF : Base $CE = B$; Height = H CIRCULAR AREA GECK : Diameter = D' CIRCULAR SEGMENT GEC : Base = $CE - B$; Height = H' ; Area = A

SECTION OF SPHERICAL SEGMENT GELC

Required:

Volume V_b of Section GELC

This volume may be expressed by the following expression:

$$V_b = \int_0^H A \, dH$$

To make this expression capable of integration the value must be expressed as a function of H . The expression for A in terms of H contains the inverse sine and is, therefore, difficult of ready mathematical integration. It has, therefore, seemed more advisable to plot this function graphically on Fig. II and perform the integration graphically.

This method of calculation consists essentially of four parts:

(1)—Determination of A for given values of H

(2)—Plotting these values on Fig. II

(3)—Planimetry of Fig. II to determine values of V_b for given values of H

(4)—Plotting these values on Fig. III

(1) DETERMINATION OF A — A is the area of a segment of height H' of a circle of diameter D' . Its value may be determined from the tables of Kent if the value of D' and H'/D' are known. These values are obtained as follows:

$$\left(\frac{D'}{2}\right)^2 = D^2 - \left(\frac{D}{2} - H\right)^2$$

$$\frac{D'}{2} = \sqrt{D^2 - \left(\frac{D}{2} - H\right)^2}$$

$$D' = 2\sqrt{D^2 - \left(\frac{D}{2} - H\right)^2}$$

$$H' = \frac{D'}{2} - \frac{D}{2}\sqrt{3}$$

$$\frac{H'}{D'} = \frac{1}{2} - \frac{\frac{D}{2}\sqrt{3}}{2\sqrt{D^2 - \left(\frac{D}{2} - H\right)^2}}$$

Expressing H' in terms of fractions of D' , we obtain numerical values for H'/D' . Employing these values and using the tables in Kent for the determination of the area of a segment, we obtain the values shown in Table I.

TABLE I

H	H'/D'	Factor No. 1	A
0.05 D	0.0270	0.00246	0.00782 D^2
0.10 D	0.0505	0.00603	0.02026 D^2
0.15 D	0.0707	0.00964	0.03287 D^2
0.20 D	0.0879	0.01297	0.04721 D^2
0.25 D	0.1022	0.01583	0.05936 D^2
0.30 D	0.1138	0.01854	0.07119 D^2
0.35 D	0.1227	0.02020	0.07898 D^2
0.40 D	0.1290	0.02156	0.08538 D^2
0.45 D	0.1327	0.02240	0.08938 D^2
0.50 D	0.1339	0.02265	0.09060 D^2

TABLE II

H	V_b	Factor No. 3
0.05 D	0.00017 D^3	0.00017
0.10 D	0.00085 D^3	0.00085
0.15 D	0.00221 D^3	0.00221
0.20 D	0.00420 D^3	0.00420
0.25 D	0.00687 D^3	0.00687
0.30 D	0.01048 D^3	0.01048
0.35 D	0.01386 D^3	0.01386
0.40 D	0.01805 D^3	0.01805
0.45 D	0.02234 D^3	0.02234
0.50 D	0.02697 D^3	0.02697

(2) PREPARATION OF FIG. II—The values of A are then plotted on Fig. II against the corresponding values of H expressed as fractions of the diameter. The scale of this chart is as follows:

Vertical—1 in. = $0.02 D^2$
 Horizontal—1 in. = $0.05 D$
 1 sq. in. = $0.001 D^3$.

(3) DETERMINATION OF V_b —The area of the portion of Fig. II beneath the curve and between the origin and any

given height, H , represents the desired volume V_b as cut off by the plane at height H . These areas have been very carefully planimetryed, the values of V_b determined for varying values of H and the results tabulated in Table II.

(4) PREPARATION OF FIG. III—The values V_b are expressed as decimal fractions of the cube of the diameter of the tank. The decimal portion of these expressions we have plotted on Fig. III against the values of H expressed as a fraction of the diameter D . By reference to this chart, then, we are enabled to obtain for any height, H , expressed as a fraction of D , the necessary decimal fraction with which to multiply the cube of the diameter of the tank in order to obtain the volume contained in the bump. This volume can be expressed in terms of gallons as follows:

$$V_b = 7.48 \times (\text{F. No. 3}) \times D^3$$

where D = diameter of tank in ft.

7.48 = conversion factor (cu. ft. to gals.)

F. No. 3 = factor obtained from Fig. III

in a manner exactly similar to the manner in which F. No. 1 is obtained from Fig. I.

THE GENERAL EXPRESSION

As previously stated, the total volume is expressed by the formula:

$$V = V_c + 2V_b$$

We have then the following formula for the desired partial volume V of a bumped headed tank:

$$V = 7.48 \times (\text{F. No. 1}) \times D^2 \times L + 2 \times 7.48 \times (\text{F. No. 3}) \times D^3$$

where D = diameter of the tank in ft. L = length of the tank in ft.

7.48 = conversion factor (cu. ft. to gals.)

F. No. 1 and F. No. 3 are factors obtained from Fig. I and Fig. III as previously described

The use of this formula not only permits the determination of the gallon contents of liquid material contained in bumped tanks from a knowledge of the dimensions of the tanks and the height of the liquid, but also permits the calibration of these tanks by a simple mathematical calculation avoiding the laborious method of filling with known quantities of liquid. At the same time this method affords an accuracy as great as is generally desired in manufacturing operation.

DISCUSSION OF DEGREE OF ACCURACY

The method of calculation employed is theoretically accurate. The degree of accuracy is limited only by the size scale on which the graphical results are plotted and the number of numerical figures carried in the mathematical calculation.

In so far, however, as the actual mechanical construction of tanks and stills varies necessarily to some extent from the design, it is hardly of any advantage to employ a method of calculation of an accuracy greater than one yielding a maximum error less than 0.1 per cent of the total content of the tank.

To obtain this desired degree of accuracy requires that the maximum possible error in determining V_b and V_c should be less than 0.1 per cent of V . Since V_b is seldom greater than 5 per cent of V , this requires that the accuracy of F. No. 3 and the corresponding Figs. II and III shall be such as to permit an error not over 2 per cent. In plotting these charts and in

all calculations, a considerably greater accuracy was maintained.

In the case of V_c , however, a certain amount of difficulty arises. V_c represents approximately 95 to 100 per cent of V . To maintain the desired final accuracy, requires that F. No. 1 be obtained with an accuracy corresponding to a maximum error of approximately one-tenth of one per cent, and consequently that Fig. 1 be plotted on a scale capable of reading to this degree of accuracy. While such a scale is quite possible, it is quite inconvenient and the writer would recommend in cases where extreme accuracy is desired that the value F. No. 1 be determined from the table for "Determination of Areas of Circular Segments" given in Kent's "Mechanical Engineering Handbook," page 121. The factor under the heading "Area" represents the desired value F. No. 1 and is given to very great accuracy. In general, however, the above Fig. 1 plotted on scale 0.1 to the inch is sufficiently accurate for most manufacturing calculations.

THE BARRETT COMPANY
17 BATTERY PLACE, NEW YORK

THE UNIT OF VISCOSITY MEASUREMENT

By PARKER C. McILHINEY

Received March 1, 1916

The scientific world expresses the results of measurement of viscosity in terms of absolute viscosity of which the units are directly related to the fundamental units of mass, length, and time. The practical world speaks of Saybolt seconds, Engler numbers, etc. The absolute C. G. S. unit of viscosity is a relatively large one so that water and similar liquids have absolute viscosities which are inconveniently small numbers, and furthermore, without giving it a name it is impracticable to use such a unit in commercial testing. Many people have the idea that absolute viscosities cannot be determined except when the viscosity is deduced from the absolute dimensions of the instrument and that the practical instruments are not adapted to determine absolute results. The fact is that there are many practical methods by which viscosity may be measured, some of them better than others, all of them subject to disadvantages which differ according to the circumstances of their use, but all of them giving results capable of being translated into the common language of absolute viscosity.

The study of this important physical property of liquids has been seriously hampered by the lack of any kind of uniformity in its measurement. The principal use which is made of viscosity measurements to-day is in the case of lubricating oils, but their use is not more widely extended because workers in different countries with different kinds of instruments think they are unable to obtain anything by their work but results of merely personal interest. Few of them know how to translate the results which they obtain into results comparable with those obtained with another instrument.

This state of affairs would be radically improved if there were some unit of measurement of viscosity which was generally intelligible and in which the results of any determination with any instrument might

be expressed. The absolute unit as already mentioned is inconveniently large and it has no name. The suggestion has been made by Deeley and Parr¹ that the unit of viscosity expressed in C. G. S. units should be called the "poise" in honor of Poiseuille, but the suggestion has not been adopted generally and it is customary to simply speak of the "absolute" viscosity of a liquid. If the "poise" is adopted as the name of the absolute unit, it has been suggested that we might use the decimal multiples and submultiples of this unit, and that then the centipoise— $1 \text{ cp} = 0.01 \text{ p}$ —would be almost exactly the viscosity of water at 20° C. or 68° F. Thus for all practical purposes in the lubricating oil business, it would be sufficiently near the truth to say that the viscosity expressed in centipoises is the specific viscosity, that is, the viscosity as compared with water at 20° C. or 68° F. as a standard liquid.

There are, as is well known, a variety of instruments with which the viscosity of liquids generally may be determined. There are three of these instruments which are in commercial use largely for the examination of lubricating oils, namely, the Saybolt Universal, the Engler, and the Redwood. All three of these instruments are capable, as shown by the work done at the Bureau of Standards in Washington,² of determining the viscosity of oils with the accuracy usually required in present-day industrial testing. In these instruments, the number of seconds required for a given amount of oil to flow through a small tube or orifice in the instrument is measured.

Tables have been prepared by the use of which the true viscosity may be calculated from the number of seconds required for any one of these three instruments. If these tables could be brought into general use, a determination of the number of seconds required by the Saybolt Universal, Engler, and Redwood instruments would be reported in terms of centipoises. If the centipoise is used as a unit, the figure obtained will be 1.0042 for water and a larger number for all oils, and the number will represent the true relation between the viscosity of the oil examined and that of water with sufficient accuracy for commercial purposes, and also the true or absolute viscosity.

In scientific work, the use either of absolute viscosity expressed in C. G. S. units or of the centipoise for convenience, will enable the workers in all the different fields in which viscosity may be determined, to express their results in a universal language and the result will certainly be that the use of viscosity as a valuable physical property will no longer be confined practically to oils but will be extended to many other lines of work. If, for example, the instrument recently described by MacMichael³ should prove serviceable in many fields, investigations in viscosity can be carried on with it upon materials for which it is adapted and the results readily compared with those

¹ "The Viscosity of Glacier Ice," *Phil. Mag.*, [6] **26** (1913), 85.

² Dr. C. W. Waidner, "Conversion Tables for Saybolt Universal, Engler, and Redwood Viscosimeters," *Proc. Am. Soc. Test. Mat.*, **15** (1915), 284.

³ R. F. MacMichael, "A New Direct-Reading Viscosimeter," *This Journal*, **7** (1915), 961.

obtained by any other worker using a different form of apparatus.

In order to facilitate such comparisons as well as to assist in the introduction of a uniform method of expressing results throughout the world, it would

bring to the attention of those who are engaged in any kind of viscosity determinations the desirability of expressing all their results in terms of either the centipoise or the poise.

The accompanying tables have been prepared as

Engler No.	SECONDS			Engler No.	SECONDS			Engler No.	SECONDS			Engler No.	SECONDS		
	Say-bolt	Red-wood	Uncorr. viscosity in centipoises		Say-bolt	Red-wood	Uncorr. viscosity in centipoises		Say-bolt	Red-wood	Uncorr. viscosity in centipoises		Say-bolt	Red-wood	Uncorr. viscosity in centipoises
3.82	141	118.0	26.2	6.16	231	192.8	44.1	8.56	321	267.9	61.9	10.96	411	343.0	79.7
3.85	142	119.0	26.5	6.18	232	193.4	44.2	8.59	322	268.9	62.1	10.99	412	344.0	79.9
3.88	143	119.9	26.8	6.21	233	194.4	44.5	8.61	323	269.5	62.4	11.01	413	344.6	80.0
3.91	144	120.8	26.9	6.24	234	195.3	44.7	8.64	324	270.4	62.5	11.04	414	345.6	80.3
3.93	145	121.4	27.1	6.27	235	196.3	44.9	8.67	325	271.4	62.7	11.07	415	346.5	80.5
3.96	146	122.4	27.3	6.29	236	196.9	45.0	8.69	326	272.0	62.8	11.09	416	347.1	80.6
3.98	147	123.0	27.4	6.32	237	197.8	45.3	8.72	327	272.9	63.0	11.12	417	348.1	80.8
4.00	148	123.6	27.6	6.34	238	198.4	45.4	8.75	328	273.9	63.3	11.15	418	349.0	81.0
4.02	149	125.0	27.7	6.37	239	199.4	45.6	8.77	329	274.5	63.4	11.17	419	349.6	81.2
4.05	150	126.0	28.0	6.40	240	200.3	45.8	8.80	330	275.4	63.6	11.20	420	350.6	81.4
4.08	151	126.9	28.3	6.42	241	200.9	46.0	8.83	331	276.4	63.8	11.23	421	351.5	81.6
4.10	152	127.5	28.4	6.45	242	201.9	46.2	8.85	332	277.0	64.0	11.25	422	352.1	81.8
4.13	153	128.4	28.6	6.48	243	202.8	46.4	8.88	333	278.0	64.2	11.28	423	353.1	82.0
4.16	154	129.4	28.9	6.51	244	203.8	46.6	8.91	334	278.9	64.4	11.31	424	354.0	82.2
4.18	155	130.0	29.1	6.53	245	204.3	46.8	8.93	335	279.5	64.6	11.33	425	354.6	82.3
4.21	156	130.9	29.3	6.56	246	205.3	47.0	8.96	336	280.4	64.9	11.36	426	355.6	82.6
4.24	157	131.9	29.5	6.59	247	206.3	47.2	8.99	337	281.4	65.1	11.39	427	356.5	82.8
4.27	158	132.8	29.8	6.61	248	206.9	47.4	9.01	338	282.0	65.3	11.41	428	357.1	82.9
4.29	159	133.4	29.9	6.64	249	207.8	47.6	9.04	339	283.0	65.5	11.44	429	358.1	83.1
4.32	160	134.4	30.2	6.67	250	208.8	47.9	9.07	340	283.9	65.7	11.47	430	359.0	83.3
4.35	161	135.3	30.4	6.69	251	209.4	48.1	9.09	341	284.5	65.9	11.49	431	359.6	83.3
4.37	162	135.9	30.5	6.72	252	210.3	48.3	9.12	342	285.5	66.1	11.52	432	360.1	83.7
4.40	163	136.8	30.8	6.75	253	211.4	48.5	9.15	343	286.4	66.3	11.55	433	361.5	83.9
4.43	164	137.8	30.9	6.77	254	211.9	48.7	9.17	344	287.0	66.5	11.57	434	362.1	84.1
4.45	165	138.4	31.1	6.80	255	212.8	48.9	9.20	345	288.0	66.7	11.60	435	363.1	84.3
4.48	166	139.3	31.3	6.83	256	213.8	49.0	9.23	346	288.9	66.9	11.63	436	364.0	84.5
4.47	167	139.0	31.3	6.85	257	214.4	49.2	9.25	347	289.5	67.0	11.65	437	364.6	84.6
4.50	168	140.0	31.5	6.89	258	215.6	49.5	9.28	348	290.5	67.2	11.68	438	365.6	84.9
4.53	169	141.1	31.8	6.91	259	216.3	49.7	9.31	349	291.4	67.5	11.71	439	366.5	85.1
4.55	170	141.7	31.9	6.93	260	216.9	49.8	9.33	350	292.0	67.6	11.73	440	367.1	85.2
4.58	171	142.7	32.2	6.96	261	217.8	50.0	9.36	351	293.0	67.8	11.76	441	368.1	85.4
4.61	172	143.6	32.4	6.99	262	218.8	50.2	9.39	352	293.9	68.0	11.79	442	369.0	85.7
4.63	173	144.2	32.5	7.01	263	219.4	50.4	9.41	353	294.5	68.2	11.81	443	369.7	85.8
4.66	174	145.2	32.7	7.04	264	220.4	50.6	9.44	354	295.5	68.4	11.84	444	370.6	86.1
4.69	175	146.1	33.0	7.07	265	221.3	50.8	9.47	355	296.4	68.6	11.87	445	371.5	86.4
4.71	176	147.7	33.1	7.09	266	221.9	51.0	9.49	356	297.0	68.8	11.89	446	372.2	86.5
4.74	177	148.7	33.3	7.12	267	222.8	51.2	9.52	357	298.0	69.0	11.92	447	373.1	86.8
4.77	178	148.6	33.6	7.15	268	223.7	51.4	9.55	358	298.9	69.3	11.95	448	374.0	87.0
4.79	179	149.2	33.8	7.17	269	224.4	51.5	9.57	359	299.5	69.3	11.97	449	374.7	87.1
4.82	180	150.1	34.0	7.20	270	225.4	51.8	9.60	360	300.5	69.5	12.00	450	375.6	87.3
4.85	181	151.1	34.2	7.23	271	226.3	52.0	9.63	361	301.4	69.8	12.03	451	376.5	87.6
4.87	182	151.7	34.3	7.25	272	226.9	52.2	9.65	362	302.0	69.9	12.05	452	377.2	87.7
4.91	183	152.9	34.7	7.28	273	227.9	52.5	9.68	363	303.0	70.1	12.08	453	378.1	87.9
4.93	184	153.6	34.8	7.31	274	228.8	52.7	9.71	364	303.9	70.4	12.11	454	379.0	88.1
4.95	185	154.2	35.0	7.33	275	229.4	52.7	9.73	365	304.5	70.5	12.13	455	379.7	88.3
4.98	186	155.1	35.2	7.36	276	230.4	53.1	9.76	366	305.5	70.8	12.16	456	380.6	88.5
5.00	187	156.0	35.3	7.39	277	231.3	53.3	9.79	367	306.4	71.1	12.19	457	381.5	88.7
5.02	188	156.6	35.5	7.41	278	231.9	53.4	9.82	368	307.4	71.3	12.21	458	382.2	88.8
5.05	189	157.6	35.7	7.44	279	232.9	53.7	9.84	369	308.0	71.5	12.24	459	383.1	89.1
5.08	190	158.5	35.9	7.47	280	233.8	53.9	9.87	370	308.9	71.7	12.27	460	384.1	89.3
5.10	191	159.1	36.1	7.49	281	234.4	54.0	9.89	371	309.6	71.8	12.29	461	384.7	89.4
5.13	192	160.1	36.3	7.52	282	235.4	54.2	9.92	372	310.5	72.0	12.32	462	385.6	89.6
5.16	193	161.0	36.5	7.55	283	236.3	54.5	9.95	373	311.4	72.2	12.35	463	386.6	89.9
5.18	194	161.6	36.7	7.57	284	236.9	54.6	9.97	374	312.1	72.4	12.37	464	387.2	90.0
5.21	195	162.6	36.9	7.60	285	237.9	54.8	10.00	375	313.0	72.6	12.40	465	388.1	90.2
5.24	196	163.5	37.1	7.63	286	238.8	55.0	10.03	376	313.9	72.8	12.43	466	389.1	90.4
5.26	197	164.1	37.3	7.65	287	239.4	55.2	10.05	377	314.6	73.0	12.45	467	389.7	90.6
5.29	198	165.0	37.7	7.68	288	240.4	55.4	10.08	378	315.5	73.2	12.48	468	390.6	90.8
5.32	199	166.0	37.7	7.71	289	241.3	55.6	10.11	379	316.4	73.4	12.51	469	391.6	91.0
5.34	200	166.6	37.9	7.73	290	241.9	55.7	10.13	380	317.1	73.5	12.53	470	392.2	91.2
5.37	201	167.5	38.1	7.76	291	242.9	56.0	10.16	381	318.0	73.8	12.56	471	393.1	91.4
5.40	202	168.5	38.4	7.79	292	243.8	56.2	10.19	382	318.9	74.0	12.59	472	394.1	91.7
5.42	203	169.1	38.5	7.81	293	244.5	56.3	10.21	383	319.6	74.1	12.61	473	394.7	91.8
5.45	204	170.0	38.7	7.84	294	246.0	56.5	10.24	384	320.5	74.3	12.64	474	395.6	91.9
5.48	205	171.0	38.9	7.87	295	246.3	56.8	10.27	385	321.5	74.5	12.67	475	396.6	92.2
5.50	206	171.9	39.1	7.89	296	247.0	56.9	10.29	386	322.1	74.7	12.69	476	397.2	92.3
5.52	207	172.5	39.3	7.92	297	247.9	57.1	10.32	387	323.0	74.9	12.72	477	398.1	92.5
5.55	208	173.4	39.5	7.95	298	248.8	57.3	10.35	388	324.0	75.1	12.75	478	399.1	92.7
5.58	209	174.4	39.7	7.97	299	249.5	57.5	10.37	389	324.6	75.3	12.77	479	399.7	92.9
5.61	210	175.3	39.9	8.00	300	250.4	57.7	10.40	390	325.5	75.5	12.80	480	400.6	93.1
5.63	211	175.9	40.1	8.03	301	251.3	57.9	10.43	391	326.5	75.7	12.83	481	401.6	93.3
5.66	212	176.9	40.3	8.05	302	252.0	58.0	10.45	392	327.1	75.8	12.85	482	402.2	93.5
5.68	213	177.5	40.4	8.08	303	252.9	58.3	10.48	393	328.0	76.1	12.88	483	403.1	93.7
5.71	214	178.4	40.7	8.11	304	253.8	58.5	10.51	394	329.0	76.3	12.91	484	404.1	94.0
5.74	215	179.4	40.9	8.13	305	254.5	58.7	10.53	395	329.6	76.4	12.93	485	404.7	94.2
5.76	216	180.0	41.0	8.16	306	255.4	58.9	10.56	396	330.5	76.6	12.96	486	405.6	94.5
5.79	217	180.9	41.2	8.19	307	256.3	59.2	10.59	397	331.5	76.8	12.99	487	406.6	94.6
5.82	218	181.9	41.5	8.21	308	257.0	59.4	10.61	398	332.1	77.0	13.01	488	407.2	94.8
5.84	219	182.5	41.7	8.24	309	257.9	59.6								

the Saybolt Universal, and the Redwood instruments as well as of their reliability.

The accompanying conversion tables do not take into account the varying specific gravity of the liquids examined. For commercial work with oils this is not done at present with the commercial instruments so that no new error or inaccuracy is introduced in such work by comparing the results of different instruments with each other or by converting them into true viscosity on the assumption that they have a uniform gravity of 1.000, but if accuracy is desired, the figure found in the column headed "Uncorrected Viscosity in Centipoises" should be multiplied by the density of the liquid at the temperature of the experiment. The density is the specific gravity of the liquid at the temperature of the test in terms of water at 4° C.

NEW YORK CITY

A METHOD FOR TESTING THE EFFICIENCY OF BOILER SCALE PREVENTATIVES

By H. K. BENSON AND O. A. HOUGEN

Received March 23, 1916

For the purpose of selecting a commercial boiler compound, the engineers of the University of Washington Power Station submitted samples of scale and of the feed water together with several boiler compounds. After analytical studies of the water, scale, and the boiler compounds were made, a method for determining the relative efficiency of the compounds was devised.

FEED WATER AND SCALE—The feed water contained considerable suspended organic matter, fine silt and clay, together with temporary and permanent hardness. The percentage composition of the resulting scale was as follows:

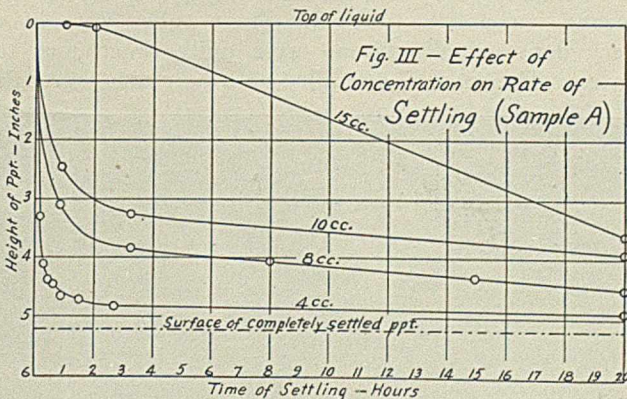
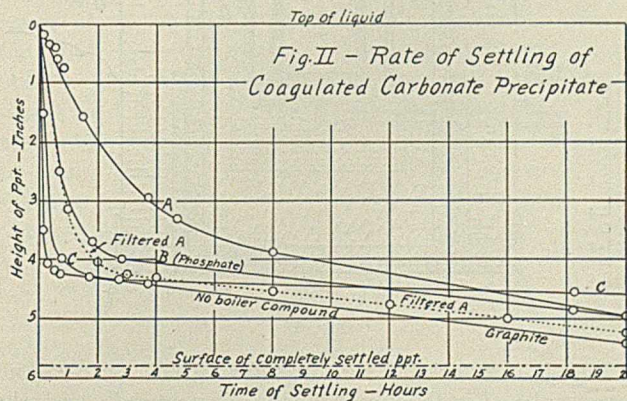
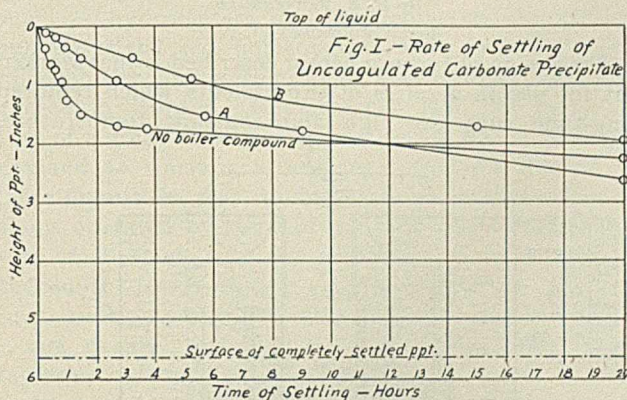
Organic Matter.....	10.93
Silica (SiO ₂).....	29.70
Iron and Alumina (Fe ₂ O ₃ + Al ₂ O ₃).....	7.42
Lime (CaO).....	38.09
Magnesia (MgO).....	4.90

BOILER COMPOUNDS—Sample A was a liquid consisting of water, sodium carbonate, graphite, and an organic solid. Sample B consisted of sodium phosphate (Na₂PO₄) in the solid form. Sample C was a commercial liquid compound of undetermined composition.

EXPERIMENTAL—900 cc. of feed water were concentrated to about 60 cc. A small quantity of solid matter settled out readily. Upon treating the clear filtrate with filtered solutions of the boiler compounds a large quantity of very finely divided colloidal precipitate was obtained; upon boiling, this coagulated into a flocculent precipitate. Inasmuch as all of the boiler compounds formed such a precipitate it is apparent that some other property than precipitation must determine the relative efficiency of boiler compounds. From the nature of scale deposition it was assumed that the function of boiler compounds is to form precipitates which do not settle out readily but remain suspended in a colloidal or flocculent condition. While the precipitate from concentrated feed water with Sample B settled completely in 2 hrs., that with Sample A was still partly suspended at the end of 5 hrs.

In order to compare the rates of settling, a 2 per cent solution of calcium chloride and magnesium nitrate was prepared. To aliquot portions of this solution equal quantities of Sample B, unfiltered Sample A, filtered Sample A, and graphite, respectively, were added. To a fifth portion no preventative was added. To each of these five solutions 1 g. of sodium carbonate was added to precipitate the carbonates of calcium and magnesium.

The ratio of settling was observed, first from a cold solution, then from one which had been boiled for



several hours at constant volume. The results are shown in Figs. I, II, and III.

CONCLUSIONS

From the curves on Fig. II it will be observed that the filtered compound has very little effect in upholding suspended water while the unfiltered compound is the most effective. Graphite, likewise, has no effect. While the flocculent phosphate precipitate is effective, the colloidal organic matter seems to be most effective

in holding the precipitate in suspension. While several factors, such as the concentration of the compounds, have not been taken into account, it is believed that the method is of some use in comparing the relative efficiency of the various commercial compounds in the form in which they are offered for actual use.

LABORATORY OF INDUSTRIAL CHEMISTRY
UNIVERSITY OF WASHINGTON, SEATTLE

A PRACTICAL DESIGN FOR A TUNGSTEN OR MOLYBDENUM-WOUND FURNACE

By F. A. FAHRENWALD

Received February 21, 1916

The design of furnace herein described is that worked out for use in a series of experiments which required long-time runs at high and constant temperature.

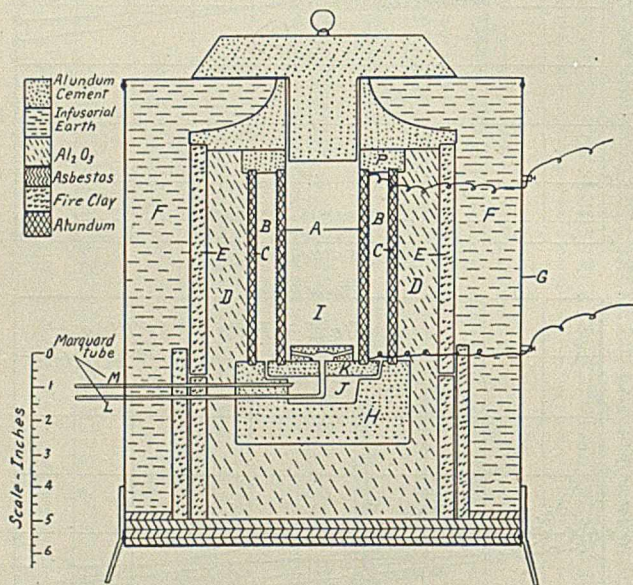


Fig. I

Fig. I is a vertical section showing the wire-wound inner tube A, the annular winding space B, and the second concentric tube C. These tubes were of a very dense alundum, and were quite impervious to gases. The space D was filled with pure, finely ground

The unit H served as a base for the two inner alundum cylinders, and into this were cemented two Marquard tubes, one of which (L) carried the required atmosphere to the melting chamber I; while the other (M) opened through J into the winding chamber B.

Fig. II shows the manner in which this gas distribution was accomplished. The parts here shown were moulded from alundum cement and when dry were carved to proper shape, and then burned. The larger unit H was so constructed that when the disc K was cemented into place over the depression J shown in H a practically gas-tight chamber was formed connecting gas tube M to the openings N, which led to the winding chamber. The tube L connected opening O with the crucible chamber.

Fig. III shows the inner tube A, with winding of spring coiled wire (which was wound more closely near the end of the tube) in position on its alundum base. The winding here shown was of 10.0 mil tungsten wire, but it was found subsequently that there was less danger of fracturing the heating element if several wires were stranded and then wrapped around the tube without coiling. Before placing in the furnace, a heavy coat of alundum cement was added to keep the wire in position. For this work the smooth tubes seem to possess a less tendency to crack than do those made with the spiral groove.

Fig. IV shows the exterior of the completed furnace with gas tubes projecting. These tubes are connected directly by rubber hose to the gas supply. Electrical connection was made by twisting several wires onto the ends of the heating coil and carrying them through the insulating materials to binding posts on the outside (on the far side of the furnace in Fig. IV).

This furnace could be raised to 1500° C. in about 45 min. and held at that point on a wattage of approximately 800; hence, if the drop of potential across the furnace was 100 volts, 8 amperes would be required. The constancy of temperature depended almost entirely upon the regulation of gas flow. The insulation was so efficient that when the heating chamber registered 1500° C. the outer jacket was at about

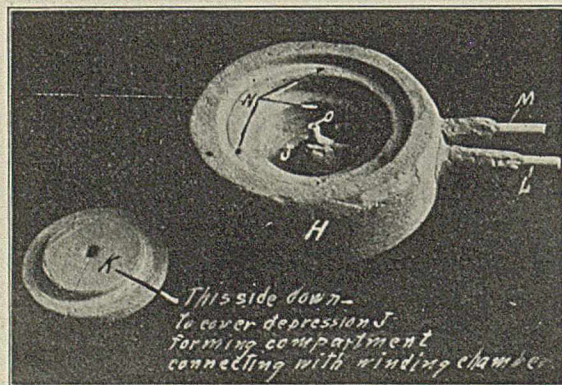


Fig. II

Al_2O_3 held in place by the fire-clay cylinder E. The annular space F was filled with infusorial earth, and the whole contained within the sheet iron jacket G. The bottom was protected with several layers of $\frac{1}{4}$ in. asbestos board, on which the fire-clay cylinder containing the alumina-packed heating unit was placed.



Fig. III

80° C. This furnace was run up to 1800° C. and in one experiment it was maintained at a temperature of 1500° C. for six days with no variation that could be detected with an optical pyrometer.

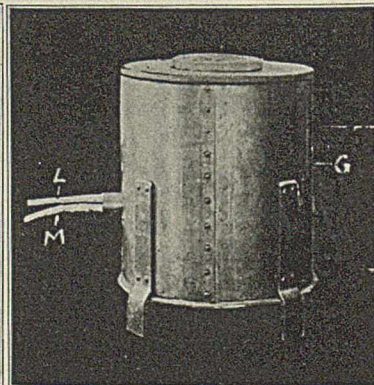


Fig. IV

THE MANUFACTURE OF CHEMICAL APPARATUS IN THE UNITED STATES¹

By ARTHUR H. THOMAS

I propose to remind you briefly of the facts regarding our sources of supply of a few representative classifications of chemical apparatus as they existed before the European war: to compare with these the conditions as they now exist, and then to consider the possibilities of retaining and extending the manufacture of this same merchandise in the United States.

In this tabulation the term "hollow glassware" is used to designate the product of the glass factory with a furnace—the "hohlglashütte" of Germany—and the term "lamp-blown and volumetric ware" to designate the product of the glass-blowing shop—the "glasbläserei" of Germany—where the finished product is shaped before the lamp from glass tubing, which tubing is, of course, always made in the glass factory or "hütte." In the United States these two industries are mostly conducted separately, while in Europe they are frequently combined in the same establishment.

I

CLASSIFICATION A—HOLLOW GLASSWARE

FLASKS, BEAKERS AND OTHER FACTORY-MADE² SHAPES INCLUDING BLANKS FOR SOME VOLUMETRIC WARE. TARIFF 45 PER CENT *ad valorem*

SOURCES BEFORE THE WAR—With the exception of one large factory in the United States which made, in addition to extensive products in other lines, a few flasks and beakers of excellent quality and reasonable price, this ware was purchased exclusively in Europe. The American production was not, in any commercial sense, a factor in the situation.

THE PRESENT SITUATION—Five factories in the United States are now regularly making flasks and beakers in large quantities. The glass used by one of these is superior in several important physical characteristics to that used for similar vessels by the European factory whose flasks and beakers have been heretofore considered the best in the world. The four other makers are using a resistance glass much alike in physical characteristics which, while not quite equal to either the American or European product above referred to, is unquestionably superior to the glass generally used throughout Germany and Austria. There are two other American factories making flasks and beakers, about which I have no definite information from actual tests. The ware turned out in one of them is of excellent appearance and that of the other, I have not seen. Neither factory is reported as producing large quantities as yet.

With the present conditions of shortage in almost all of the raw material involved, in the labor situation, and in the exhausted condition of stock in many of the large college and university storerooms, a considerable shortage for some time seems inevitable unless

¹ Address presented before the American Chemical Society, Urbana-Champaign, April 18-21, 1916.

² While ordinary bottles are, of course, a factory-made product, my remarks are not intended to apply to them.

additional capacity is operated. Under normal conditions the total convenient production of these seven American factories would more than meet our usual consumption.

CLASSIFICATION B—LAMP-BLOWN AND VOLUMETRIC WARE

ALL SHAPES MADE OF TUBING BEFORE THE BLAST LAMP INCLUDING THE GRADUATION OF BLANKS MADE IN THE FACTORY IN ADDITION TO THOSE MADE BEFORE THE LAMP TARIFF 45 PER CENT *ad valorem*

SOURCES BEFORE THE WAR—With the exception of a few items not of significance to our discussion, such as hydrometers and thermometers for clinical and industrial use, homeopathic vials and test-tubes, milk bottles and syringes, all staple stock was purchased in Europe. Repair work and the manufacture of a great variety of special items, not in sufficient demand to warrant arrangement for importation in large quantities, was conducted in a few glass-blowing shops operated by some of the larger dealers, in separate small shops in a few of the larger cities, and in the south Jersey district as an important side line in connection with three large glass factories.

THE PRESENT SITUATION—Two of the south Jersey factories referred to have practically given up the making of any regular stock in this classification because of the shortage of labor and the great demand for their own specialties. The other south Jersey factory has greatly increased its capacity for the more staple and easily made shapes and is making a commendable, but as yet totally inadequate, attempt to meet present requirements. This factory, with the few shops just described, constitutes the entire capacity in the United States to make lamp-blown and volumetric chemical apparatus. There are a few additional shops competent to make certain chemical ware, but not so engaged because of obligations in more profitable directions.

The combined output of all these establishments in the great variety of items in this classification is far from sufficient to fill the daily orders for immediate shipment. Commitments at the present time for large educational quantities, as usually undertaken at this time of the year, seem not to be justifiable with definite obligation as to either price or time of delivery.

CLASSIFICATION C—PORCELAIN WARE FOR CHEMICAL LABORATORY USE

TARIFF 50 PER CENT *ad valorem*

SOURCES BEFORE THE WAR—These goods were all purchased in Europe. One attempt to manufacture and market American laboratory porcelain ware some seventeen years ago proved unsuccessful because of poor quality of the product.

THE PRESENT SITUATION—Three potteries in the United States are now making crucibles and dishes and some other shapes in fair quantity. Another factory, not yet marketing their ware but conducting extensive experimental work, promises a product superior in quality to those already offered. One Japanese concern is regularly shipping large quantities of very excellent porcelain ware and a second

Japanese factory is sending samples and is reported to have made some shipments. Some Danish ware is being offered and several well-known British factories are advertising laboratory porcelain in the British journals, but it is unlikely that their production is equal to their own demand. The dishes and crucibles made in the United States have not thus far been as serviceable for all purposes as is desirable, but have apparently been acceptable to many users, and in one instance some recent tests show a distinct improvement in quality.

CLASSIFICATION D—FILTER PAPER

TARIFF 30 PER CENT *ad valorem*

SOURCES BEFORE THE WAR—For several years there were two, and sometimes three, paper factories in the United States making qualitative paper of good quality. Both qualitative and quantitative paper were offered by two other American firms, not paper makers, who supposedly purchased their paper stock and subjected it to the usual acid washing and other treatment in their own laboratories. The two brands of filter paper in widest use and for the greatest variety of purpose were purchased entirely in Europe.

THE PRESENT SITUATION—The two paper factories referred to are still making filter paper but are unable to contract for large orders because of the great shortage of suitable rags. The two other firms have given up deliveries for the present. Other experienced American paper makers are actively experimenting on quantitative papers. One of the widely used European brands still obtainable is being shipped at infrequent intervals, and prices have been advanced 100 per cent. One new British filter paper has appeared in considerable variety as to purpose and in some quantity, but with deliveries now much behind-hand. Still another new English maker has made a few shipments, and a third is offering qualitative grades only, but has made few, if any, large shipments. The Bureau of Standards at Washington is working on standard methods for the testing of filter papers, which information is urgently needed, as the reports on the same paper from users in actual laboratory work differ widely.

CLASSIFICATION E—HARDWARE AND SHEET METAL WARE

BURNERS, CLAMPS, SUPPORTS, WATER BATHS, DRYING OVENS, ETC. TARIFF 20 PER CENT *ad valorem*

SOURCES BEFORE THE WAR—Practically all items in sufficient demand to be called staple were made in the United States. A great variety of articles generally listed in dealers' catalogues, but not used in sufficient quantity to justify manufacturing by American methods, were imported.

THE PRESENT SITUATION—The above mentioned condition has undergone no significant change. American factories are now making some of the usually imported items in addition to those made heretofore. They would doubtless have undertaken many more such were it not for the general industrial stress now existing.

CLASSIFICATION F—OPTICAL MEASURING INSTRUMENTS

SPECTROSCOPES AND SPECTROMETERS, POLARIMETERS AND SACCHARIMETERS, REFRACTOMETERS, COLORIMETERS AND MICROSCOPES. TARIFF 35 PER CENT *ad valorem* EXCEPT ON MICROSCOPES, 25 PER CENT

SOURCES BEFORE THE WAR—The instruments in this classification as used in chemical laboratories were all purchased in Europe with the exception of microscopes, the manufacture of which has, as you all know, been extensively and successfully conducted in America for many years.

THE PRESENT SITUATION—There is no new manufacturing in America to be recorded in this line as a result of the war. The explanation is again the enormous pressure being put upon the several factories equipped for such work for deliveries of prism binoculars, range finders, telescopes as used in gunnery, periscope optics, etc. Two British factories have extended their lines to include certain refractometers and saccharimeters not heretofore made in England, but their deliveries are much delayed because of the control of these works by the British government for war requirements. The same situation explains both the inability of certain very excellent French makers of optical instruments to extend their lines, or even—with one exception—to make any deliveries of their regular goods.

CLASSIFICATION G—ANALYTICAL AND ASSAY BALANCES AND WEIGHTS

TARIFF 20 PER CENT *ad valorem* ON BRASS WEIGHTS, 50 PER CENT ON GOLD PLATED WEIGHTS

SOURCES BEFORE THE WAR—Practically no assay balances have been imported from Europe in recent years, the demand for such balances having been particularly well met by the excellent instruments of two American manufacturers. The business in analytical balances was about equally divided between three standard American makers, and three equally well-known European makers. I include in this statement those imported free of duty for educational use. Analytical weights, although made in the United States of excellent quality, were mostly imported because of price.

THE PRESENT SITUATION—The only change to note is that at present all of the American makers are far behind in their deliveries even though one of the foreign makers referred to is still accessible.

II

Let us now consider the possibilities of the future, mentioning first "Hollow Glassware," particularly flasks and beakers. It seems probable that a fair share of our consumption of flasks and beakers will be made in the United States after the conclusion of the war without any increase in duty or any curtailment of the duty-free privilege. With some restriction of duty-free entry they would, I think, all be made here. This statement is based upon the following facts:

1—The intrinsic excellence of our product. This is certainly the basic economic factor in determining where any merchandise is to be made under normal conditions of competition.

2—The highest priced American flasks and beakers are now

sold at exactly the duty-paid prices prevailing before the war for the best European brand. Furthermore, all other American flasks and beakers are now not only sold at less than these prices, but at prices no higher, generally speaking, than those hitherto prevailing on European goods of inferior quality.

3—There is a sufficient industrial and other duty-paid demand to justify the continuation of a part, at least, of our present war time production even though the large educational business is again placed abroad for duty-free importation. This duty-paid demand is increasingly restricted to flasks and beakers of the highest quality. Those of you engaged in industrial work will agree that in the works laboratory the first consideration is not what the flask or beaker costs but rather that it must not break in use.

4—Flasks and beakers are made in large and well organized glass factories of which we have in the United States several quite competent to undertake such work, and the American glass blower accustomed to the manufacture of incandescent lamp bulbs, thermos bottles, ordinary bottles, and the many shapes of household and other ware, can usually make them with a few weeks' practice.

5—And this is important—There is some possibility as to the application of automatic glass-blowing machines (which have reached a truly remarkable development in the United States as applied to the blowing of bottles and incandescent lamp bulbs) to the manufacture of flasks and beakers if a sufficiently large demand develops. If this should come to pass I think the term "duty-free" would no longer be used in connection with flasks and beakers!

Reasoning in a manner akin to the above seems to justify a similar conclusion—with some qualifications in each instance—for the classifications of "Porcelain Ware," "Filter Paper" and "Optical Measuring Instruments." "Hardware and Sheet Metal Ware" and "Analytical and Assay Balances and Weights" have already shown their ability to take care of themselves.

This disposal of these groups leaves us for further consideration the very important Classification *B* "Lamp-Blown and Volumetric Ware." It is the shortage in this group which is now causing the greatest inconvenience and it is about the making of such goods that we have much to learn if any significant fraction of our annual consumption is to be regularly manufactured in the United States. As compared with flasks and beakers we here face quite a different array of facts.

1—Our product thus far is, as a general statement, distinctly inferior in workmanship, appearance and (too frequently but not always) in accuracy of graduation.

2—These goods must be sold, on the basis of costs prevailing before the war, at much higher prices than the duty-paid prices on equivalent items of foreign make. Since the war this difference in cost has been still further increased, in many instances to the extent of 100 per cent.

3—The duty-paid demand does not constitute nearly as large a fraction of the total consumption as is the case with flasks and beakers.

4—This ware is mostly made in comparatively small and often poorly organized establishments. This is frequently true even though the shop is operated by a firm which may be fairly designated as "large and well organized" in other directions. The supply of skilled glass blowers competent to handle the great variety of such chemical ware is exceedingly limited. I doubt if there are 250 such workmen in the United States at the present time. These men have mostly come to us from Thüringian factories as skilled and accomplished artisans who

were well paid at home. They naturally demand and get still more here. A good all-round worker now gets from \$45.00 to \$60.00 per week. They do not always lend themselves to the proper subdivisions of labor for economical production. They are quite united in their common interests and naturally not greatly interested in the training and development of apprentices. They frequently are compelled to give up work on general chemical ware because of the high wage they can earn on piece work specialties.

One large concern in south Jersey is here deserving of special mention because of their output in this line which, while as yet confined largely to the simpler and more staple items, is made almost exclusively by young men and women native in the locality under the direction of a few more experienced workers. I recently visited this plant and was favorably impressed with the very encouraging progress these operatives had made in a comparatively few months.

5—And this again is important—There seems to be little possibility as to the application of automatic machines to this line, with the exception of those already developed and in efficient use for homeopathic vials and syringes.

III

With the important Classification *B*, "Lamp-Blown and Volumetric Ware," before us, and with flasks and beakers of Classification *A* still in mind, let us consider for a moment the conditions pertaining to this industry in Europe.

Not a few of you have visited that attractive little section of Thüringia which has, since the beginnings of modern chemistry and before, supplied the world with chemical glassware and with many other interesting things as well. Ilmenau, Stützerbach, Schmiedefeld, Gehlberg, Frauenwald are names familiar to you from catalogues if not from visits. Each of these towns and many others have their one or two "hütten" mostly with a "bläseerei," "ätzerei" and "schleiferei" operated by the same firm. There are also many separate lamp-blowing and graduating shops both in the towns and nestled alone among the fir-clad hills, in number quite beyond the reach of a single visit.

Here we still find the formerly wide-spread house-working industry—now decreasing because of the modern organized shop—where certain members of the family too old or unable for other reasons to make full time at the shop, do a great variety of work at home on a piece work basis. They take this finished work to the factory on Saturday night and, securing their supply of tubing for the next week's work, carry it home on their backs.

They also have there the local testing bureaus of the Kaiserlichen Normal-Eichungs-Kommission, such as the Herzoglich Sächsische Eichamt in Gehlberg, from which must radiate a vast influence toward the development of precise standards of workmanship.

There is also their well organized apprentice system and that most important institution, the "Fach-schule." I am not clear enough in the details of either of these to explain them with any authority, but am quite sure that we have in this country no trade or manual training school where a young man can learn the fundamentals of chemical or any other glass blowing, to-

gether with such science instruction as is required in such work.

Back of all this, and possibly more fundamental than any of it, there is throughout Germany and elsewhere in Europe, a well established association between the chemist in his laboratory and the glass-blowing industry, particularly as regards new apparatus. This association usually begins with the laboratory glass blower and has its first commercial extension through the medium of the small outside glass-blowing shop which is so generally found adjacent to almost every European institution maintaining a laboratory where any original work is done. Such shops are often quite independent of the laboratory but are usually a direct outcome of the work therein, and the world has been largely dependent upon them for the pioneer apparatus in many fields.

This laboratory glass blower and this adjacent outside shop seem to form the connecting link in Europe between the chemist in his laboratory and the more highly organized Thuringian manufacturer who distributes throughout the world his large production of staple articles. The development of the Beckmann thermometer and other apparatus for the determination of molecular weight by the glass blower to The Laboratory of Applied Chemistry, in Leipzig, under Beckmann's own direction; the manufacture and sale in another Leipzig shop of a great variety of apparatus for physical chemistry after Ostwald and Luther; the development and early manufacture in the basement of the Technical High School, in Dresden, of the whole line of gas analysis apparatus after Hempel under his own direction (with its further development by Dennis, of Cornell University), are a few of the many illustrations of this connection.¹

In the United States we now have some laboratory glass blowers, but should he not be a part of every chemical laboratory conducting original work if we are to develop and manufacture lamp-blown chemical apparatus to any extent? Should we not also encourage the establishment and support of these small outside shops under the wing of our large universities and research institutions where the new and special apparatus which has been developed in their laboratories may be made, still more or less under the watchful eye of the author and sold to those interested until the demand warrants its manufacture in large quantities at the lower prices possible in an organized shop?

Our present great need and our natural aptitude for new enterprise may indeed produce some increase in our capacity for organized manufacturing before the laboratory glass blower and the small outside shop habits become greatly extended. The south Jersey establishment previously mentioned is, in fact, already an instance of this, but it must have for its future profitable existence a fairly constant and

¹ Here at the University of Illinois you have a skillful glass blower in connection with the Chemical Laboratories who has rendered valuable assistance in the making of glass parts of the new apparatus for the measurement of the conductivity of electrolytes as developed by Dr. E. W. Washburn, especially the glass cell which will be known in the future as the "Washburn Conductivity Cell"

large demand for such recognized staples as can be made in great quantities and with a minimum of highly skilled labor, and should not be burdened with too much special work. You could render great assistance to such effort by eliminating from your regular laboratory practice the many shapes and sizes of lamp-blown ware not in wide use, but the making and selling^o of which hampers the manufacturer and cumber the shelves of all the larger dealers, and in both places tends to greatly increase the overhead charges and, in turn, the ultimate cost to you of all apparatus you buy.

Let us now consider for a moment, in conclusion, that bugaboo of the whole matter—the tariff! Is a higher tariff fundamentally necessary to the permanent establishment of the manufacture of chemical apparatus in the United States? It certainly is not so far as much of the apparatus we have considered is concerned. Even in our particular Classification *B* of "Lamp-Blown and Volumetric Ware" it seems not so important as a *possible curtailment of duty-free importation*. I am not unmindful that to those of you engaged in teaching, such a suggestion may seem to jeopardize the very existence of educational work in science and to be entirely too high a price to pay for the problematic transplanting of any industry of no great commercial importance.

It might, however, be practicable to discontinue the duty-free entry of at least such glass and porcelain ware as has hitherto been imported in such enormous quantities for routine student work. I mean the flasks, beakers, funnels, burettes, pipettes, evaporating dishes, crucibles, test-tubes and the like which are dispensed from the laboratory storeroom to the students for their individual work and for which the institution is paid by laboratory fees, breakage charges and similar arrangements.

The first result of such a change would certainly be a far keener interest on the part of possible manufacturers in the United States whose first question is always "How much of the consumption is provided for by duty-free importation?" Another outcome might be that the laboratory glass blower or the small outside glass-blowing shop would naturally add the function of dealing to that of glass blowing and would carry in stock for sale to the students the exact apparatus required by the student for his particular course and for which he has always paid in one way or another.

In such event the institution would be relieved of the outlay and expense attendant upon providing and keeping up the present large storeroom stocks and a tendency to extravagance because of the necessity of making up large duty-free orders surely to anticipate the needs for a long period of time might be lessened. The carelessness and indifference of the student, as a result of the apparent abundant supply of apparatus and the direct cash outlay required of him, might also be materially reduced without, great, if any, increase in the cost to him of his laboratory courses.

Paragraph 573 of the Tariff Act of October 3, 1913, provides for the duty-free entry of "philosophical and scientific apparatus" by certain societies and in-

stitutions "subject to such regulations as the Secretary of the Treasury shall prescribe." This suggestion as to possible curtailment of duty-free entry might, therefore, be carried out by a comparatively simple change in the present regulations of the Treasury Department, such as might be suggested by a suitable committee of the American Chemical Society! It is conceivable that a reasonable and moderate restriction of this sort submitted to the Secretary of the Treasury by a society composed of both educational and industrial users of apparatus might be more prompt and less disturbing in its effect than an effort on the

part of manufacturers and labor organizations to secure the necessary Congressional action for the withdrawal of the entire duty-free privilege as provided for in paragraph 573!

In the apparatus line as in the dyestuffs we shall do well to remember that the answer to the daily question "Why do we not make it in America?" requires a more profound analysis than is apparent in newspaper editorials and that what is now indicated is an intelligent and, above all, an unselfish cooperation between the manufacturer, dealer and chemist.

WEST WASHINGTON SQUARE, PHILADELPHIA

INDUSTRY AND THE UNIVERSITY

Addresses before the New York Section of the AMERICAN CHEMICAL SOCIETY, Chemists' Club, April 7, 1916

THE INDUSTRIES AND THE UNIVERSITIES

By WILLIAM H. NICHOLS

Chairman of the Board of Directors of the General Chemical Company

In common with you all, I was greatly interested in the program laid down by Dr. Wagner, our Chairman, looking toward a contribution to the question of bringing the universities in closer touch with the industries—an end not only desirable, but vital. Naturally he began with the universities, and you have doubtless read with great pleasure and profit the contributions made by the representatives of two of them on the first two evenings of the discussion, the speakers confining themselves more particularly to the subject of chemistry. I confess my feelings of pleasure were somewhat modified when in Florida, a little while ago, I received notice from Dr. Wagner that I was to be honored with the duty of stating the point of view of the industries, a rather large contract considering their diversity and my limitations. Of course, I understood perfectly that this was not in any way a contest between opposing forces; but simply an effort to get the points of view of those who had been differently situated, and whose experiences varied, the hope being that out of this seed might spring a great tree which would be of service to humanity. Everybody to-day listens with the utmost interest to what is said by any of our great professors: partly because they know so little about what the professors are doing, and mystery is always attractive, and partly because they justly have a great respect for anything they say, knowing that they are picked men, not actuated by selfish motives, and who rarely advertise themselves.

When I was a youngster, if you will pardon a personality, those who were interested in my progress concluded, after painful thought, that I was utterly unqualified for any business occupation, and that the only rôle which I held out any promise of being able to fill with credit was that of professor of some sort not specified. This shows that the professor in those days was sometimes looked upon as a kind of a humdrum person whose duties were to explain, more or less lucidly, to budding minds what some other professors had put into books, and, where their own experience justified it, which was seldom the case, delivering lectures of their own. I had a very different view, however, and felt that while I admitted the premise that I was entirely unqualified for business work, I did not see any reason for supposing I was qualified for the alternative; and so, on my own motion, without taking anybody's advice, I proceeded to do the best I could to acquire an education as a technical chemist—a profession which in those days had very few followers.

Immediately on graduation I proceeded, with the assistance of one workman, to enter the field of technical chemistry, and have been more or less employed in that field ever since. One of the very first discoveries I made was that college professors would be apt to know a great many things which I did not, and

I took occasion more than once to accept the kindly invitation of Dr. Chandler to consult him, without charge, on any problems confronting me. I remember, in this connection, another man who was not a university professor, but who was qualified to be one, who also rendered any advisory service which I called upon him to undertake. That gentleman was Dr. Manuel Alsberg, long since passed away. The only thing like a quarrel which I ever had with Dr. Alsberg resulted from his complaint that I did not consult him often enough, as, for some reason or other, he seemed to have taken an interest in my progress. So you see that the subject of the coordination of the universities with industries, as far as I am concerned, began practically with the beginning of my business life, and has been prominent in my thoughts ever since. While this does not qualify me particularly to discuss the question before us, it at least shows that I approach it with friendly feelings, and that it is not a novel proposition with me.

The first address of this series was delivered by President Butler of Columbia, and will well repay preservation. In the first paragraph he makes a statement that has an immense bearing on the whole subject, although I think he put it in as a mere pleasantry. He said that he had an impression that there had been so many changes in chemical knowledge during the thirty-five years which had elapsed since he had listened to Dr. Chandler's lectures, that if he were to attempt to reproduce any of this excellent instruction you might think him a student of archaeology rather than of chemistry. While, without any derogation of Dr. Chandler's lectures of that day, it must be admitted that the period alluded to by President Butler has produced the most astounding changes, it must not be forgotten that thirty-five years hence any speaker being educated in Columbia to-day, and who should not follow up the work, would surely have to make a similar confession, for the science of chemistry has gone forward with such leaps and bounds, and is of such limitless extent, that it has long since been impossible for anyone to fill all of the fields. In fact, many of the fields are, themselves, divided up into several departments, so that the great chemist of to-day is usually a specialist, and sometimes a specialist in quite a narrow area. The importance of this lies in the fact that the nation which is generally credited with having made the greatest advance during the past fifty years, may not be the nation which will make the greatest advance during the next half century. No one can tell who will have the honor then; but it is perfectly safe to state that whichever country stands at the head, it will be only after tremendous efforts made by the others. There is, therefore, no reason, whatever, why the American chemist, with his conceded ingenuity and imagination, may not well look forward to being the chemist in the lead a half century hence, even though he be engaged in fields which do not bring him so prominently before the eye of the public

as if he were making dyes and colors. Thus President Butler's pleasantry is really a word of hope.

I also like the way he described the problem, and I cannot do it better than in using his own language:

"The problem—if I may use a military term—is from one point of view a problem of mobilization of resources, of facilities, of opportunities for a peaceful war in the interest of science and of industry. The problem from another point of view is a problem of conservation—the conservation of our natural, our human and our institutional resources. From still another point of view it is a problem in efficiency engineering, applied on a great national scale through an organized undertaking to care for the thousand points of contact between theoretical knowledge and practical life."

I do not believe that the problem could be better stated, and I shall certainly not attempt the task. A careful consideration of it leads to so many trains of thought, that an address of the length permitted in this cannot possibly touch upon many of them. Fortunately it is so clearly stated that any man, whether a chemist or not, giving it his careful thought, can think out along lines with which he is familiar, and arrive at results.

THE INDUSTRIAL VISITING BOARD

President Butler's device to bring about the coöperation through an industrial visiting board, which seems to him to be practical, makes a different impression on my mind, as far as the field of chemistry is concerned. On more than one occasion I have alluded to the fact that the chemical engineer in the making is very much more hampered than the electrical, civil, mechanical, or mining engineer, because the latter have great operations which have been conducted by masters of the work, which they, as well as their teachers, can see and study, which is not often true in the field of chemical engineering. President Butler's suggestion that those who are in the industrial chemical field should form themselves, or be formed, into representative bodies of visitors, advisors, and counsellors, so that the student would have the benefit of contact with those engaged in the industry, and learn the problems with which they are confronted, or which they have solved, I fear would not be practicable, however desirable from the educational standpoint. It would take too long to get results, and depends for its value upon a degree of altruism to which the manufacturers, as I see them, have not yet attained. If such a committee can be formed, however, by all means set about forming it.

IMPORTANCE OF THE SMALL UNIVERSITY

President Maclaurin, of the Massachusetts Institute of Technology, in his able address of this series, lays a good deal of emphasis on the fact that his institution, while not called a university, is one, just the same, for reasons given by him, and which are all perfectly sound and conclusive. I allude to this merely to point out that in a full discussion of this matter we must not anywhere let the impression go abroad that only the coöperation of large universities is desirable. Nothing could be further from the truth than this view of the subject. After all is said, it is the individual professor, himself, and not the university with which he happens to be at the moment connected, who will have to solve many of the problems submitted. Of course, it is of untold value to the individual that he have the backing of a great institution, with all of its laboratories and other equipment, to say nothing of the *esprit de corps* inseparable from such an organization. It may well happen, however, that the very best man capable of following out a given line of research, may be found in one of the smaller institutions, and may be, himself, almost unknown. In a discussion of this question we must not lose sight of these men; but, on the contrary, must make it appear to them that they will be cordially welcome, not only in the discussion, but in any subsequent movement that may grow out of it. I am quite sure that President Maclaurin would agree with me in this, and had no idea of stating

the contrary; but I think it wise to mention it, to prevent any possible mistake. After alluding to several matters which the war has brought sharply to our attention, he goes on to say we have the schools of applied science here, to contribute to a solution of the problem, which must be along the line of giving their support to the organization of industry, so as to meet the needs of the nation as a whole, though their main contribution, here as elsewhere, must be in the supplying of men properly trained for the task. He naturally points out that there are great differences in the students themselves, and that the most that can be expected from the school is that it gives them three things—a knowledge of the fundamentals, the method of attack, and the spirit of industry and alertness for improvements. It is quite true, as has been so well stated by him, and others, in this discussion, that the universities have to take such material as comes to them, and make the best they can of it. Some graduates I have seen have plainly shown that they have not been worth the time and expense which they have cost the university, and it has seemed to me that while it is true that an institution of higher education cannot select the students which come to it originally, it ought to be very well able at the end of the first year, or sooner, to decide whether a student should be permitted to cumber the ground any longer in that institution, or whether it would be an act of kindness to all parties, to inform him that he does not hold out sufficient inducements to encourage the institution in proceeding further with his education. In some such way as this, while the original material could not be selected, it could at least be culled more thoroughly than is done at present; and while a smaller number of graduates would result, I think a larger amount of benefit to the world would be forthcoming. This is at least one way in which the university can contribute to the industries. In concluding his address, President Maclaurin says: "The universities are animated by the spirit of service, and anxious to do all they can to help. Let the industries tell us clearly what they want." This is a fair challenge, and deserves a concrete reply.

In Professor Talbot's address, delivered on the same evening, we find much of great value, and worthy of the careful study which it will doubtless receive. The reference to Professor Mann's investigation, resulting in fourteen hundred replies, mainly from members of the engineering societies, to questions designed to bring out the factors which the engineers regard as contributing most certainly to success in personal work, and also to learn the opinions of the same men as to the efficiency of our educational institutions at the present time with respect to those factors, Dr. Talbot finds that in certain very important matters the output of the universities seems to be lacking. Of course we all know that one of the most important kinds of knowledge that it is necessary for a man to acquire, is a knowledge of human nature. This proposition has only to be stated to receive immediate assent. As everyone knows, its possession is essential to great usefulness in many fields, if not in all. I do not see how a university can be expected to teach this important branch, nor why it should be blamed because its students do not enter life fully posted in this regard. It is one of the great elements of education which come to a man after he has left the college walls, and has commenced to associate with the world at large and rub up against those who are not interested in his success, or, for that matter, not interested in him at all, except in so far as he makes himself of value, or a nuisance. Its possession, however, is necessary if a man is to make even a good foreman, and even more necessary if he is to make a good superintendent, or, possibly, later, a manager of a great concern. Let us not hold the universities to blame because they cannot do the impossible. There are so many splendid things they can do, that we should confine our work to these. I can say, for the encouragement of the young graduate, who is full of a knowledge of facts and theories, that this post-graduate study will be found

to be one of the most interesting in which he can possibly engage, and when acquired will be of the utmost value to him in the application of what he has hitherto learned. Though the whole of life should be a school, and no man should graduate from it until his spirit leaves his body, it will be found that the schooling is none too long to acquire a working knowledge of human nature.

SUMMER WORK IN FACTORIES

Professor Talbot's suggestion that chemistry students should have the advantage of summer work in factories, while doubtless of great value to the student, has sometimes been found, when tried, to be something of a nuisance in the plant—provided it be a chemical plant. I am sure he will not forget that these are not educational institutions, except in so far as they are providing for a permanent staff. I have little doubt, however, that the chemical student would receive great benefit from spending his vacations in plants of general character, where he could not fail to learn a great deal which would be of subsequent value, and at least gain in the study of human nature.

Professor Talbot thoroughly appreciates the importance of arranging some way by which able men should serve both industries and universities. He alludes to the advantages which the industries have in being able to offer greater emoluments to bright men, and thinks it is possibly too much to ask of the industries to refrain from securing their services; but, he says, "It seems very desirable to make an effort to devise some plan of coöperation which will, in a considerable number of cases, permit able men to serve the industries without severing their connection with the educational institutions." I think that is one of the questions which we are trying to solve in this series of talks, and is a natural sequence to President Maclaurin's challenge.

Professor Walker, in his excellent address, makes some well-deserved criticisms of the industries, hoping that he may elicit corresponding criticism of the universities when the industries have their inning. As I said at the beginning, this is not, as I understand it, a competition between the universities and the industries, but rather a discussion leading to further and better coöperation. Hence I will acknowledge the force of some of Professor Walker's criticisms, and make no effort to excuse the industries. It is true the latter do not disclose all their problems, and it is equally true that they are foolish for not doing this, unless they are satisfied that they have within their own staff men who are capable of satisfactorily solving them. I do not believe that they hide their problems because they lack faith in the universities; but rather on the theory the ostrich is popularly supposed to entertain.

PUBLICITY FOR INDUSTRIAL RESEARCHES

I also acknowledge Professor Walker's point that scientific advantage obtained in industrial research should be made public, and heartily agree that no scientific man should be satisfied with a purely monetary return for his labor. Professor Walker points out that this publicity need not result in any way in injury to the particular industry which directed the research, and mentions Professor Gies' admirable example of Pasteur. I also acknowledge the force of the criticism that technical directors are needed in our industries, and it has always been a mystery to me how any concern would expect to succeed without such intelligent direction. I might say, however, that whatever may be their shortcomings, they make safe competitors.

Professor Walker's suggestion that universities must supply intelligent foremen, is worthy of careful consideration, and may have in it a suggestion of considerable value.

Mr. Little has, for a long time, been a real link between the universities and the industries, and has had considerable experience with those residing in outer darkness. His reference to efficiency in government, and certain prevailing notions regarding labor, wealth, and brains, are really refreshing. Re-

garding the subject under discussion, however, I was particularly interested in his remarks about the desirability of students leaving the university with a definite purpose in view. It has always been beyond my comprehension how so many of our young men can prepare for college, and pass through it, and come out with only the vaguest ideas of what they really want to do. To think of spending all of the years necessary to prepare for life, without having some definite line laid out to pursue, would seem impossible if it were not so common. I hope Mr. Little's words, added to those of so many before him, will sink in to enough minds to produce some real specialists of the future.

His remark about the neglect of the English language as a business tool well expresses a thought which has often been in my own mind. It is not only of the greatest value to any kind of an engineer or scientific man to be able to express his thoughts in good English, but sometimes it is absolutely essential. I knew a man who held a high place in the ranks of engineers, who reached that point because of his knowledge of English, and not because of his knowledge of engineering. I do not say this to convey the idea that the former might take the place of the latter; but only to show how it helped at least one inferior engineer to reach distinction.

I have not alluded to Professor Gies' address, as it was extemporaneous, and I, unfortunately, was absent. Professor Lucke's, delivered the same evening, contains much of value to the industries, as does that of Professor Whitaker. Both gentlemen have had much experience in industrial work; they have discovered many weaknesses existing therein, which are generally acknowledged by industrial managers.

"PURE" AND APPLIED CHEMISTRY

At this point I would like to inject a few words regarding so-called pure and applied chemistry, as I think their relation has sometimes been misunderstood, and a good deal of harm occasioned thereby. I am a great believer in the enormous importance of work done along lines of pure chemistry, some of which would seem to the casual observer to be of no possible value for the present, or for the future. There is no need of taking a moment of your time to discuss this, as every one of you will readily admit the great importance of work which is done along purely theoretical lines, and without anything in the mind of the worker looking to its application. At the same time I believe it to be impossible to work out any purely scientific theory, or arrive at any scientific fact without either directly, or indirectly, contributing to the good of humanity. I am aware that pure theorists may contradict this view, strange as it may seem to those of us who have been engaged on the practical side. Take the great Dr. Witt, for example. In more than one conversation he expressed to me the contempt he felt for those chemists in his own country who were prostituting chemical science to the making of money; and yet no one would be more ready than Dr. Witt, himself, to admit that the great organic chemical industry of Germany would never have progressed as it has done, without the magnificent work in pure theory done by himself and many others. The right view of the case, in my opinion, is that pure and applied chemistry are simply different phases of the same science, and that one cannot live without the other. Applied chemistry is the bringing out to useful needs of theories evolved by pure chemistry, which, in turn, is pushed forward to further investigation by the results obtained in applying these theories. Some men are better adapted to theoretical work than to practical, and of others the converse is true. Let each man be "fully persuaded in his own mind," and bring forward the results of that which he, himself, can do the best, and the world will be the richer because of the labor of all. If the universities are to assist the industries, therefore, a means must be found whereby not only the ability of the practical minds of the faculty can be utilized,

which is comparatively easy, but the ability of the pure theorist can also be taken advantage of, which is not so easy.

Referring to President Butler's statement of the problem, we find that the whole matter resolves itself into one word—coöperation; and coöperation in its broadest sense, involving government, finance, the industries, and what is pleased to call itself labor. If we are to stand any chance in the peaceful warfare of the future, we must learn how to make all of these forces coöperate better than any other people can do, or at least as well. Our form of government makes it very much more difficult for us than for some others; and yet the result must be reached unless we expect to oppose a rabble to a well-organized army. Germany has given us an instance of government coöperation which has been extremely efficient; but probably goes too far to be followed in this country. I must confess, however, that I was much impressed, not only in Berlin, but in Vienna, when I was travelling in the interest of the Eighth International Congress of Applied Chemistry, by the extremely intelligent and comprehensive knowledge which government officials possessed regarding the chemical industry, and the very great interest which they exhibited in furthering it. I could not help thinking that with that kind of intelligent government coöperation how easy it would be for us to do things in this country, which now seem to be almost impossible. But there are other methods of government coöperation which I believe would be more valuable to us, of which evidences are already appearing, and which I trust we will in time fully enjoy. Efficiency is a great deal; but it is possible to pay too much for one branch of it, at the expense of others.

ENGLISH APPRECIATION OF CHEMISTRY

In England, for some reason difficult to understand, the chemist has in the past had very little coöperation from the government, whatever may have been true of other branches of industry. As far as I am advised the government, itself, has never before the war shown any particular interest in, or acquaintance with, our profession, and they are just now realizing their mistake, and taking steps to recover lost time. Dr. M. O. Forster, F.R.S., has been working for years in the endeavor to interest the English government and people, and is at present presiding over the Technical Committee of British Dyes, Ltd., an institution with which you are doubtless familiar. In a paper read at the Annual Autumn Congress of the Textile Institute, held last October at the Technical College, Huddersfield, he said several things which I will quote, as they will express the attitude I have alluded to, as he has observed it:

"Among the numerous topics which the war, like a huge cauldron of boiling liquid, has brought to the surface of public discussion, is the proper relation between Science and Industry. It is not new, nor is it really more urgent than it has been at any time during the past thirty years, but present circumstances have combined to impress it so deeply upon the public mind that probably for the vast majority of our people its consideration came with an air of novelty. After a year of conflict, even those who never gave much thought to the subject are now agreed that a union, approaching in permanence and intimacy that of matrimony itself, must in future link these two forms of human activity if the commercial prosperity of the British Empire is to be maintained and the social welfare of its citizens augmented. The celebration of this union has been delayed and hampered by some confusion as to which is the bridegroom and which the bride. Another factor which, in my opinion, has operated more strongly, lies in the fact that Industry, bold, assertive and enterprising, has failed to recognize in the modest and retiring virtues of Science any of those qualities which are desirable and helpful in a life-partnership. In some cases Industry has been content to use Science as a handmaiden without admitting her to the privileges of complete union. An exception to this generalization may be claimed for engineering, however, where, in most of its branches, full use has been made of the underlying scientific principles by its practitioners." * * *

"My purpose in thus tracing, as briefly as possible, the manner in which organic chemistry has secured its grip on the textile industry, is to show that each stage has been reached only by

patient research, and that when reached, it has offered a fresh vista of industrial enterprise capable of yielding new sources of profitable development. Among the reasons why this country has fallen so far behind in the application of chemistry to this branch of industry is the fact that it appears to be practically impossible to explain to the busy man of affairs just what chemical research involves, and what it is capable of yielding. The business genius of this country, drugged by the engineering tradition and by fat dividends, has been blinded to the fact that successful chemical enterprise not only yields fat dividends but is completely dependent upon engineering. Hence, even those business men whose horizon is limited by profits and machinery could have wallowed in profits and rioted in machinery during the conduct of a successful courtship of chemistry, either personally or by proxy." * * * * *

After explaining the subject, he goes on to say:

"This is research, and it is because the few people who, from time to time, have been able to make dyes in this country, have been discouraged from employing chemists in conducting their researches, while such researches have been sedulously prosecuted in Germany, that we and the United States find ourselves where we are, namely, in the cart; happily, the cart has not yet reached the scaffold, although the guillotine is in sight." * * * * *

"I believe, however, that the color-makers of this country are honestly and industriously attempting this undertaking, and it is of the utmost importance that they should receive the greatest possible encouragement from the consumers, who must rigidly deny themselves the expectation of miracles, for miracles are not on the list of experiments. The neglect of thirty years, with the moral and intellectual damage arising therefrom are not to be repaired by the wave of a magician's wand." * * *

"Reverting, in conclusion, to the textile industry and organic chemistry, it may be worth while to point out that Americans are making a determined effort also to throw off the color-yoke of Germany, and in certain respects they are situated more favorably than ourselves. In the first place, their business elements comprise many alumni of the modern university, and are therefore alive to the importance of employing graduates in their organization. Secondly, they possess a flourishing heavy chemical industry, including the technical skill necessary to the production of oleum, the elixir of chemical life. Thirdly, they have great power of organization, and lastly, when the time comes, they can rely upon whatever type of intelligent Government support may appear at the critical moment most potent in application."

Evidently Dr. Forster has more faith in the ease with which American laws can be made to fit the necessities arising, than many Americans with whom I have conversed, and whose language would not make polite reading here.

GOVERNMENT COÖPERATION IN JAPAN

In somewhat sharp contrast with this, let us look for a moment at a law passed in Japan the 19th of June, 1915, called "The Law for the Encouragement of Manufacture of Dyes and Medicines." After defining what is meant by the title, the law proceeds:

"When a joint stock company established in accordance with Imperial Japanese laws and ordinances, more than one-half of whose capital, as well as a controlling number of votes, belongs to Japanese subjects, undertakes the manufacture in Japan of dyes and medicines according to the provisions of ordinance, a subsidy for a period of not more than ten years from the date of enforcement of this law may be granted to such company. The amount of the subsidy shall be such as to make the dividends which the company pays in each business year reach a rate of 8 per cent on the paid up shares."

The law and ordinances connected with it go into particulars as to how profit shall be computed, and how the company shall be made up; but the gist of the matter is, that subject to those rules and regulations the Japanese Government guarantees a return, for a period of ten years, of 8 per cent on the capital. Contrast that action taken promptly when the dye situation began to become acute, with some of the struggling efforts we have seen in our own country, and I think you will agree with me that our Oriental friends have gone much further along the lines of government coöperation than we have in this country, with all of our vaunted superiority.

So much for government coöperation. Without the most

efficient kind, supervised by men who know what they are talking about, and who understand what is said to them, the many problems before us will, in my judgment, never be satisfactorily solved.

So much has been said and written about the importance of coöperation of the other elements alluded to before, namely, finance, the industries, and labor, that it is hardly necessary in an address of this character to dwell particularly upon them. It is, however, absolutely clear to me that some means must be found within a reasonable time, which will bring about such unity of action of all forces, that our country will be working as a unit and not as a disorganized mass. Too much stress cannot be laid upon this matter here, or anywhere, although I am aware that the subject under discussion is far more limited than the great subject of universal coöperation. The point is, that while it is desirable, and necessary, that the universities and industries should coöperate, if they are the only forces that do coöperate, we will not get along very far in the solution of our problems, as a nation. Fortunately, universities teach many things beside chemistry, and it may be that some of them will discover a method for producing intelligent lawmakers, who, on account of their love of truth, will place the old, efficient, almost-forgotten virtue of patriotism above the modern, vicious idea of party.

ADVISORY COUNCIL FOR INDUSTRIES

The question we have been discussing is not a new one. It is as old as universities themselves. Much older than industries in their present highly organized state. The universities have always been ready to do their share. The industries have been getting themselves into a condition to reciprocate. Many of them have arrived at a point where the leaders recognize the need of something which they have not got, to help them forward toward the ends which they have in view. Naturally a line of contact which would serve one industry might not serve another. In fact, it is practically certain that different industries would require different methods of contact with the universities. After years of thought I have arrived at a method which, while peculiarly adapted to the needs of the Company over whose Board I have the honor of presiding, has, I think, some points of value for other companies, whether in the same field or an entirely different one. This plan is now in process of evolution, and, to a moderate extent, is an accomplished fact. I trust it will be rounded out completely within a comparatively short time.

Briefly stated, my plan is as follows: We are forming what we call an "Advisory Council," composed of great chemists in their several lines, located in various universities and schools of science. Each member of the Council will receive a modest honorarium, and be expected to attend meetings occasionally, at which specific problems will be discussed, as well as any other subject of interest to any of the members. In order that the touch may be as complete as possible, I hope to attend these meetings myself, and to have the highly valuable assistance of two or three of the best of our staff. Naturally, as the meetings will only be occasional, correspondence between the head office and members of the Council, and between the members themselves, will be frequent. New problems will be referred to the Council, and by it referred to the member best qualified to solve it. The report, if favorable, will, after discussion, be passed along to the Research Department of the Company, which, in time, if thought advisable, will bring it before the engineering staff. Problems originating with the members of the Council, itself, will be treated in the same way, and it is hoped that this will give the members an opportunity of bringing forward the results of their research work, to ascertain if it be practically valuable. Anything of value resulting from this work, whether originating with the Company, or with the members of the Council, will naturally be rewarded with a share of the profits resulting.

Starting with a small number, the Council will elect its own members, subject only to the approval of the highest officials of the Company, thus insuring the most agreeable relationships, without which the best work cannot be accomplished.

You can see at a glance many of the advantages which would accrue to both the Company and members of the Council, from this close touch. The latter will be brought face to face with real problems, will be allowed to work at their share in them in their own way, in their own laboratories, to the great benefit of their own students, and, in doing this, will have the benefit of association, not only with their fellows, but with some of the best minds which have been devoted for years to the more practical side of the question. Thus we will have a completed cycle, and thus the world ought to benefit as a result of the play of all these forces.

There may be many other ways of bringing about the same, or better, results; but after years of thought I have been unable to devise one. I see no reason why this plan should not be just as efficacious in a steel mill, or a silk mill, or any other kind of mill in which the chemist plays a part; but it need not be confined to chemists. Any university man who can contribute something of value would surely find his place in some of the industries.

This is my answer to Dr. Maclaurin's challenge, and to Professor Talbot's suggestion. The problems awaiting solution are many, the difficulties are great, and the call for universal coöperation imperious. I trust that officials of other industries, for whom I have no right to speak, will seriously take up this question, either on the lines we have adopted in our Company, or improve upon them and give us all the benefit of their study. Let coöperation be the watchword of the future.

25 BROAD STREET, NEW YORK CITY

DISCUSSION

By MARSTON TAYLOR BOGERT
Professor of Organic Chemistry, Columbia University

To review all that has been said at these meetings and to express any carefully considered opinion upon the many admirable suggestions which have been presented, would require the entire evening, and I am conscious of the fact that there are other speakers upon the program.

Of the many ways in which our chemical industries and our universities can coöperate to mutual advantage, I can discuss but one or two in the few moments available and have, therefore, selected those which appeal to me as deserving of especial emphasis just now, in that they lead directly and speedily to the desired goal, namely, results of immediate practical value to both.

As has often been pointed out, the universities exist for the diffusion and extension of knowledge, and for public service through its application, and it is upon these grounds that they appeal to and receive the support of the community. They are not intended to be money-making enterprises and, in fact, are almost invariably run at a loss, which loss is made good from endowment funds or in other ways, so that the amount of the tuition fees may not exclude capable and deserving students.

Our chemical industries, on the other hand, are organized primarily for the purpose of making money and everything else must be subordinated thereto. The universities are essentially altruistic and philanthropic; the industries, since they must earn dividends for their stockholders, are apt to be egoistic and mercenary, to put the case bluntly.

LACK OF COÖPERATION IN THE DIFFUSION OF KNOWLEDGE

In the matter of the dissemination of knowledge, particularly that relating to industrial practice, it must be evident to all that there is but little coöperation between the manufacturers and the universities. It is not strange that the manufacturers

should be averse to the publication of discoveries made in their plants since, in manufacturing as elsewhere, "knowledge is power," and new knowledge gained in the laboratories of the corporation may often be regarded very properly as among the most valuable assets of the concern.

From the standpoint of the universities, the great disadvantage of the above policy is this locking up of knowledge, for it causes a serious retardation of the general growth and development of the science and renders it much more difficult for the universities to train men properly for such industries, since all textbooks and general information available are far behind actual manufacturing practice. This is a serious handicap to those endeavoring to give up-to-date instruction in industrial chemistry, and one felt keenly by all teachers of the subject. Another immediately harmful effect of the above policy upon the universities is that it not infrequently results in some of their most capable investigators spending many of the best years of their lives and considerable sums of money in attempts to solve problems, the clues or answers to which had been discovered and filed away long before in the laboratory records of the factories.

It is, of course, futile to ask manufacturers to publish to the world their most cherished "trade secrets," or to endeavor to secure from them articles for our chemical journals describing all the manufacturing details of their industries. But in many of the great industries which have been in operation for any length of time, information has been accumulated in the course of the work which could be made known without irreparable injury to the firm concerned and to the considerable advantage of the chemical profession. It may happen, for example, that a corporation decides to abandon a certain line of work, either because conditions have made it no longer profitable or because it wishes to devote itself to other more lucrative ones. In such cases there seems no good reason why the new knowledge gained in the prosecution of the abandoned process or product should not be made public. New analytical methods and new forms of laboratory apparatus are usually published, I believe, without any objection on the part of the corporation.

INDUSTRIES AND UNIVERSITIES SHOULD SO COÖPERATE THAT THE WORK IN PURE SCIENCE IS NOT SACRIFICED

Any plan of coöperation should be rejected which compels the university chemical department to devote *all* of its energies and resources to the solution of industrial problems, the results of which are never to be divulged except to the manufacturer who has paid for them. The laboratory which follows such a plan has ceased to be a productive unit so far as its university function of disseminating knowledge is concerned, and has become to all intents and purposes a works laboratory run in the interest of the chemical manufacturer who subsidizes it. Research for profit takes the center of the stage, and research for its own sake is driven out. I do not intend to argue here the question of whether research for its own sake and for the discovery of wholly new chemical fields, the so-called "pure" research, is worthy of encouragement or not, as the material progress of that nation where "pure" research is most assiduously cultivated and where it is held in highest honor, namely, Germany, is a sufficient object lesson to any who care to study it, but what I do want to emphasize is that if the universities withdraw from research of this type, there is little likelihood of its being carried on elsewhere. That is a prospect which cannot be regarded with equanimity either by the universities or by the industries themselves, for it means the death of the goose which has already laid many golden eggs.

What the manufacturers should do, then, is not to weaken in any way the work of the universities in pure science by diverting it into other channels, but to *supplement* it by providing additional men and funds for the solution of the industrial problems. This is the ideal combination, pure science and ap-

plied science at work side by side, each reinforcing and adding to the zest and interest of the other, the point of contact being the scientific staff of the university.

ADVISORY COMMITTEES OF MANUFACTURERS FOR THE UNIVERSITIES AND OF UNIVERSITY PROFESSORS FOR THE INDUSTRIES

The universities possess staffs of scientific experts, well-equipped laboratories and libraries, all of which they are willing to share with the industries in return for financial and other assistance from the latter, but the proper adjustment of this coöperation calls for some care and thought.

Any method of handling the question, to get the best results, must obviously be based upon close relations of mutual confidence and respect. If the manufacturer is unwilling to take the university officer entirely into his confidence, the coöperation will prove a failure and unsatisfactory to both parties. As Prof. Walker has aptly expressed it, if the university professor cannot be trusted with all of the problem, he is a dangerous man to be trusted with any of it.

The speaker believes that such coöperation should include also, on the part of the universities, the creation of an advisory committee of manufacturers recognized as leaders in those chemical industries most closely related to the work of the particular laboratory concerned; and, on the part of the chemical industries, of a similar advisory committee, composed of those university professors best qualified by inclination and attainments to render service to that particular industry. Whether or not these advisory committees are constituted, the way is open to those manufacturers who wish to establish such coöperative relations with university officers, and the university professor stands willing and eager, in the great majority of cases, to meet the manufacturer half way in all such matters.

RESEARCH FELLOWSHIPS AND A RESEARCH INSTITUTE

An excellent method of making coöperation of this kind effective, is for the manufacturer to establish industrial research fellowships at the university for the solution of problems of immediate importance to him, supplying sufficient funds to secure really skillful investigators, and providing raw material and any special equipment needed, the university giving the use of its laboratories and libraries and the services of its scientific staff to supervise and direct the work. The results of these investigations then become the property of the manufacturer who has paid for them, and may or may not be published as the manufacturer and the university agree. As these industrial fellowships multiply in the university, and the special equipment provided therefor increases, they compose a real graduate school of specific industries where advanced students (usually those who have already received their Ph.D. degrees) may receive that special training in the details of manufacturing practice which it is not feasible to include in the regular undergraduate curriculum, and from which the door into the factory stands open for men of demonstrated energy and ability. The university teacher benefits greatly from this contact with the industries by gaining familiarity with manufacturing methods and the industrial point of view, and is enabled to infuse new life and interest into his lectures. As the natural result of his study of many of these industrial problems, he finds important pure science problems cropping up everywhere, and these he refers to his group of pure science investigators, composed mainly of candidates for the Ph.D. degree, a degree which is awarded only on the basis of *published* results. Such a graduate school should be housed preferably in a building of its own, devoted exclusively to chemical research.

It is difficult to conceive of any more beneficent endowment for a great city like New York than the establishment of a properly equipped research institute for pure and applied chemistry, to do for chemistry what the Rockefeller Institute, for example, is now doing for the cause of medicine. Such an institution

could render the community splendid service, not only by the research work which it actually accomplished and by the highly trained men it turned out, but also by acting as a clearing house between the manufacturers on the one hand and the research chemists of the country on the other, to bring together the problems to be solved and the men capable of solving them. Its fine equipment, its distinguished staff, the confidence engendered by its results accomplished, and the prestige it would enjoy among both manufacturers and investigators would make it eminently qualified for such service. In fulfilling this function it would, on the one hand, gather and keep on file, properly classified and indexed, a list of the various industrial problems requiring solution: wastes, by-products, unutilized raw materials, new uses for chemical products, the improvement of wasteful and costly processes, the production of new and useful chemical substances, and the like. On the other hand, it would keep also a full list of the research workers and consulting experts of the country, their special lines of work, equipment, etc. It would then be in position to render the following definite service:

1. TO THE MANUFACTURER—To explain to him in what ways the efficiency of his manufacturing operations seems capable of improvement by the chemist, and to tell him who are the best qualified men in the country to help him with these particular problems.

2. TO THE UNIVERSITY LABORATORIES—To call the attention of the men in charge to those industrially important problems which seem most nearly related to the research work for which the laboratory is noted. There are many laboratories which would attack with eager enthusiasm such problems were they aware of their existence. Most students are particularly keen for problems of just this kind, yet the teacher is often uninformed concerning the character or amount of the by-products going to waste in his immediate neighborhood, a careful study of which might bring the abiding satisfaction of having converted useless substances into something of service to the community, and lead not only to financial reward for the manufacturer as well as for the investigator, but might also save us much of the present pollution of our streams and tidewaters and of the air we breathe.

An institution conducting work of this nature need never fear that it will be giving away all of its research subjects, for there will always be far more than enough to go round and the careful study of any one inevitably leads to the uncovering of a whole new crop of problems. Further than this, the influence of an institution rendering such service can scarcely be overestimated. It would be the handmaid of all, and yet recognized as the leader of all, national in its scope, with a director and advisory council, keeping close watch on the industrial chemical research work of the country, coördinating, assisting, encouraging and stimulating it in every way possible.

The best proof that such work can be done here is that much the same kind of work is now being done with conspicuous success in the applied science field by the Mellon Institute of the University of Pittsburgh, an admirably equipped establishment, founded by the princely generosity of the Mellons of Pittsburgh; and, in the pure science field by the Kaiser Wilhelm Institute, in the Dahlem suburb of Berlin.

The success of the Mellon Institute has been phenomenal, far surpassing the dreams of its most enthusiastic supporters. Although its fine new building was completed but a year ago, it is already filled to overflowing with industrial research fellows, and the Director has announced that they cannot accommodate any more. Nearly forty different fellowships are now in operation there or have been arranged for, occupying the attention of between sixty and seventy graduate workers gathered from all parts of the country, for the support of which the manufacturers will this year contribute over \$130,000, with from \$50,000 to \$60,000 additional offered in bonuses for the successful solution of certain of these problems. The latest addition to this

industrial research institute, and it is a significant one, is a professorship of research in pure chemistry, to which chair Dr. Martin A. Rosanoff has been called.

As to the great Kaiser Wilhelm Institute for research in pure chemistry, I would remind you that it too is supported largely by the chemical manufacturers. In 1913, when I had the pleasure of visiting this establishment, it had two large and imposing stone structures, one for Physical Chemistry, under the direction of Prof. Haber, and one for Organic Chemistry, under the direction of Geheimrat Beckmann and Prof. Willstätter.

There is thus nothing new in the plan of coöperation suggested above, as it is essentially that worked out and first given a practical trial by the late Prof. Duncan, and has culminated in the founding of the Mellon Institute. The reasons why I have picked it out for emphasizing are, as stated, that it appears to me to lead most directly to the goal sought, that it is not an untried experiment but a demonstrated and conspicuous success, and one which has accomplished more in a short time than any other with which I am familiar, and because the chemical manufacturers of this vicinity have not yet availed themselves of it to any great extent.

When it comes to the troublesome question of the publication of the results of industrial investigations and the diffusion of chemical knowledge, the situation must be faced squarely and the fact clearly recognized that manufacturing corporations are not universities, but are organized to turn out a product at a profit. It is unreasonable, therefore, to criticize them as though they had been founded for purely altruistic and philanthropic ends.

President Butler, in his admirable address,¹ points out clearly the distinction between the functions of the college and of the university in the community, and that this problem of coöperation touches both. In this paper the writer has confined his remarks to those features of the problem which concern the universities chiefly.

To sum up, the writer favors closer and more confidential relations between the chemical industries and the university professors, the creation of advisory committees of manufacturers for the university laboratories and of university professors for the industries, the establishment of industrial fellowships by the manufacturers at the universities, to supplement and reinforce the work already being carried on there, or still better, the creation of a great chemical research institute in this world metropolis.

To attain that efficiency which is the only sure path to supremacy in any field of human endeavor, our universities and our industries must work together in entire sympathy and understanding, and it rests now with the manufacturer to decide whether he will seek this closer coöperation or not.

ORGANIC LABORATORY
COLUMBIA UNIVERSITY, NEW YORK

DISCUSSION

By ELON HUNTINGTON HOOKER

President of the Hooker Electrochemical Company

"What can the University do to foster the rapidly expanding chemical industries?"

"What can the Industries do to promote a higher yield of University leaven, to their own uplifting, and to the general good?"

Perhaps no field offers a more promising outlook to the university graduate of to-day than chemical engineering. The demand for him has come with an acceleration which is rendering the supply inadequate. Indeed, a few years since he was hardly to be found.

Of late the universities have tried to produce him "in embryo." The task is a large one and so far as I know has not yet been

¹ THIS JOURNAL, 7 (1915), 1069.

solved. Our own experience to date has been that we must take a chemist and train him by dint of serious inroads on the treasury to be an engineer or failing this we have been forced to train engineers to be chemists.

I think I speak a thought to which managers of industrial enterprises will respond sympathetically in saying that thus far engineers and chemists show in their work what seems superficially a natural antipathy for one another. Probed under the surface there is disclosed merely a difference in habits of thought, units of measurement, and working materials. It is hard for one to get the viewpoint of the other.

We find a disparity of view in other walks of life. The student trained in the law school to a commendable respect for precedent finds this trend becoming fixed in the early years of his practice. As he ripens to greater usefulness he finds himself fixed as with a gyroscope to certain lines of thought which make precedent and respect for orderly process so nearly an end in themselves that his usefulness as a human factor is impaired. He can only respond with prodigious effort to those rapidly changing conditions which must be wisely met at whatever strain to legal procedure.

It is the human fact, not the orderly process, which is the paramount issue. Along these lines we have suffered much in the field of government these recent years. So it is with chemists and engineers.

Our experience is that chemists are unable to force themselves into forms of procedure which will produce a reasonable estimate of cost; that engineers are unable to work out a problem experimentally on a laboratory scale with glass and rubber but must go to costly steel, concrete, bricks and mortar for trivial experiments and that both fail to carry their experimentation far enough to insure ultimate success, but embark prematurely in operation.

Frank Munsey once explained to me why it was undesirable that young men should go to college. He rounded out his argument by pointing to George W. Perkins' career. One could not help being amused at his deduction. The concentration, continuity of purpose, keenness of mind and prodigious working capacity which Mr. Perkins has always exhibited are qualities which would have brought him to the front with or without college. Mr. Crane of Chicago formerly expressed views similar to Mr. Munsey's, but we may look upon that line of argument as belonging to the past.

The essential thing is that the young graduate should enter practical affairs with humility and with the realization that for business purposes he is at the moment several years behind the man of the same qualities who did not go to college. He will gradually outstrip the other if he concentrates on his work with a willing hand. The first essential in the university man is a trained mind habituated to reach logical and accurate conclusions from the facts at his command. This mental training should be in the main acquired before entering the university.

The chemical industry needs most to-day technical graduates of broader culture. A pithy, succinct, clear and forcible presentation of a mediocre proposal often goes further than an involved presentation of an excellent proposition.

Good general education preceding the technical training has become increasingly important. Emphasis on English and economics has often been laid, but it should be further emphasized and more stress be given to public speaking. To this day the benefit of a course in Roman law at college in teaching habits of analysis is gratefully remembered. The study of sciences can give equal mental training but notwithstanding Dr. Abraham Flexner's new school proposals, there is nothing equal to Greek and Latin for widening the vocabulary.

I have long thought the universities and colleges should teach geography. What elements we received in school made but a passing impression. There is of course a much broader pre-

sentation of this subject to-day, but a study in maturer years of physical geography and the resources—agricultural, mineral, political and human—of the different countries would offer a ready key to stores of information needed by the technical graduate. It could be made a most interesting and inspiring field.

After all what is needed of the student, as in after-life, is single-mindedness and tenacity of purpose. William James has used a term "energizing" to indicate an act of will by which one individual of equal brain capacity with another yet surpasses him by occasionally breaking through, by conscious effort, into a sub-stratum of the brain where activity yields a higher quality of product. The cultivation of this capacity brings results in research as well as in active life.

In urging where possible a liberal foundation before the technical course I have in mind that heretofore most men have secured their university training before they were old enough to appreciate and make the most of it. It has seemed a catastrophe to lose a year during the college period. On the contrary, those men who take a year off to work in some industry have the same advantage in subsequent usefulness which lies with those who are forced to work their way through college. They know what they are after and realize that money is being spent and sacrifices made to acquire a definite asset.

The obvious thing which the university can do for the industries is to send professors on sabbatical years to work in the outside world and draw in increasing measure from men in the industries for lectures to students. Cornell has done this consistently for some time; Columbia and the Massachusetts Institute of Technology have done the same. It should be further emphasized.

Men in after-life remember with an almost personal appreciation or resentment those professors whose lecture field enters into the every-day routine of their particular business or profession. The teacher whose exposition of algebra was dull and depressing to a future engineer, who had enjoyed his preceding mathematics and found keen interest in the ensuing calculus, is remembered through life, rightly or wrongly, as the man who gave him a "game leg."

On the other hand, keen enthusiasm is aroused and lasting benefit secured as at Zürich from the lectures of Conrad Zschokka, who came often to talk on hydraulics, leaving the night train from Marseilles, fairly dripping with experiences of the day before in the construction of the great harbor works there, or the movable dams in the Seine and Rhone.

The obligation of industry to the university is great; the discharge of the responsibility should be a pleasure. Our industries must not only maintain themselves but must forge ahead, particularly in a time of world readjustment and opportunity such as the present. The textbooks of to-day are superseded through the discoveries of to-morrow. Research and scientific scholarship must ever follow the lead of and find their best opportunity through the university organism.

Scientific work is now, of course, appreciated and well remunerated by the more advanced of the industries and it is constantly on its mettle to keep ahead providing new and orderly channels for the investment of capital and of any exuberance of activity. The frequent failure of research to lead to useful ends is offset by that inertia of industry which finds difficulty in keeping pace with the opportunities presented for revision of methods and machinery.

Prizes were once offered to foremen and officials of an industry considered by some of its friends to be in the forefront of technical development. The administration was swamped within two months with enough valuable suggestions for improvements to require five years for installation, and had to withdraw further prizes from pure plethora of invention. It

has not yet caught up with the manifest opportunities disclosed.

Reproach has been made that the industrial managers do not open up problems in their entirety to the universities for fear data may be disclosed to competitors. There is much to be said in reply for certain of the industries.

Every right-thinking man feels the human impulse to offer freely of the result of his labor and brains for the advancement of science and in the interest of education. It is easy to say that by the time your competitor has learned what you are doing and copied it, a wide-awake concern will be several jumps in advance. Most of us, I think, also concede that process and machinery patents are of value in the main only to enable one to bring together capital and afford protection during a formative period. Nevertheless, it is equally true that the details of apparatus operation, the so-called "tricks of the trade," the deductions from accumulated data which serve to guide the driver to keep his engine on the rails—all these are vital and are the inestimable accumulation of the years. In a specialized industry these may represent huge sums of past waste and they are not likely to be disclosed to the advantage of a competitor by an executive who feels his responsibility as a trustee.

There is a very real contribution from the world of industry to the universities which the recently organized Research Corporation aspires to make. I refer to affording a channel through which the output of invention in university faculties and among graduate and research students may be saved to the advancement of industry. Many ideas of undoubted industrial value are thus generated but go no further because opportunity is not at hand for their exploitation.

The Research Corporation, as some of you may be aware, aims to present itself as a nonpartisan element between inventor, licensee, manufacturer, consumer and even the patent office and other government bureaus and departments at home and abroad to aid in working out improvements of advantage to the industrial world and at the same time capable of making money for the further endowment of science.

Here is an opportunity whereby original ideas developed in the universities may become productive, of lasting benefit to science and to industry. The corporation by charter provision devotes all of its earnings and the activities of its notable governing board to the cause of science through gifts to institutions of learning.

40 WALL STREET, NEW YORK CITY

DISCUSSION

By P. A. LEVENE

Member of the Rockefeller Institute for Medical Research

All through history, from the early to present days, science was and still is a function of the economic needs of a people.

The science of the early agricultural state was astronomy; mathematics and again astronomy were the sciences of the state economically built on domestic and foreign trade. More advanced agriculture encouraged biology and the present industrial state is founded on the exact sciences. Theodore Richards, as Berlin exchange professor, remarked in his opening address: "If Leonardo da Vinci had lived to-day, he should have chosen engineering for his profession."

All through history science was made to serve society through its two distinct branches: one dealing with the fundamental conceptions of natural (at times supernatural) forces, the other with the problems of practical life. One is science in its larger theoretical aspect; the other science in narrow specialized fields. One led up to reconstruction of social orders, to economic revolutions, to the founding of industries; the other introduced improvements in methods of production of one commodity or another, at times perhaps of a small branch of an industry.

One created the wealth of nations; the other helped in accumulating fortunes which seemed vast only on a scale of personal property.

All through history the two branches of science were housed and nursed by two classes of people distinct in their temperaments, susceptibilities, and reactions. One class was grouped around academies and universities, and the other around the guilds, trades and crafts.

It is important that the leaders of industry of to-day should bear in mind the respective debt for their existence that they owe to every one of these two branches of science. It is still more important for them to realize that in the race for supremacy between nations the victory will belong to the one strongest in scientific attainment.

Up to the present, our own industries, and our chemical industry among them, were built on foreign and on borrowed science. Our contributions were principally in the line of practical improvements in the methods of production. Our schools were professional and technical schools. Conditions are changing rapidly. Our industries are challenging those of the rest of the civilized world. There is a vague awakening of a feeling of the value of science. And judging from the addresses delivered in the meetings of this society there seems to be a tendency to draw the scientific university force into direct service of the industry.

There is grave danger in it for this country where universities are maintained by private endowment. It is important for the industries to realize that discretion is needed also in the employment of our scientific forces. Men of great executive ability are not kept in positions of subordinate clerks. Men endowed with ability for theoretical research should not be made to waste their energies in the improvement of methods of production. This is a matter of ultimate economy. Service on advisory boards of industries necessarily must distract the energies of the university professor. The practice is particularly dangerous for the reason that a president of an industrial corporation may also be a member of the governing board of a university.

Undoubtedly there is need for coöperation between the industries and the university. Industries being the principal beneficiaries of scientific achievement should also be the principal contributors in the maintenance of the theoretical work of the university. Since the teaching duties in our universities are very burdensome, the establishment of research professorships, and research fellowships seems most advisable. The German industries have realized the sagacity of such a plan, for recently there was organized by them a group of institutes for theoretical research under the name "Die Naturwissenschaftlichen Kaiser-Wilhelm-Institute." In order that the institutes may enjoy all the advantages of the university, every institute director is made university professor. The industries provide the endowment. The university does not require teaching duties; the industries do not require service on advisory boards. The gain will be for both university and industry.

NEW YORK CITY

DISCUSSION

By B. L. MURRAY

Chemist, Merck and Company

In order to bring about the fullest coöperation between our universities and our industries two lines of work seem to be necessary. One is the effort to learn new things, to discover new knowledge: that is, to conduct a campaign of research. The other is to make fuller application of our present knowledge. Neither one of these lines should be minimized, neither belittled nor neglected, for in each lies tremendous possibilities for our national welfare. In the atmosphere and company of scientists one may hear so much about investigation, about orig-

inal work, about research, that this line would seem to be the only one of importance. But in the society of the industries is found a constant study of how to increase efficiency—that is, how to apply our present knowledge and appliances to better advantage.

If you inquire which of these two lines is of greater importance and along which our efforts shall be expended it will be necessary to make a guarded answer; for a single successful researcher in a single piece of work may revolutionize a whole industry—or do far more. He may discover something as important as the telephone or electric light. He *may* do this. Of course it is uncertain, but it becomes very important *if* successful, and so is worth trying. On the other hand, the better application of our present knowledge is *sure* of success. It lacks the element of uncertainty and has in addition a breadth wholly unrealized by most of us. I think it would be safe to say that our most pressing need is for coöperation in the use of the information already at hand. Work of this nature would furnish relief to industries almost from the outset, and it could easily continue for years without wearing itself out. But our country is large enough, and our resources sufficient for us to carry on research at the same time; and that is advisable.

In reviewing the papers of the various educators that we have had the pleasure of hearing on this subject during the past winter it is found that almost every one feels the need of more funds the better to further the ends of teaching. Indeed one educator feels that with money we could so expand our present methods of teaching as to make them all-sufficient. The second note sounded by the speakers is the call for more intimate contact between the universities and the industries. It is evident that both these points are well taken. Funds and still more funds are necessary: Contact, friendly contact, intimate contact is just as necessary; they go together; neither will accomplish much alone. Imagine a condition in which the university, while drawing its funds from industry, makes no adequate return to it. Imagine industry in close contact with and in large measure dependent upon the university, but still refusing to support it. Both conditions are intolerable and fortunately are only imaginary. The question at hand is how to promote both funds and contact to a greater extent than at present. I am satisfied that with contact carried to the proper extent, almost if not quite to intimate contact, funds will become available. This is said because it is felt that with fuller acquaintance leaders of industry will acquire greater confidence in our educators and be ready to exchange their funds for improvements in their industrial operations. Is it not purely an exchange proposition?

There is in fact a great lack of contact, of fellowship, or comradeship, even a great lack of acquaintanceship between the officials and teachers of our schools and the officials and responsible men of our industries. If one stops to consider the subject, the impression grows that to a great extent, perhaps even generally, these two groups are essentially strangers: They are working so independently of each other in what should be a common field. Examples will readily come to mind on reflection. The condition is aggravated by many small things often overlooked. The atmosphere of life in the profession of teaching is so utterly different from that of the business world. Surely no elaboration of this point is needed; nor is there need of an attempt to place the responsibility for the situation on either side. It is simply a question of how to bring the two together in harmony.

What are the means of developing this contact? What suggestions can come from the industries to the universities that will help out in our present time of need? Six ways of developing contact have come to my attention and will be briefly reviewed.

One of the means of producing the desired contact, that has been tried on a more or less extensive scale, is the fellowship

idea. Fellowships and scholarships have been established at universities by numerous industries. At times, perhaps, it has been done merely as an advertisement for the party making the grant of the funds, although in some cases, at least, the fellow is supposed to study problems of interest to, and finally to join the ranks of, the firm involved. The success or failure of this seems to depend in large part on the relations existing between the professor and the members of the firm. Disagreement may arise, since it is necessary for some one to decide what particular work is of interest to the firm and just what the fellow shall do. In some educational institutions this means of contact is discouraged, and it is thought to be of limited value. Yet it is not always so. In some cases the student spends part of his time with the firm and part with the teacher. This means of contact should be continued, but only limited results seem to be promised by it.

This leads naturally to the second means of improvement in contact, which I shall call intermittent training. Prof. Talbot says that teachers often marvel at the more intelligent and receptive attitude noted in students who for one cause or another have been obliged to spend a year, or even a summer, in some industry before or during their student career. It is usually the poor boy's privilege to "stay out a year and earn some money." And in all seriousness it is generally better for him than going to school that particular year. Let the boy go to his classrooms for two or three years and then go into industrial work for a few months. He'll soon find out what he wants to study when he goes back to his classes. He will have a much keener appreciation of what is going to be useful to him.

Why not encourage or require the students to get some practical experience before they graduate? It is well worth trying on an extensive scale. In some lines it has long been the custom. It is in vogue to-day in many schools of pharmacy, in some schools of commerce, in partial effect at least in dentistry and in medicine.

I would not, however, have the movement stop with the students. It would be an excellent idea, as already suggested by others, for teachers to try a few months in industrial life. The universities could well afford to grant the necessary leaves of absence, regularly, if they are necessary. In some cases, no doubt, the teachers would welcome such an opportunity during the vacation months, although it must be confessed that in an experience of many years an application from a teacher for vacation employment cannot be recalled. Still there is undoubtedly in this an opportunity for real improvement in the teaching force of the universities.

We have heard from the speakers at previous meetings that the university cannot select the raw material from which to produce *graduates*. The *teaching force* is drawn from the same raw material. And we are told in addition that the best material for teaching cannot be held in the universities because the industries pay higher. This in effect amounts to saying that the teaching force of our universities is apt to be less efficient than the graduates that enter industrial life. It is thought too that faculties many times are inbred. An inquiry made in one large university chemical laboratory sometime ago discovered only one teacher that had seen service in the industries. How can teachers fit students for industrial life without a knowledge of it themselves? How can they give to students a positive leaning or properly direct them to specific fields without such fields being wholly familiar to the teachers?

Another means of contact that is excellent takes the form of lectures or addresses delivered by capable men selected from the industries. Such speakers can supplement the teacher's lectures in a way that is especially interesting to the students. They can be instructive as well. Organize this movement and it can be made important, and worthy of much more extended

application than it enjoys at present. It can be made something more than a pleasant diversion from the routine of student lectures.

If the industries at times furnish speakers to address the college students, why not reverse the situation and have the teachers address the industries? Nearly all industries are organized, and nearly all have occasional meetings. Such meetings provide appropriate occasions for good rousing addresses by prominent educators. They must, of course, be in sympathy with the audience. Industries should invite such speakers. If this suggestion were followed out hundreds of opportunities for contact of this kind would occur during the course of a year.

The visiting committee mentioned by President Butler would also seem to be an excellent means of contact. The various departments of the university are visited by a body of men, appointed from industrial life, whose duty it is to examine the teaching and offer constructive criticism. It requires broad-minded men for good work on such a committee, and to adopt suggestions from such a committee requires broad-minded teachers. Our country is full of both. May I suggest that the members of such visiting committees be recruited in part at least from the various organizations of the industries.

The extension work of our universities is regarded by me as a most important method of coöperation with our industries. It may be made a *powerful* means of contact between university and industry. Such a form of coöperation will not appear at first sight as very promising, because it is so modest in its nature. It does not seek to furnish information to the captains of industry or to the captains of research; nor does it seek to solve the difficult problems of investigation that are more properly solved by other means. But it does greatly increase efficiency; and at the very point in industry where efficiency needs an increase. That is, it helps the humble worker, the foreman, the boss, or perhaps the superintendent or chemist.

There are in the ranks of industry thousands of men to whom the opportunity of a college or university training never came. But these men are none the less deserving of such a training. They often have a keen desire for learning and self-improvement. They are our sturdiest citizens and will usually be found direct-

ing the work of others. Attendance for a few weeks at extension courses, especially if those courses cover subjects with which the men are daily occupied, will quicken and keen and hearten them to a remarkable degree. Such students will often gather from an extension teacher just the stray bits of information that will help them in their daily tasks. It leads to their advancement in the works. Hope is newly awakened in them, they see some progress, and their futures assume new and brighter aspects. It does not usually take long for such men to command greater respect from their associates, and in addition to encourage the latter to greater efforts on their own part. Increased efficiency results, and it comes to the attention of the employer.

It is impossible to escape the feeling that this matter is not fully understood and not fully appreciated by our educators. It may even be unattractive to some of them. It does not result in a long list of graduates when Commencement Day comes around. It does not increase the number of original papers that may be published in the university press. In fact, it is not showy at all. It is just simply effective. It may well be called the mustard-plaster form of contact between universities and industries. It takes hold. And it is on ideas similar to this that Benjamin Franklin, Peter Cooper and others founded such excellent schools of practical training.

I know men who, after working all day, will snatch a quick supper and travel two hours to attend extension courses; and, after the evening has been spent under the reassuring and encouraging influence of the teacher, bringing with him the atmosphere of a different world, the homeward journey must be made, again at the expense of two precious hours. Students of this kind are always eager to take subjects to the very limit of their physical endurance.

I heartily suggest to our regents, trustees, and other educators to bring their teaching more fully within the reach of *these* eager students. If the courses offered bear directly on practical work of every-day industrial life one of the most powerful means of contact will be found, and certainly a great step in coöperation will be accomplished.

RAHWAY, N. J.

ADDRESSES

A DIAGRAM FOR THE CALIBRATION OF VOLUMETRIC APPARATUS AND THE REDUCTION OF THE VOLUMES OF LIQUIDS TO A STANDARD TEMPERATURE OF 20° C.¹

By HORACE G. DEMING

Received December 9, 1915

It is surprising how many chemists fail to correct for the variation in the strength of standard solutions due to changes in temperature. The fact does not seem to be generally known or remembered that errors of as much as a fifth of a per cent may easily be introduced by such neglect.

It is believed that a part of the nonobservance of this precaution is due to the difficulty that is experienced in making the necessary computations, for it is human nature to seek to avoid that which is found to be difficult. For this reason anything that tends to make easy the introduction of corrections for errors of this kind has a tendency to raise the average standard of analytical work throughout the world. A chart is here presented that serves to reduce the calculation of temperature errors to a simple mechanical operation. It is hoped that its publication will lead to a somewhat more general observance of desirable precautions in routine analytical work.

¹ See also Bureau of Standards, *Circular 19*, for tables from which the corrections in the calibrations can be quickly derived. [EDITOR'S NOTE.]

A recent paper¹ explained the underlying principles of a number of charts or diagrams, among others the so-called alignment chart, of which the chart here presented is an example. The latter has been accurately constructed, and readers who wish to make use of it will be able to employ a tracing. But it is thought worth while to describe the principles of its construction, in order that the same method may be applied to other similar problems, such as the reduction of weights to a vacuum, and the correction of refractometer readings for changes of temperature. The chart about to be described is really a combination of two charts, that will be explained separately.

CALIBRATION OF VOLUMETRIC APPARATUS

The chart consists of three parallel scales, *A*, *B*, and *C*, equal distances apart. Along *A* is plotted a logarithmic scale, from 5 to 100, each number representing the apparent weight, in grams, of water weighed in the air with brass weights at any given temperature. The point representing 10 g. is marked *p*. Unit distance on the logarithmic scale, namely, the distance from 10 to 100, was taken as $33\frac{1}{3}$ cm. in the drawing from which the chart on this page was reduced, the reduction being about one-half.

Along the right side of *C*, toward its upper end, is plotted a logarithmic scale of temperatures, from 10° to 33°, for use

¹ THIS JOURNAL, 8 (1916), 264.

in the conversion of grams to cubic centimeters. Each numbered degree of temperature appears at a point measured off from a reference point, r , and situated at a distance from the latter that is proportional to the logarithm of the volume (V) by which a kilogram of water, weighed in the air at the given temperature, exceeds the capacity of a flask holding exactly 1000 cc. at a standard temperature of 20° C. The quantities that need to be considered are the apparent loss of weight of a kilogram of water, due to the buoyancy of the air (taken as 1.05 g.); the density (d) of water at the temperature at which it is weighed; and the cubical coefficient of expansion of glass (taken as 0.000027). The latter is needed because it is desired to know the volume of the flask, not at the temperature at which it is calibrated, but at the standard temperature of 20° C. It is evident that

$$V = \frac{1000 + 1.05}{d} - 1000[1 + 0.000027(t-20)].$$

If V is expressed in cubic centimeters, it will be convenient to take the unit logarithmic distance along C equal to that adopted in laying down the graduations of A .

The scale B is placed exactly midway between A and C ; and a point, q , lying in a straight line passing through p and r , is taken as the reference point in laying off the graduations of B . These graduations are carried in both directions from q , unit distance being half that adopted in laying off the two outer scales. A more convenient way of locating the points on the middle scale is to connect each point on scale A in turn with the point r . The intersections of the lines thus drawn with B give the graduations of the latter.

Now since $0 = \log 1$, the point r , which has been taken as the zero point of scale C , represents a temperature at which 1000 g. of water exceed 1000 cc. by 1 cc. namely, by 1 part in 1000. Connecting this point with p , which has been taken as 10 g., we intersect the middle axis at a point q , which, therefore, corresponds to the product of $1/1000$ and 10, namely, to 0.01 cc. (See the principle of the alignment chart, as explained in the former paper.)

The point r is, therefore, labelled with the value 0.01, and the other points of the middle axis are given values proportional to the numbers of scale A to which they correspond.

The chart is now ready for use in the calibration of volumetric apparatus for a standard temperature of 20° C., by weighing water at any temperature. Let us suppose that a graduated pipette has been found to discharge 49.85 g. of water at 30° C. Connect 50° (approximately 49.85) on scale A , with 30° on the right side of scale C by a straight edge. Note that scale B is intersected at 0.26. The true capacity of the pipette at 20° C. is, therefore, $49.85 + 0.26 = 50.11$ cc., its capacity at the temperature at which it was calibrated being a trifle more.¹

By following this method, all the pieces of volumetric apparatus in the laboratory will

have been adjusted to the same temperature. It is preferable to the method described in some textbooks, in which no allowance is made for the change in volume of the apparatus with change of temperature. The result of the latter plan is that each piece of apparatus has its volume determined at the temperature that the water used in calibration happened to have. The error involved is about 0.01 per cent for every difference of 3° between the temperatures at which the vessels are standardized.

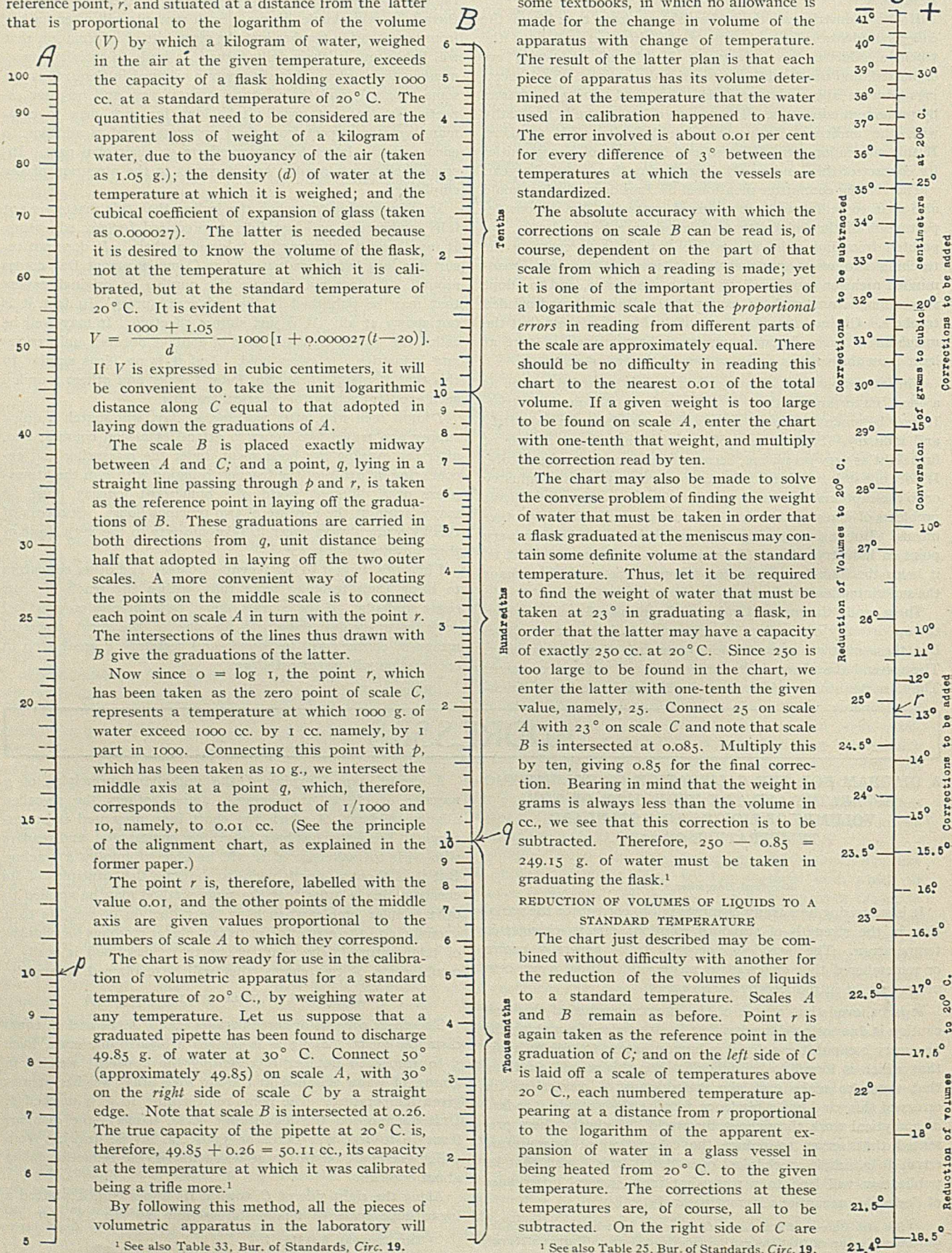
The absolute accuracy with which the corrections on scale B can be read is, of course, dependent on the part of that scale from which a reading is made; yet it is one of the important properties of a logarithmic scale that the *proportional errors* in reading from different parts of the scale are approximately equal. There should be no difficulty in reading this chart to the nearest 0.01 of the total volume. If a given weight is too large to be found on scale A , enter the chart with one-tenth that weight, and multiply the correction read by ten.

The chart may also be made to solve the converse problem of finding the weight of water that must be taken in order that a flask graduated at the meniscus may contain some definite volume at the standard temperature. Thus, let it be required to find the weight of water that must be taken at 23° in graduating a flask, in order that the latter may have a capacity of exactly 250 cc. at 20° C. Since 250 is too large to be found in the chart, we enter the latter with one-tenth the given value, namely, 25. Connect 25 on scale A with 23° on scale C and note that scale B is intersected at 0.85. Multiply this by ten, giving 8.5 for the final correction. Bearing in mind that the weight in grams is always less than the volume in cc., we see that this correction is to be subtracted. Therefore, $250 - 8.5 = 241.5$ g. of water must be taken in graduating the flask.¹

REDUCTION OF VOLUMES OF LIQUIDS TO A STANDARD TEMPERATURE

The chart just described may be combined without difficulty with another for the reduction of the volumes of liquids to a standard temperature. Scales A and B remain as before. Point r is again taken as the reference point in the graduation of C ; and on the left side of C is laid off a scale of temperatures above 20° C., each numbered temperature appearing at a distance from r proportional to the logarithm of the apparent expansion of water in a glass vessel in being heated from 20° C. to the given temperature. The corrections at these temperatures are, of course, all to be subtracted. On the right side of C are

This seems to



¹ See also Table 33, Bur. of Standards, *Circ.* 19.

¹ See also Table 25, Bur. of Standards, *Circ.* 19.

likewise laid off temperatures below 20° C., at distances from r proportional to the logarithms of the apparent contraction of water in glass vessels in being cooled from 20° C. to the given temperature. These corrections are, of course, all additive.

In order to prevent mistakes in the use of the chart, the graduations on scale C should be marked very plainly in a way that will show whether they correspond to additive or subtractive corrections, and whether they are to be used in the calibration of apparatus by weighing water, or in the reduction of volumes to a standard temperature of 20° C. It is very easy to make an error by reading a temperature from the *calibration scale* when a correction of volumes is wanted, and *vice versa*. In copying this chart it might be a good plan to construct the calibration scale of temperatures in red ink in order to lessen the danger of an error of this kind.

As an illustration of the use of the chart for the reduction of volumes to a standard temperature, let us suppose that a burette reading of 35.25 cc. has been obtained at 28° . Connecting 35 on scale A with 28° on the left side of scale C we note that scale B is crossed at 0.06 cc. Because this correction is indicated as being subtractive, it is deducted from the burette reading, giving 35.19 for the volume reduced to 20° C. It will be noticed that 0.06 cc. in a total volume of 35 cc. corresponds to a relative error of about $\frac{1}{6}$ per cent, and one that is well worth correcting.

Since the rate of expansion of water over small ranges of temperature is approximately constant, it is possible to use the chart just constructed for the reduction of volumes to 15° C. In this case each of the numbers on the left side of scale C is decreased by 5 units.

An interesting property of the alignment chart is that it permits us to introduce a constant factor without changing anything other than the relative positions of p , q and r . For example, if it is desired to use the chart just constructed for the reduction to the standard temperature of a liquid having a cubical coefficient somewhat greater than that of water, this may be done by simply moving the scale C upward a slight distance with respect to the other two scales. For every 10 per cent increase of expansibility over water, scale C will have to be moved upward a distance of 6 mm. in a chart the size of that here given. For example, if we have to deal with a liquid having a cubical coefficient of expansion about 30 per cent greater than that of water, we may reduce any given volume of it to the standard temperature of 20° by means of the chart constructed for water, with the sole difference that each point denoting temperature is to be taken as occurring about 18 mm. above its actual location. As this rule is only an approximate one, true within small ranges, it is sufficient to estimate these distances by eye at the time the chart is read. If more accurate results are wanted, with liquids whose coefficient of expansion is several times that of water, it will be necessary to construct another chart on the principles that have been described.

It is worth noting that the coefficient of expansion of normal sulfuric acid and normal solutions of the alkalis appears to be about 50 per cent greater than that of water, and that of normal hydrochloric acid about 20 per cent greater. For this reason one should be especially careful to make the necessary temperature corrections if solutions of this strength are used in titration. For the ordinary $N/10$ solutions the coefficient of expansion may be taken as about 10 per cent greater than that of water. Thus with 45 cc. of N NaOH at 28° C., the correction is -0.117 cc., the result being obtained by reading the chart as if the 28° mark had been moved upward 30 mm., or else by reading the correction for water and increasing the result by 50 per cent of itself.

Aside from the correct graduation of the scales, the only points that need to be especially observed in the construction of the chart are that the three scales are exactly parallel, that scale B is exactly midway between the others, and that the points

p , q and r lie in the same straight line. If these conditions are observed, the parallel scales may be any distance apart, and the graduations may begin at any point.

The writer is indebted to Mr. Francisco Quisumbing for the carefully executed drawing that illustrates this article. It is based on the data of Thiesen, Scheel, and Diesselhorst, as given in Van Nostrand's "Chemical Annual," 2nd Ed., page 459, the corrections for the buoyancy of the air and the expansion of glass between 20° and the temperature of calibration being as given above.

UNIVERSITY OF THE PHILIPPINES, MANILA

THE AMERICAN CHEMIST AND THE WAR'S PROBLEMS¹

By JAMES R. WITHROW

A volume could be written upon this subject if one possessed the power to assemble the material. The new problems which have arisen; the old ones which have become acute because of changed conditions; the splendid way in which the problems have been met where they were a matter of invention or skill; the new methods and processes which have sprung up as though born full-grown; the many old ones which have been improved, altered and utilized in new connections; the way in which the chemists of the country have risen to emergencies which have compelled them to manufacture products in whose manufacture they had had no prior experience—all these would easily fill entire chapters in such a volume. Even so, no earthly progress, achievement or consideration can lift the pall which settles over us when we permit our minds to dwell upon the spectacle of this war. And whose mind can be diverted from it for any length of time? He must indeed exist far below the kindling point who does not resent and despise with all his soul the philosophy and ideals which made it possible. It would be out of place, therefore, to consider our subject from the point of view of achievement, or felicitation, on any alleged good which has come to the science of chemistry because of the war. Surely no one would want progress at such a cost to his fellow man. We approach the subject rather in a spirit of thankfulness that we have been enabled to save something out of the wreck, and that our experience had prepared us in advance so that we have been enabled to prevent the collateral business and economic tragedies of the war from spreading universally. It is not in any spirit of gladness, therefore, at the evil providence which has fallen upon our European neighbors, that we recognize that this war has exalted the importance of chemistry in the minds of those who had not much opportunity hitherto to appreciate its value, nor is it with any jubilation that we take pleasure as chemists in meeting our new problems and emergencies arising from the war.

The satisfaction to many industrial chemists in the last two years of being able to contribute to the solution of these problems and of being conscious of the salvation of many businesses from financial ruin through the exercise of their chemical experience, has seldom been so widely distributed as it now is. What an inspiration it would be to read, spread out upon the pages of such a book as we have mentioned, the chemical successes, big and little, of the past two years. It is not likely that many of them will be known for a while because of the fact that business caution forbids their publicity in many cases, and that the vigorous campaign of destruction of equipment and diversion of supplies in order to hamper export from this country, makes silence a necessity in self-defense.

The problems of the war are of two kinds, those due to changed conditions, and those arising from supplying munitions at high speed. Among the former are changes in raw materials made necessary by the failure of imports or by unusual consump-

¹ Address presented before Section C of the American Association for the Advancement of Science, Columbus, Ohio December 30, 1915.

tion of raw material in other channels, such as for products not heretofore manufactured in this country, to the extent made necessary under present war conditions. These changed circumstances were also due in part to new demands for materials and products, which have arisen in the complete rearrangement of things that has come about in many circles since the war began. The other war problems which have arisen, those directly connected with munitions supply, are frequently of a difficult nature. All these various problems, however, have been met in practically every case with a degree of success that has surprised even ourselves.

Naturally one of the first serious effects of the war on American industries was the stagnation produced by the enforced cessation of exports in various lines. Such things as rosin, turpentine, petroleum products, acetate of lime and methyl alcohol were seriously affected for a varying length of time. Then the demand for munitions, for instance, became the wood distillation industry's salvation and with great celerity, acetone plants were attached to many of the works of this industry and the high prices which its products command have brought unprecedented prosperity and have correspondingly hampered progressive improvements. Production, not efficiency, is at present the slogan for this and many other industries. Setbacks of the nature cited usually take time for readjustment and frequently the chemist is a material factor therein. The producer himself is often compelled to add the next manufacturing step to his own operations. Where the new demands were ample, these attempts have succeeded and the war's conclusion will find an increased tendency to manufacture at the source.

The setbacks to industry arising from the disturbance in exports, while they were important financially, were minor matters compared with those arising from such changed conditions as failure of raw materials or their curtailment by absorption in new or abnormally expanded industries. It is here that the chemist is needed most and it is here that he has been of immeasurable service, and has met the problems that have arisen in wonderful style. He was seriously hampered at first by the uncertainty as to the facts. The fundamental thing in every industry is the market. At first much damage was wrought and delay produced by false reports as to stocks on hand and supply, particularly, of imports. Much withholding of goods for higher prices was practiced and even yet the pirates of commerce seek ways and means of evading contracts, even on deliveries of goods which they were receiving without cessation, so as to avail themselves of the inflated market prices. Some clever work by consumers trapped at least some of these unscrupulous brokers and sellers. All manner of fictitious prices were demanded of those unfamiliar with the facts.

As soon as the true status of demand and supply became reasonably certain, many changes were effected which will give gradual and probably ultimate relief. On every hand we see chemical activity without end. Products like synthetic phenol and barium salts, not made in this country before the war, are now made in large amount. Great expansion in production has taken place in the case of such materials as benzol, toluol, aniline products, naphthalene, carbon tetrachloride, acids, alkalis, chlorates, bichromates, and even oxalic acid. With all of these we were largely or in part dependent on imports, but have almost ceased to be so since the war began. Now, fertilizer plants erect their own sulfuric acid works and insecticide makers their own arsenic plants, textile mills make their own bleach. Numbers of manufacturers are replacing potash compounds by sodium compounds and to my own surprise at least, often with great improvement in results. Professor Watts has just told you this afternoon how the ceramist is making this country less and less dependent upon imports in that field by scientific purification and utilization of domestic clays.

Manufacturers of numerous miscellaneous chemicals and pharmaceutical preparations proceed to refine and produce their own crude raw materials and intermediates. The dye famine—for it is real in certain quarters—stirs up corporations with capital of hundreds of millions to enter the field. One of these new companies has installed half a million dollars' worth of machinery in the last few weeks. Indigo and other dyes are being made in nearly half-ton batches which will soon expand to a several-ton size. Where formerly was the most peaceful of occupations, even fertilizer manufacture, every effort now goes to the making of munitions. New plants spring up at the beck and call of new conditions such as the world has never seen. Think of a battery of 100 nitric acid stills each charging 4000 lbs. of sodium nitrate three times a day! Think of the sulfuric acid required and the nitric acid produced! Think of the fact that this one of a number such (the largest nitric acid plant in the world, it is said) is a plant which a year ago did not exist except in the mind and plans of a group of chemical engineers. How little are we able to comprehend the reality of producing 1,000,000 lbs. per day of guncotton where a year ago was merely pine woods. What does it mean with reference to design of plant, erection and operation to anyone who has not managed chemical engineering operations, to recount the engineering operations involved in this enormous production of guncotton in a single plant? Work that is conducted in ten to fifteen parallel procedures or "cotton-lines," which with their accompanying accessories include cleaning and alkali digestion of the cotton; bleaching with chloride of lime; manufacture of sulfuric acid for the production of nitric acid and "mixed acid;" nitration of the cotton in 30-lb. batches; the hazardous wringing and hasty submerging of the cotton in water, to avoid the consequences of heating by too slow dilution of the strong acid held sponge-like by the cotton; the conveying of this material in the "cotton-line" to the washers where the remaining acid in the tube-shaped cotton fibers is removed; and finally the removal from the water as wet or damp guncotton, the commercial product of many plants. This end-product, of course, is but the beginning of raw material for the various nitrocelluloses, smokeless powders and other high explosives. Yet this scale of operations is not going on in just one plant of this kind or even in this one industry. This is a sample of what is happening every day and is the American chemical engineers' answer to the question, "How are you meeting the war's problems?"

At some of these things we are permitted to take at least a peep. No one man can know all of even such gross developments, and practically every chemist we meet has his enthusiastic story of the progress of his own and familiar fields. We all do know, however, that if this is the character of the outward developments, there must be legions of quiet research and other experimental attacks on the new problems, and literally hundreds of solutions being worked out for minor problems in factory and plant, not to speak of the vast amount of work in other departments of chemistry made necessary by all these things. Then, too, there is the ever-verdant crop of interesting suggestions, revolutionary changes and inventions throughout the list of the chemical industries. In fact, they are doubly numerous and aggressive under the stimulation of such a time as this. It is never wise to predict their success or failure in many cases until years even have elapsed. It is true that a large number of these new things *never* make good. It is equally true that some of them *will* make good and that all of them indicate progress, for they are strivings, and progress comes by striving.

It is equally true also that many of the chemical expedients which are in successful use under war conditions will automatically be put aside when normal conditions resume. It is fundamental industrial chemical intelligence that a procedure which is ridiculous under some conditions may be a godsend under

others. We do not expect every change installed to be really normal progress, for it will not be so in the ordinary sense at least. On the other hand, it would be wrong also to say that the mushroom plants producing munitions are not signs of progress. They unquestionably are not such signs in so far as they are temporary. They do not measure true expansion in their respective fields. He would be a novice or singularly blind, however, who did not see that the construction of such plants on the undreamed-of scale I have already mentioned, not to speak of the new materials and procedures which have been incorporated in many of them, makes for greatly enlarged experience in chemical engineering designing, construction and operation. It is easy to see the pressure these things are going to exert upon the future development of American chemical industries. The American chemist's experience is becoming greatly expanded and the significance of this is apparent when we consider that engineering progress is a function of demand and skill or experience in solving problems. The demand increment is ever expanding with the development of the country. In addition, the skill acquired in the production of munitions is a valuable potential asset for defense should such a necessity ever arise. Such preparedness is highly to be desired. Then, too, at the close of the war when the output of these plants is no longer needed for that purpose, their equipment and intelligence will be directed into whatever field promises most. Already some of these concerns are assured that some of their products will find a continuous demand after the manufacturing of munitions ceases, which will be some little time after actual hostilities are at an end. The field of dye production is already attracting some of them. Without doubt the industrial rearrangements to follow the war will leave us much better situated in our ability to cope with the problems of chemical production. At any rate, powerful financial interests will attack these problems as they never have been attacked before. These interests will constitute another great force, which will be particularly effective after the war. When they seek new outlets for materials such as alcohol, benzol and acids, whose production they are greatly accelerating at the present, the gasoline and other problems will be greatly affected. These interests will be found after the war lined up behind the industrial chemists who have been struggling for years against all kinds of unfair competition and disreputable depreciation. Then again, any change in process, be it ever so timeworn or transient in its chemical nature, if it actually is put into successful operation under the then existing conditions, must of necessity push out the boundaries of experience to greater and greater distances and make us better able to meet the problems of the future. Chemical engineering is like any other division of engineering, it grows by what it accomplishes. In this proof of ability to meet a transient emergency the American chemist is certainly reaping a hundredfold as a result of his unadvertised care in the meeting of his industrial problems of the years gone by. Individual cases of progress and development which I have mentioned, it is easily seen, are rarely of great importance in themselves. We have not been revolutionizing on a great scale nor have we been jumping at once into great, new, national industries, but we are rather directing the normal steady gait of our progressive industrial development, with a keener perception toward more complete self-containedness, and thorough industrial preparedness. Some of the industries mentioned which receive much public attention are of relatively little importance compared with many other items affected. The dyestuff shortage appears to annoy many, but the complaint is out of all proportion to the facts and the damage done, compared with that of other commodities. We import normally, for instance, \$9,000,000 in coal-tar dyes per annum, and if we should make them all ourselves—which we will only gradually approximate—we would increase our chemical manu-

factures only 2 per cent and our total manufactures 0.05 per cent.

Though we have made reasonable headway on our problems we are keenly aware that much remains to be done. We do not expect to set the market right in the dye or other matters, in a year or two. These developments take time and have always taken time. Neither should we deceive ourselves or the public with thinking because of what we are doing that we could turn out, without the most careful and detailed previous planning, adequate munitions for our own defense "in sixty days" to supply the "two million men who would spring to arms," as we so often hear would happen in that undesired emergency.

It would be interesting to discuss in detail some of the transient, as well as probably permanent advances, where they happen to be a matter of personal knowledge, if it were wise to hand information to the assassins who lie in wait to hamper some of them, for military reasons. It might be well, therefore, to spend just a little time in emphasizing some general considerations which are connected with this subject.

There is little use in attempting to disguise the fact that the present war is a struggle between the chemical engineering genius of the Central Powers and that of the rest of the world. Quite irrespective of the war's origin, aims, ideals or political circumstances, these are the cohorts from which each side derives its power.

When we consider the strategic position of the Central Powers themselves, their capable education and training, their system of government, which, no matter what we may think of its selfish effect on the world as a whole, we must admit makes for more effective concentration upon its own governmental objectives—when we take into account all these things it must often appear to us that the greatest outstanding feature of the past two years is the miracle of the Entente Powers' resistance to the terribly efficiently prepared onslaught of the Central Powers. This resistance is due, to an extremely large extent, to the efficiency of the chemists of the neutral and Entente nations. The chemists of the Entente Powers and of America have arisen to the emergency as no chemists have ever done before in the history of the world. Confronted at the beginning of the war by antagonists whose munitions industry for years had been developed for just such a contingency, these chemists have in less than two years built up a rival industry at least as strong. Plant after plant has sprung up of such perfection of design and operation that one wonders how the mind of man was capable of such engineering. Though the speed with which these new and unexpected problems have been solved may appear surprising, no one who is informed as to the progress and development of industrial chemistry in this country could have reason to doubt that American chemical engineers and industrial chemists would rise to any emergency which it was within human power to meet. They have already and will continue to live up to what we have a right to expect of them, in view of their past successes. We would be surprised if a similar degree of success did not crown the efforts of the chemists of the other countries, France, Britain, Italy, Germany, Austria and Russia; for it has never been the habit of American chemists to boastfully claim superiority because of any advantage, real or imaginary, with which they, like any group, are apt to be blessed for a greater or less period of time. We have always appreciated chemical contributions to progress from whatever source they have come and praised unstintingly the individual, wherever he may be, who has taken a distinct step forward, for we firmly believe this is an important help in advancing the progress of the science.

These general developments are naturally not a matter of public information, except when attention is called to them. The chemist works almost entirely beneath the surface of things, and only in a few spectacular cases is public attention drawn to

his work. It is quite natural, therefore, that appreciation and praise of foreign chemical achievement and particularly our consistent praise of German achievement to our students by our university teachers of chemistry have been misunderstood, and have prepared a fertile field for foreign propagandas to establish a false impression of the superiority of certain groups of foreign chemists. We would scarcely object to a good-natured adulation of anyone's fatherland and its achievements. Such things always contain good and are stimulating to everyone, and it is a pleasure to hear them when free from arrogance, even when the adulation contains little that is new or even strictly true. When, however, this privilege is abused so that the point of superiority must be made by depreciating American efforts it has a vicious, positive result upon the minds of the uninformed, and at times causes great financial loss to them.

If the shortcomings of American chemistry were frankly discussed and compared with foreign successes in a chemical publication, some help might be given to those who could derive benefit from it. When this is *not* frankly done, but simply issued as an incidental *depreciation* of American chemistry, particularly when discussing foreign chemical achievement, and still worse when in a non-chemical publication, the object can scarcely be rated as creditable.¹

If the myth of the overwhelming industrial chemical superiority of German chemists ever was really believed in that country, the military forces of the Central Powers at least must marvel at the way the supposedly inferior foreign industrial chemists have displayed such astounding ability and speed in meeting the problems of munitions production, particularly, too, in countries where governmental mobilization of industries was unknown before the war and, in America at least, still is unknown. At any rate it has become evident that lack of self-advertisement is no sign of lack of ability or activity, and that ability to handle science skillfully and powerfully is not confined to any one race or nation. We do not feel that there is much to be gained by confuting claims of the chemical superiority of foreign countries in this and other similar articles, for it is curious how this war has developed farsightedness to the extent that some *Americans* can see only the chemical developments abroad.

I hope I have made it clear that it is the abuse of a privilege against which I speak, and not against individuals, for we do not let narrow-minded attacks affect our regard for individual Germans any more than we allow our opinions on the history of the past two years to affect this regard for such individuals. Everyone of us know Germans who are the most whole-souled and kindly men—who we are grateful to know and who scorn to be guilty of, or take advantage of, chauvinism. Depreciations of American efforts will bury themselves, without any assistance from us, and I emphasize them here only to call the attention of teachers of chemistry to the fact that we

owe protection to the business community and the public against such misrepresentation. We should never cease our appreciation of foreign chemists of whatever nation, but in addition it is our duty first to inform *ourselves* and then our students as to what our own chemists have done to solve our problems in this country. We have been able to blame our shirking this duty in the past upon the fact that it was easy to get information about foreign chemical achievement and no one seemed anxious to give publicity to American development. We, as teachers, have certainly done little to remedy this condition. The *American Chemical Society*, however, has spread the results of American efforts before us and made them accessible in its *JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY* for the last two years, in the shape of a series of addresses on the chemist's contributions to American industries. There are other addresses in these same volumes profoundly informing along these lines and this is particularly true of the Perkin Medal addresses each year in the same *Journal*. In addition, Professor S. P. Sadtler, in the *American Journal of Pharmacy*, for October, 1915 (an address before the National Exposition of Chemical Industries), in giving popular information along this line limits himself entirely to chemical industries *originated* as well as developed by the American chemist, and Edgar F. Smith's "History of Chemistry in America," but recently issued, should be read by every student of chemistry.

None of this work is in any sense a vain, glorious adulation of the chemist as some superbeing, nor is it an attempt to compete in the questionable game of lauding one nationality above another. It is merely a matter of a belated form of education which our universities and chemists hitherto have largely denied to the American business man, and which he has a right to expect of them. The record is one for which we have good reason to be thankful and, as we teachers no longer have the excuse of ignorance about American progress, we are at fault, if the rising generation has not an appreciation of the progress of chemistry in America, commensurate with the high level of its development.

In conclusion then, let us take courage from the fact that though much damage has been done to us and our industries by the war, our efforts at salvage benefit us as experience, power and preparedness. We have seen that the chemists of America have met the war situation well and do not require defense at the hands of anyone. It becomes increasingly evident that business has been awakened to the value of chemistry as a source of power and wealth as business has never had occasion or opportunity to be hitherto. Let us hope also that not only the spectators but also all the combatants may learn, even if impelled by bitter war's experience, to appreciate the worth, each of the other, and that all nations are "made of one blood to dwell on the face of the earth."

THE OHIO STATE UNIVERSITY, COLUMBUS

CURRENT INDUSTRIAL NEWS

A YEAR'S WORK IN FOREST SERVICE INDUSTRIAL INVESTIGATIONS

The annual report of the Office of Industrial Investigations of the Forest Service shows developments in its work of direct interest to the wood-using industries and consumers of forest products generally.

One new phase of this work is the formation of a wood waste exchange and the collection of detailed information regarding the supply of wood wastes and the demand for it. This information is made available in the form of specific quotations from *bona fide* buyers and sellers of waste who cooperate by supplying complete information regarding the exact form,

¹ Specific reference omitted by editor with consent of author.

species, sizes, and amounts of waste available or desired. Schedules requesting this information were sent to a number of wood-using establishments and a list was gradually built up. It now contains the names of several hundred manufacturers. Lists of opportunities to buy or sell waste are published every three months and sent to the various coöperators. Manufacturers have coöperated heartily and reports of sales are being received regularly.

A large amount of specific information has been made available to the public regarding the location of manufacturers, buyers, sellers, importers, and exporters of forest products. Detailed information has also been collected regarding the forms of raw material needed or available at various establishments

and the value of various products f. o. b. mill and at the principal markets. Records of lumber prices secured in coöperation with various lumber associations from mills throughout the United States were issued quarterly. Besides the records that have been issued in former years for the important woods in the principal producing regions, quarterly records were added for spruce and hemlock in West Virginia, New York, and New England, and for cedar poles in Minnesota and chestnut poles in the East. Information as to the conditions involved were obtained whenever possible. A directory of American sawmills was compiled in coöperation with the Department of Commerce, showing the kind of lumber cut by each mill, the forms and dimensions of its products, and the railroads over which the material is shipped.

In coöperation with the Bureau of Crop Estimates, statistics on the lumber production of the United States were collected and a report published covering the year 1913, which showed the production of nearly as much lumber in that year as in 1912. Steps were taken, in coöperation with the American Wood Preservers' Association, to secure for the coming year statistics on the number of poles and ties and the amount of various other kinds of forest products purchased by the principal railroad, telephone, and telegraph companies; and a report on the amount of wood preservatives used and the amount of timber treated in the United States in 1914 was published. Approximately 100 plants coöperated in supplying information regarding the amount of wood preservatives used, including practically all of the establishments of importance engaged in the industry.

Data were also compiled on the veneer, box, and cooperage industries. A preliminary report on the box industry was published in coöperation with the National Association of Box Manufacturers. This report furnished information of use to the industry, and to the Interstate Commerce Commission in their investigations of shipping containers. It was also made use of by the American Society for Testing Materials in working out standards for shipping containers.

The Office has also enlarged its activities in coöperation with various other branches of the Federal Government. The work has been chiefly the inspection of lumber, the revision of specifications, the furnishing of information regarding prices and the suitability of various woods for particular uses, the suggestion of better methods of handling and storing lumber, and the preparation of lists of bidders on various products. At the request of the Navy Department, a study was made of the methods of handling and piling lumber at various navy yards, and a report was prepared in which recommendations were made regarding the best means of preventing deterioration. A large amount of lumber was inspected for the Navy Department at various points east of the Mississippi. Generally the object of the inspection was to determine whether the shipment was up to the grade called for in the specification; but occasionally the Forest Service was called upon for the identification of species. Specifications for grading hickory handles were prepared and were adopted by the Navy Department, the War Department, and the Panama Canal. The Panama Canal used these specifications in the purchase of a large number of handles during the year. The specifications are coming more and more into commercial use, and eleven large railway systems have adopted them in one or more of their divisions.

A field study of southern pines in the Carolinas, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, and Missouri was conducted to determine the quality of wood grown in the various parts of the Southeast and the quality of lumber in the typical markets in the East and Middle West. The work resulted in the collection of data of immediate practical use in connection with the preparation of more satisfactory rules for grading structural timbers.

The reports on the wood-using industries of the various States were continued, and three new reports were published—Pennsylvania, New Jersey and Georgia. This makes a total of 33 State wood-using industry reports issued so far. Reports for Indiana and West Virginia were completed and placed in the hands of the publishers. Data on the wood-using industries of the remaining States have been collected. A final report on the wood-using industries of the United States is in preparation, in which combined data collected in the various studies will appear by species and by industries.

Many requests were received from the public for information regarding the most profitable uses of certain woods, the markets for them, the most satisfactory woods for certain uses, where they may be obtained, etc. Inquiries come from small sawmill owners, timber owners, and manufacturers of finished and semi-finished forest products. Through the wood-using industry studies the Office is well equipped to give such information. A large amount of utilization data is compiled monthly, including lists of wood-using establishments and specifications for raw material, and will be used for the benefit of lumbermen, woodlot owners, and the Forest Service coöperators throughout the United States.

In connection with the general lumber industry study now being carried on by the Forest Service, the Office of Industrial Investigations has studied the adaptation of grading and manufacturing to consumers' needs, particular attention being given to yellow pine and oak. Data were compiled also on the relative values of oak logs in lumber, veneer, cooperage, and ties.

NEW COAL FIELD

According to the London *Evening Post*, a Stavanger morning paper states that a Norwegian Company has been formed for the purpose of exploiting the extensive coal fields of Beeren Island, near Spitzbergen. Geologists and engineers, who have investigated the deposits, report that the quantity of coal obtainable is practically inexhaustible, while it seems to be of very good quality, its heating power being greater than that of ordinary British coal. Beeren Island is always accessible, so that export trade can be carried on during the whole year. It is expected that no difficulty will be experienced in finding good harbors.—MCMILLAN.

TREATMENT FOR DISCOLORED CHINA CLAY

According to the *Dyer and Calico Printer*, the yellow discoloration of clay is due to presence of iron and, to remedy it, a blue coloring agent such as a soluble aniline dye is added. This neutralizes the yellow and makes the clay appear whiter. It has also been proposed to remove the iron altogether by chemical treatment. An entirely new method has been patented by Messrs. Feldheimer and Gee, London [B. P. 894 (1915)]. To nullify the discoloration, some of the clay is first washed to free it from impurities and to this is added a very dilute solution of ferrocyanide (less than 1 per cent) to produce sufficient prussian blue to neutralize the discoloration of the remainder of the clay.—M.

MINERAL RESOURCES OF CHINA

Iron ore can be found, according to an article in *Engineer* (121, No. 3142), in almost every province in China, but the working of the ore on an extensive scale has been carried out in only a few. The annual production of pig iron in Hupeh in the last two years was almost 160,000 tons, while the total amount produced in all the other provinces together was also about 160,000 tons. If up-to-date, thoroughly modern, methods of smelting were employed, the production of pig iron would be sufficient to supply the needs of the country and also to permit of large shipments being sent to foreign countries, especially Japan and the United States. Tin ore is found to some ex-

tent in China, the most important deposits being those of Yunnan, Kiangsi, Honan, Kweichow and Szechwan. The output of pure tin is about 4,000 tons without taking into account the considerable quantity of tin ore mined in other provinces.

Copper comes from the districts of Yunnan, Szechwan, Kirin, Anhui, and Kansu, the annual production of pure copper being about 2,400 tons. China is the largest producer of antimony in the world, no less than 20,000 tons crude antimony, 4,000 tons refined antimony, and 15,000 tons of the ore being produced annually. The chief centers of the antimony industry are Hunan, Yunnan, and Kwantung.

Lead deposits are found in Hunan, Yunnan, Kwangsi, Szechwan and Kweichow, the annual production of ore being about 16,000 tons.—M.

BRITISH ALCOHOL TRADE

According to the *Engineer*, it is authoritatively stated that the British Government has decided to take over all the patent-still distilleries. The requirements of strong spirits in connection with the manufacture of munitions are still under 15,000,000 gallons per annum, whereas the total output of patent-still distilleries is over 40,000,000 gallons. This output will, however, be substantially reduced by the curtailment of the imports of raw materials. The Government scheme was discussed at a meeting of the distillers of the United Kingdom in London recently, but the proceedings were not divulged. It is understood that nearly all the great distilleries have hitherto been making for the Government spirit at 60 per cent overproof for the manufacture of high explosives. The time has now been reached when it is felt that a larger supply and more expeditious production are urgently needed with the result that it is proposed to commandeer all the grain distilleries.—M.

MINERAL RESOURCES OF GREAT BRITAIN

The British Board of Agriculture and Fisheries gives notice of the publication of three volumes containing special reports on the mineral resources of Great Britain. These reports have been specially prepared by the Director of the Geological Survey in response to numerous inquiries that have arisen through the conditions brought about by the war. In Vol. I, the uses, distribution, treatment and output of tungsten and manganese ores are dealt with and particulars of mines, active and inactive, are given. Vol. II deals with the sources, uses, and treatment of barytes and witherite, the sulfate and carbonate of barium. The mines, from which the minerals are raised, are described in full. Vol. III gives a description of the properties, uses, treatment and modes of occurrence of gypsum, anhydrite, celestine and strontianite. Details of the workings in all parts of Great Britain are given with statistics as to output. The price of Vols. I and III is 24 cents, and Vol. II, 36 cents.—M.

LATEST COKE RECOVERY PLANT INSTALLATIONS

A very complete and modern plant, says *Chemical News* (113, No. 2939), has been installed at Normanby Park Steelworks, Yorkshire, England, for the making of coke, tar, ammonia and benzol. The buildings are of ferro-concrete on the Monchel-Hennebique system and, in addition to an immense washing apparatus, two batteries of 48 generative coke ovens of the Semet-Solvay type, capable of dealing with 3,000 tons of coal per week have been installed. The power for the working of the plant is supplied by gas engines which use up the blast furnace gases. The main washery building is 65 ft. long by 40 ft. wide, two-thirds of it being 77 ft. high, while the remainder rises in the form of a tower 94 ft. high and is surmounted by a huge ferro-concrete tank capable of holding 62,000 gallons. The coking ovens are supplied with washed coal at any required rate up to 100 tons per hour by means of conveyor bands

connected by a runway under which changing machines receive and stamp the slack into compression boxes. Each of the 96 ovens carbonizes 50 tons washed coal per week. The coke is pushed out through the quenchers to an inclined hearth over which it passes to 36 in. tray conveyors which deliver the product to the central screening machine and thence to the blast furnaces. The gases from the ovens are collected into a large main and exhausted through air and water condensers, thence passing through the extractors and scrubbing washers for the absorption of benzol and remaining ammonia. After this treatment the gases are utilized, one-half for heating the flues in the coke ovens, the other half in the steelworks. The tar-ammonia liquor and benzol extracted from the gases are treated in buildings situated between the coal washery and the batteries of coke ovens.—M.

MALAY STATE WOLFRAM

Reports show that the output last year was 3,940 pikuls (1 pikul = 142.7 lbs.), compared with 3,898 pikuls for the previous year. The chief producer was the Titi Mines Company, which had a yield of 1,199 pikuls. The market price in London was 55/- per unit, but to producers abroad the price was lower, thus, in Melbourne and Sydney, it was 48/1 per unit. A company recently was formed in Melbourne with a capital of £50,000, called the King Island Scheelite Company, for the purpose of treating deposits there. The assay value of the ore is equal to 2.34 tungstic acid.—M.

RUSSIAN TRADE

The British Vice-Consul at Ekaterinburg reports that, in Ural mining works, a great dearth of machinery is beginning to be felt, and fears are being expressed whether the allied powers will be able to supply the enormous quantity formerly supplied by the Germans. Not to mention new enterprises, machinery at present in use, owing to the difficulty of repairing parts, will likely be run out so that all current business will in all probability require new machinery after the war. The demand for catalogues and specifications in the Russian language has never been so great as at present. Russian buyers are eager to find where reliable information can be had as to where their requirements can be obtained. Great preparations should be made by firms anxious to get a share of the Russian trade after the war. Travellers with a knowledge of the Russian language and technical knowledge of machinery should be sent to the Ural mining district, where the Russians will be glad to give them every assistance.—M.

THE USE OF POLARIZED LIGHT IN ENGINEERING TESTS

Some interesting and highly important revelations were made by Prof. E. C. Coker in a lecture given before the Royal Institute, London. Recent researches show that polarized light can be made use of in such practical matters as bridge building and aeroplane construction. The stresses and strains in a great bridge and in the different parts of air craft are very hard to work out. The calculations can, however, be simplified if a model be made of transparent material and the strains watched by polarized light. The lecturer showed how a bridge intended to be thrown over a gorge, was first made of glass. Polarized light was passed through every part and in analysis each stress was shown by the colors which different parts assumed. Full brown color indicated 1,000 lbs. per sq. in., while a brilliant red showed enormous pressure. It was found that glass and glass-working were too costly for making models, and xylonite, which could be moulded into any shape, was afterwards selected. Polarized light, if sent through under normal conditions, gives no colors but, if the slightest bend or strain is applied, color effects are produced. Prof. Coker

showed on the screen series of the links of aëroplanes made from xylonite models; the change of color could be watched to indicate how strains affected them. This new method of testing the designs of structures would seem to have a great future.—M.

POTASH FROM OLIVE OIL RESIDUES

From analytical results published in *L'Italia Agricola* by A. Aita, olive oil residues (the blackish turbid liquid deposited at bottom of sink under oil presses) contained the following:

	Per cent
Soluble in water.....	13.57
Alkaline chlorides.....	1.57
Iron oxide (FeO).....	1.34
Carbon dioxide (CO ₂).....	1.87
Insoluble in water.....	1.05

The amount of potash in the liquid is given as about 1.5 per cent or slightly more. By the evaporation and combustion of 100 gals. of this residue from 30 to 35 lbs. of ash were recovered. The volume of the liquid is double that of the olive oil produced. If the average yearly production of olive oil in Italy is estimated at 44,000,000 gals., it is calculated that 15,000 tons ash can be recovered from the liquid residuum and the value of this exceeds \$400,000. A Commission has been formed to consider the possibility of utilizing this residuum for the manufacture of potash salts. The Commission informed the *Associazione chimica industriali* of Turin that the process was simple and the expenses of concentrating in ordinary triple action apparatus were not greater than 10 cents per 100 gals., reckoning fuel at about \$6 per ton. The nitrogen content in olive oil residuum is equal to about one-third the potash content and, therefore, of great value. It would be, perhaps, advisable to secure both the nitrogen and the potash by, adopting a method other than the incineration one.—M.

MINING IN MADAGASCAR

According to the *Mining World*, Madagascar seems to be rich in mineral deposits. In addition to gold, which is found in alluvial deposits widely spread over the island, ores of antimony, copper, iron and tin are stated to be in abundance, to say nothing of asphalt, coal, graphite, mica, platinum, precious stones and petroleum. No coal developments have taken place of late in the coal-bearing area discovered in the southern province of Betroka, but a concession for working copper near Ambositra has been granted and also one for working nickel. Alluvial gold deposits have been found in the valley of the Ampoasary, a tributary of the Mananjary River about 40 miles east of the town of Ambositra and in the district of Maevatanana. About 5,000 natives are employed in washing auriferous gravel in pans. The production of fine gold for 1912 amounted to only 2,120 kilograms, which showed a decrease of 730 kilograms on the previous year, the decrease being mainly due to the difficulty of obtaining labor in the principal mining districts. Graphite is worked chiefly in the neighborhood of Tananarive and is found disseminated in the form of spangles interstratified in the gneiss and appears to occupy the place of mica. It is easily separated from the gneiss by hand washing. Prospecting for graphite is engaging the attention of many prospectors in Madagascar at the present time. Galena is found at Ankitokazo in the northern province of Diego-Suarez. No work is at present being done in petroleum claims. Small quantities of platinum are being obtained in the province of Vatomandry. The principal workings for precious stones are those of Mount Ibity and of the river Manandona, near Antsirabé.—M.

EFFECT OF SULFATES ON CROPS

Certain plants, says the *Pharmaceutical Journal*, seem to be benefited by treatment with sulfates, but others show less response to sulfates than to phosphates. Plants belonging to

Cruciferae and *Leguminosae* are most favorably affected by treatment with calcium sulfate although the latter appears to stimulate seed production in cereals such as barley and oats, but to have little or no effect on the straw. In the case of clover, the increase of air-dry content due to calcium sulfate was 23 per cent, while with rape, calcium sulfate mixed with complete fertilizer, gave a crop of 17 per cent heavier than with complete fertilizer alone; with radishes, the increase in crop under the same conditions was 9 per cent. The root development of red clover and rape showed a marked increase under the influence of calcium sulfate dressing. Free sulfur is harmful, even in large supplies of calcium carbonate.—M.

UNITED KINGDOM IMPORT DUTIES

The following list gives the import duties on items of interest to the chemical trade, in accordance with a general order of the Board of Customs and Excise. The tariff quoted in the "Return" is that in operation on January 1, 1916:

ARTICLES	Rates of duty			
	£	s	d	
Chloral hydrate, per lb.....	1	9		\$0.42
Chloroform, per lb.....	4	4		1.04
Collodion, per gal.....	1	14	11	8.38
Ether, acetic, per lb.....	2	7		0.62
Ether, butyric, per gal.....	1	1	10	5.04
Ether, sulfuric, per gal.....	1	16	6	8.76
Ethyl bromide, per lb.....	1	1	5	0.34
Ethyl chloride, per gal.....	1	1	10	5.04
Ethyl iodide, per gal.....	19	0		4.56
Glucose, solid, per cwt.....	5	11		1.42
Glucose, liquid, per cwt.....	4	3		1.02
Motor spirit (a), per gal.....			6	0.12
Saccharin (b) and mixtures containing saccharin or other substances of like action—per oz.....	3			0.72
Soap, transparent, in manufacture of which spirit has been used—per lb.....		3		0.06

(a) In cases where Commissioners of Customs and Excise may approve, motor spirit may be delivered without payment of duty or in payment of half duty.

(b) This substance not to be imported in packages containing less than 11 lbs., must not be packed with goods of any other description and must be specially reported and entered for warehousing at following ports only: Dover, Folkstone, Goole, Grangemouth, Grimsby, Harwich, Hull, Leith, London, Newhaven, Southampton, West Hartlepool.

—M.

BRITISH BOARD OF TRADE

During the month of March, the British Board of Trade received inquiries from firms in the United Kingdom and abroad regarding sources of supply for the following articles. Firms which may be able to supply information regarding these things are requested to communicate with the Director of the Commercial Intelligence Branch, Board of Trade, 73 Basinghall Street, London, E. C.:

Aëroplane fittings	Machinery for shaping vulcanite and galalith rods in cigarette holders
Alloy, ignition for pocket lighters	Machinery for automatically filling sacks and tin boxes
Bottles, gum	Mining plant for output of 300 tons per day of 15 per cent pure NaNO ₂ including complete railway equipment, stationary engines, etc.
Cane, whanghee	Masks, dolls, papier maché, faced with silk
Charcoal, stick and lump	Nails, wire, for butter boxes
CHEMICALS:	Neuberg chalk, substitute for metal polish
Acid phosphate of sodium and ammonium	Needles, pearl, machine
Acetic acid, 60 per cent	Paste, soldering, noncorrosive
Bleaching powder	Pith, finely ground
Lactic acid, 50 per cent	Precious stones, agate, onyx, lapis, jade.
Potassium permanganate	Rollers, hard tungsten steel
Sulfuric acid	Rollers, for rolling mills, tempered steel
Phosphate for self-raising flour	Straps, chin, rubber
Potassium nitrate	Studs, collar, metal
Sodium bromide	Screws, iron
Catches, silver and nickel-silver for purses	Silk, artificial, 1,000 lbs. required
Celluloid beads	Slide rules
Celluloid caps for pomade pots	Teats, rubber, on cards
Celluloid watch covers	Trunks, metal, for export
Cylinders, mining, rustless	Tortoise shell, real and imitation
Cutlery, rustless, stainless	Vacuum flasks, cheap
Engines, detachable for rowboats	
Hoop-iron, 3/8 in. by 30 gauge	
Hoop-iron, 3/4 in. by 26 gauge	
Hydrogen gas plant, "Linde" system	
Iron clamps, small, cheap	
Jet, raw, for making cigarette holders	
Lifting jacks, screw	

A firm in Brazil is making inquiries regarding sources of supply of the following chemicals, formerly imported from Germany:

Chloride of lime; acetic acid; alum; sodium sulfide; Glauber salt (calcinated), also crystal; Epsom salts; sodium nitrate, aluminum sulfate; dextrin and potato starch. Firms supplying these may apply to Board of Trade, London; reference number [85] should be quoted.—M.

UTILIZATION OF PEAT

The economical utilization of peat in the generation of gaseous fuel even with the recovery of the by-products is said to be to-day, an accomplished fact. The tar, on distillation, according to work described in the *Journal of Society of Chemical Industry* [35 (1916), 247], gives neutral oils differing from those obtained from coal tar and from the paraffins by being highly unsaturated. This is shown by the rapidity with which they absorb atmospheric oxygen. When extracted with alkaline solutions, substances with high boiling points and powerful germicidal activity are removed. These oils are sparingly soluble in water but may be used in suspension or emulsified by soap solutions or, as solid disinfectants, when mixed with hard soap, dextrin or similar substances. Small quantities of pyridine bases occur in the crude peat tar oil. The higher fractions of the neutral oils are waxes and resemble montan wax lignite. The residue from distillation of peat tar is a typical soft pitch, suitable for use as asphalt, caulking or electrical insulation.—M.

SELENIUM

In a series of articles published in the February numbers of the *Electrician*, W. K. Cooper has given an account of the properties of selenium which will prove of value to any who may be interested in the technical applications of the sensitiveness to light which the substance exhibits. Such information had, previous to the appearance of the above papers, to be sought for in the scientific journals published in all parts of the world, a task sometimes by no means easy. This is now available in a compact and readable form. An account is first given of the various forms of selenium with the modes of preparation. Their sensitiveness to light in general and to the variations of the wave length of the light is then discussed and, although no general theory has been deduced from the experimental facts at hand, sufficient information is available to indicate that, before long, it will be more intensively used than at present, when its use is mainly restricted to the automatic lighting of isolated buoys at sea.—M.

NICKEL

From official papers given to the Canadian Parliament, says the *Mining Journal*, it appears that the International Nickel Corporation has agreed to a request from the government and will erect in the Dominion at such point as seems in their judgment most economical for operation, a plant for refining nickel of such initial capacity as will secure to Great Britain and Canada within themselves, a supply sufficient for their requirements. The company is reported to have just concluded a contract with Great Britain for a large tonnage of nickel equal to 20 per cent of the production to be delivered in monthly instalments over one year.—M.

MINING DEVICE

A device has recently been patented intended to indicate the slightest movement of ground, when adjusted in stope or tunnel, and thus to give warning of impending falls of roofs. Instant intimation is given to a watchman or to the mine manager's office by completion of a circuit through the instrument. The ringing of a bell and the showing of a red light in the device itself may serve where it is near the miners. The Mining

Commissioners in the South African gold mines and also in Australia state that there is need for such an instrument and, in the latter country, legislation for its use in dangerous mines is about to be made.—M.

OIL PROPERTIES IN GUATEMALA

The government of Guatemala is said to have taken measures to retain exclusive right of the oil deposits of the Republic. A recent presidential decree specifies that oil and hydrocarbons may be acquired or worked in no other way than by lease from the government for terms of not more than 10 years and such leases can be made only by native or naturalized residents of Guatemala. Special regulations give terms in which oil fields may be purchased.—M.

PHOSPHATES FROM PACIFIC ISLANDS

In a bulletin from the Imperial Institute, London, it would appear that phosphate is the chief mineral product of the German Pacific Colonies. Nauru and Ocean Island of the Marshall group are estimated to contain not less than 50,000,000 tons phosphate rock, while Angaur Island, in the Pelew group, is supposed to contain 2,500,000 tons phosphatic deposit. The total exports of phosphate from Nauru and Angaur in 1912, which went principally to Australia, New Zealand and Japan, were valued at a quarter of a million sterling.—M.

NEW PROJECTS IN SPAIN

It is rumored that there will shortly be formed a subsidiary company of the Compañía Minera de Sierra Menera with a capital of 20 million pesetas for the establishment of blast furnaces in Sagunto, also, that the Real Compañía Asturiana is to lay down at Arnao another large zinc plant but fitted for treating blende.—M.

TEMPERING OF STEEL

According to the *Gas World*, gas has come into use in France as a means of heating-up tools of "rapid steel" (chrome-tungsten steel) for the purpose of tempering them. The temperature required is 1000° C. (1,832° F.) and the tool is plunged in a bath of fused caustic soda. The material being rather fragile, any defects in tempering shorten the life of the tool, but it is found that with gas tempering the life of the tool is fully twice as long as that of a similar tool tempered with a coke or oil fire.—M.

SCIENTIFIC RESEARCH IN AUSTRALIA

Mr. Hughes, the Prime Minister of Australia, who is at present on a visit to England, outlined a scheme for the establishment of an organization for scientific research in Australia, in a recent speech delivered in London. He mentioned the following, especially, as questions for immediate study: The recovery of lanoline and potash salts in the "dross" thrown away after wool-scouring; the cultivation of beet for sugar; the development of fisheries; the improvement of gold recovery and other metallurgical problems; the extraction of valuable oils and resins from negative plants; afforestation and the systematic investigation of diseases affecting stock.—M.

SALT MINES IN VENEZUELA

The lease of the Venezuelan salt mines by the River and Coast Navigation Company having expired on December 31, 1915, and no application for another lease having been received in response to a call in November last, the government of Venezuela took over the direct administration of the salt mines on January 1, 1916, in accordance with a presidential decree.—M.

SCIENTIFIC SOCIETIES

LAYING OF THE CORNER STONE OF THE CHEMISTRY BUILDING OF THE BUREAU OF STANDARDS, WASHINGTON

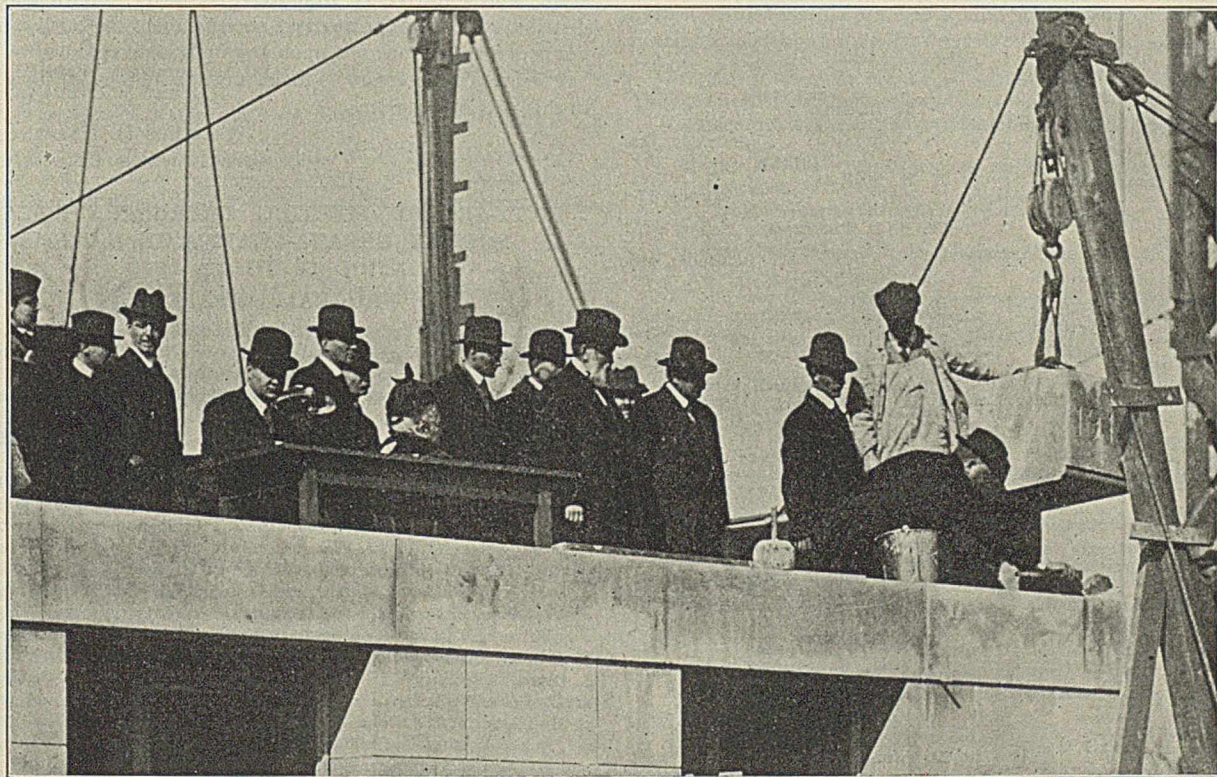
On March 23, 1916, the corner stone of the new chemistry building of the Bureau of Standards, at Washington, D. C., was laid by the Hon. William C. Redfield, Secretary of Commerce. The building is about 60 X 200 ft., constructed of brick and stone, and is to be four stories in height, in addition to attic and basement. It will provide adequate laboratory space for about 120 chemists, besides rooms for offices, supplies, etc. It will probably be ready for occupancy early in the spring of 1917.

In his opening remarks, Dr. S. W. Stratton, director of the Bureau of Standards, sketched the early history of the Bureau and the circumstances leading to the selection of the present site, and to the erection of the various buildings, of which the new chemistry building is the seventh. In discussing the work of the chemistry division, he said:

"It can safely be stated that the Bureau of Standards has led all other institutions of its kind in the association of chemis-

render her secrets. They are extracted from her by toil, and of the toilers who draw them forth it may be said with truth, 'to him that hath shall be given and he shall have abundance.' Such work is the triumph of the spirit of man and of the mind of man over material things. The progress that has been made seems slow when measured in its daily march, yet if we look back far enough to get a due perspective we can see that the road that has been traveled is long. It has not been an easy road. It has been conquered step by step. We have had to build the ladders by which we climbed and to mount to our present knowledge round by round. There has gone much of human patience, much of struggle, much of unselfishness, much of enthusiasm for truth for its own sake, into the winning of the way that has thus far been won. A great thinker has said, 'The Universe is plastic in the hands of man in proportion as he brings the power of the Creator to bear upon it.' The work which wins has always a spiritual value. Moral impotence does not achieve permanent successes. The seeker after truth must, in the main, himself be true, else are his conquests limited. * * * * *

"So the best of mind and heart and spirit are united here both as we look toward the past and forward into the future. Who knows what shall be when this building shall have wrought its perfect and finished work and made way in its turn to its successor? Thus much we can say of that time, that the things



LAYING THE CORNER STONE OF THE NEW CHEMISTRY BUILDING OF THE BUREAU OF STANDARDS, WASHINGTON

try with physics and engineering in the solution of problems arising in connection with standards and standardization. By this gathering together the chemical work of the Bureau in a single building equipped with apparatus and utilities peculiar to chemical work, the work of the chemical division will be greatly facilitated. It is hoped that this concentration of the chemical work will not prevent the segregation of its application to the various fields of the Bureau's activities—for the Bureau's success in all lines will ever depend upon the close coordination of chemistry, physics, and engineering."

In his address, the Secretary of Commerce, in speaking of the work of the Bureau of Standards, said:

"I have often thought of this service as one which pushes back more and more each day the shades of darkness which limit our present knowledge. Nature does not readily sur-

that then shall be will be based upon the work that is here to be wrought out. The foundations of our present knowledge were laid by the great investigators of the past. On them you are here to build that which in its turn shall sustain the structure of the future. Let us hope that the chemists of a future day shall find their work for mankind more effective and their efforts in that work more inspired by what is here to be done."

After the corner stone was laid by the Secretary of Commerce, Dr. W. F. Hillebrand, chief chemist of the Bureau, first referred to his early associations with government chemical work, in the Denver laboratory of the Geological Survey, and then said:

"What the dim future may have in store in the way of successors or additions to the structure we are now dedicating,

each one may try to picture for himself, but there is no doubt in my own mind that this future foreshadows credit for the Bureau and the chemical profession if we and our successors hold fast to the guiding principles that have been established already—seriousness of purpose, never-ending study, open-mindedness, largest willingness and intention to cooperate, accuracy in work, and entire honesty and fairness in presenting the results of that work."

He then read a list of the articles enclosed in the copper box, which had been hermetically sealed and deposited in the corner stone. This list included photographs of the personnel, with autographic signatures, various reports and publications showing the Bureau activities, especially of the chemistry division, a few standard analyzed samples, specimens of paper, written upon in ink (included to test their lasting qualities), and also a bottle of lime to absorb moisture.

In conclusion, Dr. Hillebrand paid tribute to the interest and cooperation of the Secretary of Commerce, the director of the Bureau, the building committee, the engineer of the Bureau, and the architects who designed the building.

ORGANIZATION FOR INDUSTRIAL PREPAREDNESS

To the Members of the American Chemical Society:

Complying with President Wilson's request of January 13, 1916, published in the February number of THIS JOURNAL, the following members of our Society have been appointed representatives on the State boards of the Organization for Industrial Preparedness:

B. B. ROSS	Alabama	Auburn, Ala.	W. L. HOWELL	Louisiana	Room 315, Custom House New Orleans, La.
W. P. LASS	Alaska	c/o Speel River Project Juneau, Alaska	R. H. MCKEE	Maine	Orono, Me.
F. N. GUILD	Arizona	Tucson, Arizona	W. B. D. PENNIMAN	Maryland	6 E. Franklin Street Baltimore, Md.
J. B. RATHER	Arkansas	Agric. Expt. Station Fayetteville, Ark.	A. D. LITTLE	Massachusetts	93 Broad Street Boston, Mass.
EDMUND O'NEILL	California	Univ. of California Berkeley, Cal.	H. T. GRABER	Michigan	697 Trumbull Avenue Detroit, Mich.
R. B. MOORE	Colorado	502 Foster Building Denver, Colo.	G. B. FRANKFORTER	Minnesota	Univ. of Minnesota Minneapolis, Minn.
E. W. MORLEY	Connecticut	West Hartford, Conn.	W. F. HAND	Mississippi	Agricultural College, Miss.
CHARLES L. REESE	Delaware	Box 424, Chester, Pa.	L. F. NICKELL	Missouri	Washington University St. Louis, Mo.
CHARLES L. PARSONS	District of Columbia	Box 505, Washington, D. C.	E. P. MATHEWSON	Montana	Anaconda, Mon.
E. R. FLINT	Florida	Gainesville, Fla.	C. F. CROWLEY	Nebraska	3315 Burt Street Omaha, Neb.
F. N. SMALLEY	Georgia	R. F. D. 2, Box 20 Savannah, Ga.	MAXWELL ADAMS	Nevada	University of Nevada Reno, Nev.
J. S. JONES	Idaho	Agric. Expt. Station Moscow, Idaho	H. K. MOORE	New Hampshire	Box 165, Berlin, N. H.
WILLIAM HOSKINS	Illinois	2009 W. Monroe Street Chicago, Ill.	H. S. MINER	New Jersey	Welsbach Light Company Gloucester City, N. J.
H. E. BARNARD	Indiana	State Laboratory of Hygiene Indianapolis, Ind.	J. D. CLARK	New Mexico	Univ. of New Mexico Albuquerque, N. M.
W. F. COOVER	Iowa	Iowa State College Ames, Iowa	T. B. WAGNER	New York	17 Battery Place New York, N. Y.
W. A. WHITAKER	Kansas	University of Kansas Lawrence, Kan.	F. P. VENABLE	North Carolina	Chapel Hill, N. C.
A. M. BRECKLER	Kentucky	1801 First Street Louisville, Ky.	E. F. LADD	North Dakota	Agricultural College Fargo, N. D.

J. R. WITHROW	Ohio	Ohio State University Columbus, Ohio	G. W. GRAY	Texas	The Texas Company Houston, Tex.
EDWIN DEBARR	Oklahoma	Norman, Okla.	W. C. EBAUGH	Utah	208 Douglas Street Salt Lake City, Utah
O. F. STAFFORD	Oregon	Eugene, Ore.	G. W. BURROWS	Vermont	299 S. Union Street Burlington, Vt.
R. F. BACON	Pennsylvania	Univ. of Pittsburgh Pittsburgh, Pa.	F. B. CARPENTER	Virginia	Virginia-Carolina Chem. Co. Richmond, Va.
J. E. BUCHER	Rhode Island	Brown University Providence, R. I.	H. K. BENSON	Washington	Univ. of Washington Seattle, Wash.
R. N. BRACKETT	South Carolina	Clemson College, S. C.	A. R. WHITEHILL	West Virginia	Box 394, Morgantown, W. Va.
W. J. SHARWOOD	South Dakota	Lead, S. D.	C. F. BURGESS	Wisconsin	625 Williamson Street Madison, Wis.
J. F. NORRIS	Tennessee	Vanderbilt University Nashville, Tenn.	R. B. MOUDY	Wyoming	Laramie, Wyoming

The work of this organization is about to begin. The details have been thoroughly prepared. It is extremely desirable that the work should be promptly completed. To accomplish this the earnest cooperation of each member of the Society with his state representative is absolutely necessary. With the work distributed among our nearly 8,000 members the burden should not prove unduly onerous upon any individual member.

I feel it is unnecessary to make any special plea for loyal effort in this patriotic service.

CHARLES H. HERTY

CHAPEL HILL, N. C.
March 25, 1916

Président American Chemical Society

FIFTY-SECOND MEETING AMERICAN CHEMICAL SOCIETY, URBANA-CHAMPAIGN, ILLINOIS APRIL 18 TO 21, 1916 PROGRAM OF PAPERS

GENERAL PROGRAM

Address of Welcome. EDMUND J. JAMES, President of University of Illinois.

Response. CHARLES HOLMES HERTY, President of American Chemical Society.

General Addresses: The Composition of Corn as Affected by Nineteen Generations of Seed Selection. L. H. SMITH.

The Manufacture of Chemical Apparatus in the United States. ARTHUR H. THOMAS. (See THIS JOURNAL, 8 (1916), 437.)

The War and the American Chemical Industry. RAYMOND F. BACON.

On the Influence Exerted by Electrolytes on the Equilibrium of Emulsions, Jellies, and Living Cells. G. H. A. CLOWES.

Some Effects of High Pressures. JOHN JOHNSTON.

University Convocation and Dedication Exercises. HON. EDWARD F. DUNNE, Governor of Illinois, presiding. Addresses: PRES. EDMUND J. JAMES, University of Illinois; PROF. ALEXANDER SMITH, Columbia University; DR. W. R. WHITNEY, General Electric Company, and member of the United States Naval Board.

Public Lectures: Production of Radium. CHARLES L. PARSONS.
Use of Radium in Treatment of Cancer. CURTIS F. BURNAM.

AGRICULTURAL AND FOOD CHEMISTRY DIVISION

L. M. TOLMAN, Chairman

GLEN F. MASON, Secretary

Chemist in Food Control

A. Manufacturing Standpoint:

1. Cattle Foods. CARL S. MINER.
2. Starch and Glucose. A. P. BRYANT.
3. Canning. W. D. BIGELOW.
4. Gelatine. J. R. POWELL.
5. Flour. HARRY SNYDER.
6. Salt Purification. W. W. SKINNER.
7. Flavoring Extracts. GEORGE LLOYD.
8. General. W. M. HOSKINS.

B. Distributing Standpoint:

9. General Foods. A. V. H. MORY.

C. Law Enforcement Standpoint:

10. City. LUCIUS P. BROWN.
11. State. DAVID KLEIN.
12. National. L. M. TOLMAN.

Food Investigations

13. Preventing the Staling of Bread by Cooling in a Predetermined Atmosphere. ARNOLD WAHL.
14. The Use of Picric Acid in Meat Sugar Solutions. W. B. SMITH.
15. Analysis of Maple Products. VIII. J. F. SNELL.
16. Chinese Preserved Eggs. PIDAN. CHI CHE WONG AND KATHERINE BLUNT.
17. A Study of American Beers to Show the Effects on Their Composition of Various Raw Materials Used in Their Production. L. M. TOLMAN AND J. G. RILEY.

Agricultural Chemistry

18. The Effects of Plant Foods upon the Amount and Quality of Substances Used for Foods, Particularly Fruit and Vegetables. H. A. HUSTON.
19. Does the Oxidation of Tetrathionate to Sulfate Affect the Accuracy of the Estimation of Thiosulfate by Means of Iodine? P. L. BLUMENTHAL AND S. D. AVERITT.
20. Separation and Estimation of Polysulfides and Thiosulfate in Lime-Sulfur Solutions. S. D. AVERITT.
21. Some Studies on Liquid Fertilizer. G. D. BEAL AND D. T. ENGLIS.
22. The Detection of Lime Used as a Neutralizer in Dairy Products. H. J. WICHMAN.

BIOLOGICAL CHEMISTRY DIVISION

C. L. ALSBERG, *Chairman*I. K. PHELPS, *Secretary*

1. On the Formation of Soap Jellies and the Process of Blood Coagulation. G. H. A. CLOWES.
2. The So-Called Caseinates. W. D. BANCROFT.
3. Action of Rennin on Caseine. W. D. BANCROFT.
4. On Electrolyte Antagonisms in Physical and Biological Systems. G. H. A. CLOWES.
5. On Anesthesia. G. H. A. CLOWES.
6. Further Observations on the Surface Tension of Saponin Solutions. C. L. ALSBERG AND H. E. WOODWARD.
7. Relative Sensitivity of Some Commercial Litmus Papers. A. VIEHOVER AND C. O. EWING.
8. The Aëration Method for Total Nitrogen Determinations. R. S. POTTER AND R. S. SNYDER.
9. Titrimetric Determination of Nitrite N. B. S. DAVISSON.
10. Determination of Ammonia by Aëration. B. S. DAVISSON.
11. Investigation of the Kjeldahl Method for Determining Nitrogen. A New Aëration Apparatus. I. K. PHELPS AND H. W. DAUDT.
12. Remarks on the Physical and Biological Chemistry of Fat. MARTIN H. FISCHER.
13. Mutarotation of Gelatine and Its Significance in Gelation. C. R. SMITH.
14. Studies upon the Effects of Acids on the Swelling of Certain Colloids. A. D. HIRSCHFELDER.
15. Brain Lipoids as a Haemostatic. A. D. HIRSCHFELDER.
16. The Pharmacological Action of Citrates. R. A. HALL AND R. E. MORRIS.
17. The Fate of Methylene Disalicylic Acid and Derivatives in the Body. R. A. HALL AND E. D. BROWN.
18. The Role of Cystine in the Maintenance of Nitrogenous Equilibrium in Dogs on a Low Protein Diet. H. B. LEWIS.
19. The Excretion of Uric Acid after Ingestion of Sodium Benzoate in Man. H. B. LEWIS AND W. G. KARR.
20. A Comparative Study of the Urea Content of the Blood and Tissues of Some Vertebrates. W. G. KARR AND H. B. LEWIS.
21. On the Esterification of Amino Acids. H. A. SHONLE AND H. H. MITCHELL.
22. Feeding Experiments on the Nutritive Value of Casein. E. M. K. GEHLING AND H. H. MITCHELL.
23. On the Determination of the Digestibility of the Constituents of a Mixed Diet. H. H. MITCHELL AND H. S. GRINDLEY.
24. The Hydrogen Electropotentials of Phthalate, Phosphate, and Borate Buffer Mixtures. W. M. CLARK AND H. A. LUBS.
25. Chemical Studies on the Decomposition of Red Oak by *Fomes applanatus* and of Red Spruce by *Trametes pini var. abietis*. E. J. PIPER, C. J. HUMPHREY AND S. F. ACREE.
26. Some Observations on the Bacterial Metabolism of Sulfur Compounds. F. W. TANNER.
27. A Colorimetric Method of Estimating Amyolytic Activity. V. C. MYERS.
28. The Colorimetric Determination of Glucose, Sucrose, Dextrin, and Starch in Food Stuffs. V. C. MYERS AND A. R. ROSE.
29. On the Citric Acid Production of *Aspergillus niger*. J. N. CURRIE.
30. The Equation of Fermentation of Glucose by *Bacillus coli communis*. O. KAMM.
31. The Liberation of Ammonia from Ammonium Salts by *B. coli communis*. R. BENGIS AND A. R. ROSE.
32. The Change in Urinary Constituents Following the Feeding of *B. coli communis*. A. KNUDSON AND A. R. ROSE.
33. A Study of the Ethereal Sulfates of the Urine in Certain Chronic Diseases. J. ROSENBLUM.

34. The Ammonia Content of Human Gastric Juice. J. ROSENBLUM AND JENA MILTAN.
35. Some Auxoamylases. E. W. ROCKWOOD.
36. A Chemical and Bacteriological Study of Some Non-Pathological Gastric Residuums. C. C. FOWLER, M. LEVINE AND S. B. MORE.
37. A Study of Eighty Samples of Gastric Residuums Obtained from Apparently Normal Women. C. C. FOWLER AND Z. ZENTMIRE.
38. The Preparation of a Synthetic Milk for Use in Infant Metabolism Studies. A. W. BOSWORTH.
39. Concerning the Utilization of Inosite in the Animal Organism. The Effect of Inosite upon the Metabolism of Man. R. J. ANDERSON AND A. W. BOSWORTH.
40. Concerning the Utilization of Inosite in the Animal Organism. In the Dog. R. J. ANDERSON.
41. The Analysis of Urine as a Part of the Physical Examination of the College Man. G. O. HIGLEY.
42. The Non-Protein Constituents of Foods and Feeding Stuffs. H. S. GRINDLEY AND H. C. ECKSTEIN.
43. Swine Feeding Experiments to Determine the Nutritive Value of the Amino Acids. J. C. ROSS.
44. Chemical Methods in Diagnosis. I. Renal Function. L. J. DESHA.
45. Contributions of the Chemist to the Science and Art of Medicine. L. J. DESHA.
46. The Reaction of the Pancreas and Other Organs. J. H. LONG AND F. FENGER.
47. The Chemical Aspect of Photosynthesis in Plants. H. A. SPOEHR.
48. The Growth of Isolated Plant Embryos. G. D. BUCKNER AND J. H. KASTLE.
49. Plant Immuno-Chemistry. R. W. THATCHER.
50. The Presence and Origin of Volatile Fatty Acids in Soils. E. H. WALTERS.
51. The Organic Phosphorus of Soil. R. S. POTTER AND T. H. BENTON.
52. The Changes in the Amino Acid Nitrogen and "Soluble Non-Protein Nitrogen" in Heated Soils. R. S. POTTER AND R. S. SNYDER.
53. Studies on the Distribution of Nitrogen in Egg Lecithin. M. L. FOSTER.
54. The Nitrogen Distribution in Certain Seeds. C. L. ALSBERG AND F. BREWSTER.
55. Oxalic Acid and Its Salts in Foods and Spices. A. VIEHOVER AND J. F. CLEVINGER.
56. On Some Proteins from the Jack Bean, *Canavalia ensiformis*. C. O. JOHNS AND D. B. JONES.
57. On an Alcohol-Soluble Protein from Kafir Corn, *Andropogon sorghum*. C. O. JOHNS AND D. B. JONES.
58. A Synthesis of Tetracarbonimid. D. E. WORRALL AND M. K. MCNAMARA.

Special Program for Home Economics

59. Diet in Its Relation to the Treatment of Diabetes. E. E. BUTTERFIELD.
60. A Study of Carbohydrates as Milk Modifiers. RUTH WHEELER.
61. The Occurrence of Creatin in the Urine of Children. LOUISE STANLEY.
62. The Relation of a Diet High in Calcium to the Calcium Content of the Tissues. AMY L. DANIELS.
63. Phospholipins, Lecithin, Cephalin, and Similar Substances. M. LOUISE FOSTER.
64. Digest of Data on Mineral Substances in the Diet. GRACE MACLEOD.
65. Title announced at the meeting. F. W. HOWE.
66. Title announced at the meeting. ALICE F. BLOOD.
67. Report of a Survey of the Food Conditions at Sing Sing Prison. EMILY B. SEAMAN.
68. The Relation of Biological Chemistry to Problems of the Community. EMILY B. SEAMAN.
69. A Bacteriological Study of Hamburger Steak. EDWIN LEFEVRE.
70. The Temperature of Potatoes while Cooking and a Method of Measuring Temperature during Cooking and Canning. R. D. MILNER.
71. Washing and Cleaning. W. D. BANCROFT.
72. Whipped Cream, Etc. W. D. BANCROFT.
73. Mayonnaise. W. D. BANCROFT.
74. Cleaning Silver by Contact with Aluminum in Alkaline Solution. H. L. LANG AND C. F. WALTON, JR.
75. Iron Rust and Its Removal—New Methods. H. L. LANG AND ANNA H. WHITTELSEY.
76. Solution of Antimony from Some Enamelled Cooking Utensils. ELIZABETH W. MILLER.

FERTILIZER CHEMISTRY DIVISION

- J. E. BRECKENRIDGE, *Chairman* F. B. CARPENTER, *Secretary*
- Plant Food Deficiencies of Coastal Plain and Piedmont Soils. C. B. WILLIAMS.
- Reports of Committees.

INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS DIVISION

H. E. HOWE, *Chairman*S. H. SALISBURY, JR., *Secretary*

1. The Determination of Ash in Coals with a High Percentage of Calcium Carbonate. S. W. PARR.
2. The Mechanical Sampling of Illinois Coal. S. W. PARR.
3. A New Form of Adiabatic Calorimeter. S. W. PARR.
4. Report on Last Year's Progress of the Industrial Fellowship System of the Mellon Institute. R. F. BACON.
5. An Investigation of Composition Flooring. R. F. BACON AND R. R. SHIVELY.
6. A Contribution to the Chemistry of Laundering. H. G. ELLEDGE.
7. On the Use of Certain Yeast Nutriments in Bread Making. H. A. KOHMAN.
8. On Hydrated Lime. J. F. MACKEY.
9. On the Prevention of Glass Pot Corrosion. S. R. SCHOLES.
10. On the Behavior of Manganese in Glass. S. R. SCHOLES AND E. W. TILLOTSON.
11. Further Experiments on the Volatilization of Platinum. G. K. BURGESS AND R. G. WALTENBERG.
12. History and Present Methods of Fluorspar Production in Illinois. CARL C. LUEDEKING.
13. Chemistry and Technology of Glass. ALEXANDER SILVERMAN.
14. New Volumetric Determination of Nickel and Cobalt. W. D. ENGLE AND R. G. GUSTAVSON.
15. Copper Deposition in Electrotyping Baths. (Preliminary Report.) W. BLUM, H. D. HOLLER, H. RAWDON AND E. L. LASIER.
16. Our Unnecessary Waste of Potash Compounds. JAMES R. WITHROW.
17. Experiments on the Corrosion of Iron and Steel. W. D. RICHARDSON.
18. Ethyl Alcohol from Wood Waste. IV. Yields from Various Species of Wood. F. W. KRESSMANN.
19. Notes on Tar from Some Mid-Western Cannel Coals. J. C. INGRAM.
20. Comments on the Krebitz Process of Soap Manufacture and Glycerol Recovery. G. S. WRISLEY.
21. An Unusual Explosion in Connection with Potassium Chlorate. F. E. ROWLAND.
22. Laboratory Control in the Manufacture of Corn Syrup. A. P. BRYANT.
23. Effect of Aging upon the Constants of Chinese Wood Oil. D. F. MCFARLAND AND H. R. LEE.
24. Effect of Fillers in Synthetic Molding Compounds. L. V. REDMAN, A. J. WEITH AND F. P. BROCK.
25. Printing Plates from Phenol Resins. L. V. REDMAN, A. J. WEITH AND F. P. BROCK.
26. The Effects of Moisture Introduced into the Digester in the Cooking of Soda Pulp. SIDNEY D. WELLS.

ORGANIC CHEMISTRY DIVISION

C. G. DERICK, *Chairman*H. L. FISHER, *Secretary*

1. The Synthesis of *p*-Cymene Monocarboxylic Acids and of Certain of Their Derivatives. M. T. BOGERT AND J. R. TUTTLE.
2. Benzoylene Urea and Some of Its Nitro Derivatives. M. T. BOGERT AND G. SCATCHARD.
3. A New Group of Azo Dyestuffs. M. T. BOGERT.
4. Methylene Disalicylic Acid and Derivatives. ROBERT A. HALL.
5. The Addition Compounds of Phenols with Organic Acids. JAMES KENDALL.
6. Derivatives of Isocamphoric Acid—An Unusual Formation of a Methyl Ether of a Hydroxy Acid. G. S. SKINNER AND W. A. NOYES.
7. Researches on Pyrimidine-Nucleotides. New Developments. TREAT B. JOHNSON.
8. The Action of Ferric Chloride and Other Ferric Compounds upon Cellulose. LOUIS KAHLBERG.
9. The Isomeric Lactones, Caryophyllin and Urson. FRANCIS D. DODGE.
10. Tautomeric Equilibrium Constants and Chemical Structure. A Measure of Valence in Terms of Energy. C. G. DERICK.
11. Preparation and Characterization of Trimethylene Oxide. D. W. BISSEL AND C. G. DERICK.
12. The Action of Metallic Oxides on Trimethylene Halides and of Heat upon $\text{ClCH}_2\text{CH}_2\text{CH}_2\text{-O-Mg-I}$. E. H. VOLLWEILER AND C. G. DERICK.
13. The Preparation and the Characterization of ϵ -Acetylcaproic Acid. ST. ELMO BRADY AND C. G. DERICK.
14. The Behavior of β -Phenoxy Ethyl Bromide in the Wurtz Synthesis. ST. ELMO BRADY.
15. The Preparation and Characterization of δ -Acetylvalerianic Acid. R. W. HESS AND C. G. DERICK.
16. A Study of the Isomeric Aminoethylbenzenes and Certain of Their Derivatives. O. S. KEENER, O. KAMM AND C. G. DERICK.

17. Syntheses in the Naphthalene Series. OLIVER KAMM AND H. B. McCLUGAGE.
18. A Study of the Equilibrium in the Friedel and Crafts Reaction. OLIVER KAMM AND S. D. KIRKPATRICK.
19. On the Reactions of the Formamidines. V. On Some Pyrazolone Derivatives. F. B. DAINS, H. R. O'BRIEN AND C. L. JOHNSON.
20. Contribution to our Knowledge of Dichlorether. Part II. G. B. FRANKFORTER AND S. J. REICHERT.
21. The Action of Aluminum Chloride on the Alcohols and Carbohydrates Alone and in the Presence of Other Organic Compounds. G. B. FRANKFORTER AND V. KOKATNUR.
22. A Catalytic Decomposition of Some Phenol Salts. W. H. HUNTER.
23. Some Work on the Reimer-Tiemann Reaction. W. H. HUNTER.
24. Notes on the Use of the Multiple Unit Electric Furnace and of a Modified Carbon Dioxide Generator in the Dumas Method for the Determination of Nitrogen. HARRY L. FISHER.
25. The Relations in Composition of Petroleum, Coal, and Natural Asphalts. C. F. MABERY.
26. The Occurrence of Esdragol in Rosin. CHARLES H. HERTY AND V. A. COULTER.
27. On the Phenolsulfonphthalein Dyes and the Quinonephenolate Theory of Indicators. E. C. WHITE, H. A. LUBS AND S. F. ACREE.
28. On the Use of Viscose as a Dialysis Membrane. H. A. LEWIS AND S. F. ACREE.
29. On the Tautomeric Reactions of the Silver and Mercury Salts of 1-Phenyl-4,5-dihydro-5-oxy-3-triazolyl Methyl Sulfone with Alkyl Halides. E. H. WIGHT AND S. F. ACREE.
30. On the Reactions of Both the Ions and Molecules of Acids, Bases, and Salts: The Inversion of Menthone by Sodium, Potassium and Lithium Ethylates. W. A. GRUSE AND S. F. ACREE.
31. The Galactan of *Larix occidentalis*. R. W. SCHORGER AND D. F. SMITH.
32. Further Evidence for the Electronic Formula of Benzene and the Substitution Rule. H. S. FRY.
33. Reactions in Non-Aqueous Solvents: Chromyl Chloride and Phosphorus Halides. H. S. FRY AND J. L. DONNELLY.
34. Electronic Tautomerism: The Existence of Electromers in Dynamic Equilibrium. H. S. FRY.
35. Partial Hydrogenation of Cottonseed Oil. BEN H. NICOLET.
36. The Reaction between Alcohols and Hydrochloric and Hydrobromic Acids. JAMES F. NORRIS.
37. The Nitro Phenyl Esters. H. I. JONES.
38. Esterification of Acids by Isomeric Mercaptans. J. W. KIMBALL AND E. EMMET REID.
39. Esterification of Isomeric Acids by Mercaptan. J. H. SACHS AND E. EMMET REID.
40. Catalytic Preparation of Nitriles. G. D. VAN EPPS AND E. EMMET REID.
41. The Preparation of Nitriles. G. D. VAN EPPS AND E. EMMET REID.
42. The Identification of Acids. E. EMMET REID.
43. Some Anomalies in the Solidification Points of Fats. B. H. NICOLET AND L. M. LIDDLE.
44. On the Nitration of Toluene. I. W. HUMPHREY.
45. The Hydrolysis of Chloropentanes as Affected by High Pressures: Synthetic Fusel Oil. H. ESSEX AND B. T. BROOKS.
46. The Effect of Sulfur on the Auto-Oxidation of Organic Compounds. B. T. BROOKS, I. W. HUMPHREY AND B. Y. LONG.
47. Two New Methods of Determining Acetylene in Gaseous Mixtures. G. O. CURME, JR.
48. Note on Lead Propionates. S. FRANK COX.
49. Crystalline β -Methyl Fructoside and Its Tetracetates. C. S. HUDSON AND D. H. BRAUNS.
50. A Fourth Crystalline Pentacetate of Galactose and Some Related Compounds. C. S. HUDSON AND J. M. JOHNSON.
51. The Isomeric Pentacetates of Glucosamine and of Chondrosamine. C. S. HUDSON AND J. K. DALE.
52. Indirect Measurements of the Rotatory Powers of Some of the Alpha and Beta Forms of the Sugars by Means of Solubility Measurements. C. S. HUDSON AND E. YANOVSKY.
53. Some Numerical Relations among the Rotatory Powers of the Compound Sugars. C. S. HUDSON.

PHARMACEUTICAL CHEMISTRY DIVISION

JOHN H. LONG, *Chairman*GEO. D. BEAL, *Secretary*

1. The New Features of the U. S. P. IX. JOSEPH P. REMINGTON.
2. The Toxicity of the Volatile Principles of Coffee, with Comments on Coffee Substitutes. L. E. SAYRE.
3. The Pancreatin Tests of the Pharmacopoeia. J. H. LONG.
4. Rennett: A Note and a Correction. HOWARD T. GRABER.
5. Pepsin: A Résumé of Tests. HOWARD T. GRABER.
6. Relative Toxicity of Different Species of Digitalis. ROBERT A. HALL, E. L. NEWCOMB AND R. E. MORRIS.

13. Activated Sludge Experiments at the Baltimore Sewage Disposal Plant. CALVIN W. HENDRICK.
7. On the Apparent and Real Ash Content of Digitalis. NORBERT MUELLER AND EDWARD KREMERS.
8. Alkaloidal Assay by Immiscible Solvents. H. F. LEWIS AND G. D. BEAL.
9. The Preparation and Characteristics of Emetine. FRANK O. TAYLOR.
10. Some Unexpected Reactions in Pharmaceutical Mixtures. FRANK O. TAYLOR.
11. The Strength of Fluid Extracts. H. A. LANGENHAN AND EDWARD KREMERS.
12. On Tincture of Peppermint for Coloring Purposes. NORBERT MUELLER AND EDWARD KREMERS.
13. Further Notes on the Identification of the Emodin-Containing Drugs. RUTH E. OKEY AND G. D. BEAL.
14. Determination of Small Amounts of Water and Alcohol in Ether for Anaesthesia. E. MALLINCKRODT, JR.
15. The Detection of Minute Quantities of Unsaturated Hydrocarbons in Liquid Petrolatum. C. H. BRIGGS AND W. L. IRWIN.

PHYSICAL AND INORGANIC CHEMISTRY DIVISION

IRVING LANGMUIR, *Chairman*

JAMES KENDALL, *Secretary*

1. The Chromic-Chromous Potential at Mercury Electrodes. GEORGE SHANNON FORBES AND H. N. RICHTER.
2. Heterogeneous Equilibria between Aqueous and Metallic Solutions: A Study of Mixed Sodium and Potassium Salt Solutions at Total Concentrations Varying from 0.2 N to 4.0 N. G. MCPHAIL SMITH AND T. R. BALL.
3. The Contamination of Precipitates in Gravimetric Analysis: Solid Solution and Adsorption vs. Higher-Order Compounds. G. MCPHAIL SMITH.
4. An Electrically Controlled Calorimeter for Measuring Heats of Dilution. D. A. MACINNES AND J. M. BRAHAM.
5. On the Evolution of the Elements According to the Hydrogen-Helium System. W. D. HARKINS.
6. Theoretical Relations of the Atomic Weights. W. D. HARKINS.
7. A New Gravimetric Method for the Separation of Aluminum from Zinc, Manganese, Nickel, Cobalt, Iron, and Chromium. LOUIS KAHLENBERG AND K. P. YOUNG.
8. The Electromotive Forces of Concentration Cells and Their Relation to the Transference Number. D. A. MACINNES.
9. The Complete Solubility Curve of Calcium Carbonate. JOHN JOHNSTON.
10. The Specific Conductivity of Pure Water in Equilibrium with Atmospheric Carbon Dioxide. JAMES KENDALL.
11. An Apparatus for Determining Freezing Point Lowering. R. G. VAN NAME AND W. G. BROWN.
12. The Colloidal Phosphates and Arsenates of Iron. HARRY N. HOLMES.
13. The Formation of Crystals in Gels. HARRY N. HOLMES.
14. The Potential of Iodine Concentration Cells. GRINNELL JONES.
15. A Supposed Effect of the Form of Container upon the Density of a Gas. WILLIAM A. NOYES AND LAURENCE C. JOHNSON.
16. A Demonstration of the Selective "Action" of Clay on Soluble Sulfides. JOHN C. INGRAM.
17. The Theory and Mechanism of Adsorption. IRVING LANGMUIR.
18. The Oxides of Iron. II. Magnetic Properties of the System $Fe_2O_3-Fe_3O_4$. R. B. SOSMAN AND J. C. HOSTETTER.
19. The Dissociation of Ferric Oxide in Air. J. C. HOSTETTER AND R. B. SOSMAN.
20. On the Measurement of the True and Apparent Electrical Conductivities of Solutions: Inductance, Capacity, Frequency, and Resistance Relations. H. P. HASTINGS, W. A. TAYLOR AND S. F. ACREE.
21. Separation of the Elements of the Tin Group. J. M. WELCH AND H. C. P. WEBER.
22. Differential Iodimetry. III. Determination of Vanadium in the Presence of Iron and Uranium. O. L. BARNEBEY.
23. Differential Iodimetry. II. Determination of Chromium in the Presence of Iron. O. L. BARNEBEY.
24. Precipitation of Magnesium Ammonium Orthophosphate. EDWARD G. MAHIN.
25. Some Laboratory Experiments on the Extraction of Radium from Carnotite Ores. A. G. LOOMIS AND HERMAN SCHLUNDT.
26. A System for Reports on Quantitative Analysis to be Used in Teaching. E. GILL.
27. The Action of Anhydrous Aluminum Chloride upon Unsaturated Hydrocarbons. W. E. HENDERSON AND W. C. GANGLOFF.
28. The Determination of Solubility Curves by the Method of Flotation. W. E. HENDERSON AND GEBHART STEGEMAN.
29. Determination of Transition Points by the Measurement of Electromotive Force. W. E. HENDERSON AND I. W. GEIGER.
30. A Systematic Procedure for the Separation of the Anions. First Group. H. A. WINCKELMANN AND H. C. P. WEBER.
31. On Some Molecular Compounds in Glass. E. W. TILLOTSON.

32. On the Variable Rotatory Power of Dissolved Organic Substances. M. A. ROSANOFF AND H. A. MORTON.
33. On the Constant a of Van der Waals' Equation. M. A. ROSANOFF AND H. C. CORLISS.
34. On the Change of Transition Points with Pressure. M. A. ROSANOFF.
35. A Rational Process of Fractional Distillation. M. A. ROSANOFF.
36. A Study of Some of the Physical Properties of Mixtures of Dielectric Oils and Water. (Preliminary Report.) L. I. SHAW AND L. A. PAPPENHAGEN.
37. Change of Conductivity with Time in the System MeOH + I. (Preliminary Report.) L. I. SHAW AND J. P. TRICKEY.
38. Atomic Weight of Yttrium. C. W. BALKE AND B. S. HOPKINS.
39. The Potassium Iodide Reaction for Platinum. W. J. PRINCE AND H. C. P. WEBER.
40. The Viscosity of Alcoholic Solutions. O. F. TOWER.
41. The Relation between Molecular Cohesion and Surface Tension. Eötvös Law. ALBERT P. MATHEWS.
42. Determination of Aluminum as Oxide. WILLIAM BLUM.
43. A Study of Tantalum Pentachloride for Atomic Weight Purposes. G. W. SEARS AND C. W. BALKE.
44. A Study of the Dialysis of a Colloidal Solution of Hydrated Chromic Oxide in Chromium Chloride. MARKS NEIDLE AND J. BARAB.
45. The Temperature Effect in Dialysis, and a Simple Rapid Dialyser. MARKS NEIDLE.
46. Production of Triatomic Hydrogen by Radium Rays. G. L. WENDT.
47. The Effect of Dissolved Substances on the Velocity of Crystallization of Water. J. H. WALTON AND A. BRAUN.
48. The Atomic Weight of Dysprosium. EDGAR W. ENGLE AND C. W. BALKE.
49. Potassium Lead Tartrate. R. S. DEAN.
50. Density of Aqueous Copper Sulfate-Sulfuric Acid Solutions. H. D. HOLLER AND E. L. PEPPER.
51. An Electrical Insulating Material for Use in Moist Atmospheres. EDWARD W. WASHBURN.
52. Types of Wheatstone Bridges for Alternating Current Work. EDWARD W. WASHBURN.
53. Induced Reactions in the Analytical Chemistry of Lead. V. H. GOTTSCHALK.
54. An Attempt to Combine Nitrogen and Chlorine Directly. B. R. HONOVSKI, L. C. JOHNSON, F. O. ANDEREGG AND W. A. NOYES.
55. The Nernst Luteation Constant in Gaseous Systems. N. HOWELL FURMAN.
56. The Reactivity of Acids. HUGH S. TAYLOR.
57. The Specific Heat and the Specific Molecular Energy of Chemical Elements and Compounds. FRED P. SIEBEL.
58. Vapor Pressures of Ethyl Alcohol and Alcohol Water Mixtures at 25° and Composition of Vapors in Equilibrium with the Mixtures. I. H. DERBY AND F. DANIELS.
59. Complete Dissociation in Concentrated Solutions of Sodium Chloride and Potassium Chloride. I. H. DERBY, D. MAYARD AND E. T. FEGON.
60. The Dissociation Pressures of Various Salt Hydrates and the Vapor Pressures of Their Saturated Solutions. I. H. DERBY AND V. YNGVE.
61. The Swelling of Rubber in Various Liquids and the Nature of the Process. I. H. DERBY, P. D. SCHULTZ AND O. D. CUNNINGHAM.
62. A Study of 0.1 Normal HCl Calomel Electrodes. N. E. LOOMIS.

WATER, SEWAGE AND SANITATION DIVISION

EDWARD BARTOW, *Chairman*

H. P. CORSON, *Secretary*

1. Sanitary Surveys as a Feature of Public Health Work. H. E. BARNARD.
 2. Sanitary Survey Methods. J. C. DIGGS.
 3. A Sanitary Survey of Logansport, Ind. J. C. DIGGS.
 4. Swimming Pool Sanitation. W. LEE LEWIS.
 5. The Rate of Ammonia Distillation in Water. F. W. BRUCKMILLER.
 6. A Modification of the Whipple Method for Direct Nesslerization. F. W. BRUCKMILLER.
 7. The Determination of Carbonic Acid, Combined and Free, in Water. JOHN JOHNSTON.
 8. The Numerical Treatment of *B. coli* Values in Water Analysis. EARLE B. PHELPS AND WILLIAM F. WELLS.
- Symposium on the Activated Sludge Method of Sewage Purification:
9. The Development at Lawrence, Mass., of the Method of Sewage Purification by Aëration and Growth—Activated Sludge. H. W. CLARK.
 10. Composition of the Effluent Air from an Activated Sludge Tank. F. N. CRAWFORD AND EDWARD BARTOW.
 11. Experiments with Activated Sludge at Milwaukee, Wis. W. D. COPELAND.
 12. The Aëration of Sewage in the Presence of Activated Sludge from the Standpoint of an Engineer. E. J. FORT.

14. Chemical Observations of the Activated Sludge Process as Applied to Stock Yards Sewage. ARTHUR LEDERER.
15. The Activated Sludge Process. W. D. RICHARDSON.
16. The Sewage Experiment Station of the Illinois State Water Survey. J. F. SCHNELLBACH AND EDWARD BARTOW.
17. The Experiments with Activated Sludge at Brockton, Mass. ROBERT SPURR WESTON.
18. Some Results on the Treatment of Packing House Sewage by the Aeration Process in the Presence of Activated Sludge. PAUL RUDNICK AND G. L. NOBLE.
19. The Saving Effected by Using a Softened Water in Boilers. G. S. COTTER.
20. The Treatment of Industrial Wastes. HARRISON P. EDDY.
21. Some Studies on Chemical Self-Purification in the Ohio River. EARLE B. PHELPS AND HAROLD W. STREETER.
22. Oxygen Demand Determination in the Field. F. W. BRUCKMILLER.
23. The Determination of Nitrates in Sewages by the Ortho-Toluidine Reagent. EARLE B. PHELPS AND H. L. SHOUB.
24. Studies on the Removal of Manganese from Water Supplies. H. P. CORSON AND EDWARD BARTOW.
25. The Value of Softened Water to a Railroad. R. C. BARDWELL.
26. Softened Water and Its Benefits in Laundry Work. JOHN H. RYAN.
27. Some Features of Swimming Tank Control. W. LEE LEWIS.
28. Final Report of the Committee on Standard Methods of Analysis

AMERICAN ELECTROCHEMICAL SOCIETY, TWENTY-NINTH GENERAL MEETING, WASHINGTON
APRIL 27 TO 29, 1916

The Twenty-Ninth General Meeting of the American Electrochemical Society was held at Washington, D. C., April 27 to 29, 1916, with headquarters at the New Willard Hotel. All of the sessions were held at the New Willard Hotel except the Saturday (29th) morning session, at the Bureau of Standards, Assembly Hall of the Electrical Building. The annual business meeting of the Society was held at the Thursday (27th) morning session.

PROGRAM OF PAPERS

- Presidential Address. LAWRENCE ADDICKS.
Symposium on Coöperation in Industrial Research: The Professional Society. LAWRENCE ADDICKS, F. A. LIDBURY.
The University. W. D. BANCROFT, W. H. WALKER.
The Government. D. A. LYON.
The Corporation. L. H. BAEKELAND, W. R. WHITNEY.
The Detectors in Wireless Telegraphy. W. D. BANCROFT.
Hydrogen for Military Purposes. E. D. ARDERY.
Liquid Chlorine. G. ORNSTEIN.
Magnesium. W. M. GROSVENOR.
Symposium on Niagara Falls Power and the American Industries:
The Power Development. I. R. EDMANDS.
Electric Furnace Products. F. J. TONE.
The Chemical Industries. A. H. HOOKER.
The Nitrogen Question. W. S. LANDIS.
Reclamation Service Water Power. A. P. DAVIS.
The Brittleness of Annealed Copper. W. E. RUDER.
Cobalt as an Element for Thermocouples. O. L. KOWALKE.
Electrical Resistance of Copper-Nickel Alloys. F. M. SEBAST AND G. L. GRAY.
Faults in the Small Electric Arc Furnace. W. M. MCKNIGHT.
The Rennerfelt Electric Arc Furnace. C. H. VOM BAUR.
Water Power Development for Electrochemical Purposes. J. H. PIERCE.
The Passive State of Metals. C. W. BENNETT AND W. S. BURNHAM.
Overvoltage. C. W. BENNETT.
Overvoltage and Monatomic Hydrogen. W. D. BANCROFT.
Depolarization by Electrical Waves. W. D. BANCROFT.
Electrode Surface Phenomena. W. C. ARSEM.
Contact Resistance of Metal Electrodes. N. K. CHANEY.
Contact Potentials and Electrochemical Potentials. I. LANGMUIR.
Polarization in LeClanché Cells. D. A. MACINNES.
Electrolytic Formation of Perchlorate. C. W. BENNETT AND E. L. MACK.
Unstable States in Arc and Glow. W. G. CADY.
Electric Arcs in Vapors and Gases at Low Pressures. W. A. DARRAH.
The Moore Tube for Color Matching. W. MCF. MOORE.
Corrosion and the Engineer. W. H. WALKER.
Effect of Rust upon the Progress of Rust. J. ASTON.
Influence of Frequency of Current on Electrolytic Corrosion. B. MCCOLLUM AND G. H. AHLBORN.
Some Unsolved Problems of the Electroplater. G. B. HOGABOOM.

- Nickel Plating. F. C. MATHERS, E. H. STUART AND E. G. STURDEVANT.
Rapid Nickel Plating. O. P. WATTS.
Tests of Tin Plating Baths. F. C. MATHERS AND B. W. COCKRUM.
Peptone as an Addition Agent in Stannous Ammonium Oxalate Baths. F. C. MATHERS AND B. W. COCKRUM.
Addition Agents in Electrodepositing Silver from Silver Nitrate Solutions. F. C. MATHERS AND J. R. KNEBLER.
Electrolytic Zinc. W. R. INGALLS.
Recent Progress in Electrolytic Iron. O. W. STOREY.

The American Institute of Electrical Engineers held a meeting on Wednesday, April 26th, at the New Willard Hotel, to which the members of the American Electrochemical Society were invited. The program was as follows:

- Address. PRESIDENT JOHN J. CARTY.
Electrochemical Industries and Their Interest in the Development of Water Power. LAWRENCE ADDICKS.
Water Power Development and the Food Problem. H. S. CUSHMAN.
Relation of Water Power to Increased Transportation. L. B. STILLWELL.
The Relation of Water Power to the National Defense. W. R. WHITNEY.
The Water Power Situation, Including Its Financial Aspect. GANO DUNN.

Reciprocally, the members of the American Institute of Electrical Engineers were invited to the sessions of the American Electrochemical Society, those on Thursday having been arranged to be of particular interest to electrical engineers.

STANDARD METHODS OF SAMPLING AND ANALYSIS
AND STANDARD SAMPLES

By W. F. HILLEBRAND
Received April 13, 1916

The writer presented to the Second Pan-American Scientific Congress a paper bearing the above title, the ultimate publication of which is uncertain. The greater part of the paper discussed the subject in its relations to the countries participating in the Congress, in the light of certain resolutions which the Congress had received as a legacy from its immediate predecessor. Certain portions of this might be of somewhat general interest, but cannot well be divorced from their context. The latter part of the paper, however, may have sufficient interest to chemists of the United States to warrant immediate and separate publication, and is herewith presented in its original form, except as to a few minor changes necessitated by the present form of publication.

PRINCIPLES ON WHICH STANDARD METHODS AND SAMPLES
SHOULD BE BASED

The fundamental principles that should guide in establishing standard methods and standard samples, principles that have been oftentimes in the past too little considered in spite of the warnings of various writers, may be stated as follows:

CRITERIA FOR STANDARD METHODS

What are the criteria by which a standard method for commercial use should be judged? The chief of these appear to be:

- 1—That its limits of accuracy and applicability are clearly defined and understood.
- 2—That it should yield sufficiently accurate and concordant results in the hands of different analysts.
- 3—That it should not demand such close adherence to detail or such manipulative skill and judgment, or such time consumption as to affect seriously its usefulness.
- 4—That it should have been tested upon material of high purity or upon material carefully analyzed by independent and reliable methods.
- 5—That the results obtainable upon a given class of materials should not be too dependent upon the composition (steel, iron). Based upon these and perhaps other criteria it is probable that

many methods used as standard fail to measure up to our ideal requirement.

CRITERIA FOR STANDARD SAMPLES

In fixing the criteria by which to judge the fitness of standard samples we have to distinguish between those (A) which serve merely as a check upon analytical procedure and those (B) which find use as primary standards in volumetric and polarimetric analysis or in calorimetry. Samples of the first class are usually more or less complex mixtures of chemical (mineral) individuals, while those of the second are single chemical individuals of the highest attainable purity.

CLASS A: 1—The material must be similar in all essential characteristics (physical and chemical) to the commercial materials that are to be tested in comparison with it.

2—The sample should be so homogeneous in all its parts that the variations are negligible for the purposes in view.

3—Its composition should have been determined by independent and reliable methods affording agreeing results.

4—It must be so stable under all ordinary conditions that no detectable change of composition will occur during the anticipated life of the sample.

This last proviso excludes at once substances that are prone to oxidation (most, if not all, sulfide ores and all coals) and those whose moisture content varies with that of the atmosphere (coals and many ores, etc.).

CLASS B: 1—There must be reasonable ease of preparation and accurate reproducibility.

2—The purity must be determinable with sufficient accuracy and the purified material must be stable indefinitely under ordinary conditions of the laboratory.

3—The use of the material in regular work must demand neither complex apparatus nor difficult manipulation.

4—Such precision must be attainable when it is used with ordinary care, that one or at the most few determinations suffice for the fixing of the value of a standard solution or to calibrate an instrument.

5—The accuracy obtained under ordinary conditions of its use in standardization must be at least as great as that required in the use of the solution or instrument to be standardized.

Going still further back we must presuppose for the attainment of results of high accuracy, both in the study of primary methods and in the application of these to standard samples, that the ultimate standards upon which they are based are of an accuracy commensurate with the needs of the case. Thus, there should be used only reagents of the highest quality, instruments of accuracy calibrated on the same basis, the same units of measurement, and, last but not least, the question of atomic weights should not have been overlooked.

In explanation of the expression "the same units of measurement" only one example need be mentioned. We have the Mohr liter and the true liter. Manifestly these cannot be used interchangeably. Then the temperatures of standard solutions must be approximately alike if comparable results are to be expected. With this last condition is closely connected the temperature at which the measuring vessels have been calibrated. Wide difference may result from the use of some with reference mark 15° and others with 25°; hence the need for uniform calibration.

The question of atomic weights is of peculiar interest and has been urged by others in times past. It is also perhaps the one most often overlooked. For some gravimetric work it is of no significance whether or not the atomic weights are accurately known or the latest accepted ones are used, as for instance, when the amount of aluminum oxide in a material is sought and it is eventually to be weighed as such. The case is differ-

ent when an elementary substance sought is weighed as part of a complex molecule or when the determination of an element or compound is based on volumetric analysis, the primary standard for which is not the same element. Neglect to take this consideration into account may make a large difference in the valuation of cargo lots of materials based on volumetric analysis, as when different atomic weights are used by cooperating analysts.

Fortunately we have as to atomic weights a body of recognized authority in the International Committee on Atomic Weights, whose annual revisions are known to all chemists.¹

Finally, it should be borne in mind that to some of the atomic weights uncertainties attach which are larger than the differences or errors of some methods of analysis. It is, therefore, a waste of effort to try to refine a commercial method so far that its probable error falls below that of the atomic weights that are involved.

MATERIALS COVERED BY METHODS OF LEGAL OR OTHER AUTHORITY STANDING IN THE UNITED STATES

The use of methods that have been proposed as standard is very seldom binding upon anyone, not even upon members of societies which may have adopted them formally. To certain of them, however, there has been given legal standing, recognized in courts of law, either through act of some federal, state, or municipal body, or of departmental officers whose action may be regarded as having the force of law. It is proper, therefore, in a list of so-called standard methods, to discriminate between those which have been legalized in the above sense and are mandatory under certain circumstances and those which have no mandatory or legalized character, although they may have been recommended formally by some competent body. There may be considered, further, a class of methods whose use is compulsory in the laboratories of certain large industrial concerns or which are put forth by others as the methods by which the composition or quality of goods contracted for shall be determined. In cases like the last, the method of test may form part of the specification for the article or material in question. It has been difficult to decide for some methods in which of the above categories they should be placed, or even if they should find place at all. The list which follows includes no methods that were published merely as reports of progress. It is, however, probably not exhaustive and may not be free from error in some of its details, but it is believed that it embodies no flagrant omissions or imperfections. The author will esteem it a favor if those who may be aware of omissions or other imperfections will bring them to his attention.

A word of warning may not be amiss as to the real standing that should be accorded a given method in this or any other list that may yet be prepared. Some organizations put forth no method that has not been either critically studied experimentally or else formulated by experts on the basis of special knowledge and information. Others throw no such safeguard about the method they recommend, but copy from other bodies or adopt methods that may be in more or less common use but have never been critically tested. Methods of the last type are necessarily less to be trusted than the others. Again, unfortunately, instances are not lacking where methods have been formulated by committees not well qualified for the task. Against such as these the average user is without protection.

I—METHODS RECOGNIZED BY COURTS OF LAW IN THE UNITED STATES

I—METHODS OF THE UNITED STATES PHARMACOPOEIA COVERING THE TESTING OF DRUGS AND MEDICINES, as given in the Eighth Decennial Revision. The Ninth Revision is in press

¹ It will perhaps be known to most readers that the 8th International Congress of Applied Chemistry recommended that for commercial transactions the atomic weights put forth by the above committee should remain in force from one Congress to the next and should not change from year to year.

¹ S. McBride, *J. Am. Chem. Soc.*, **34** (1912), 394; Bureau of Standards, *Circ.* **40** (1912), 4.

and should appear within the next few months. The specifications and methods of the Pharmacopoeia are compulsory in the enforcement of the Federal Food and Drugs Act of 1906, in so far as they are applicable, and of laws of many states regulating drugs and medicines.

2—METHODS OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS, as published in *Bull. 107* (revised), 1908, of the Bureau of Chemistry, Department of Agriculture, and about to appear freshly revised in the February, 1916, and subsequent numbers of the *Quarterly Journal of Official Agricultural Chemists*, Carl L. Alsberg, *Secretary*, Washington, D. C.

The use of these methods, in so far as they apply, is compulsory in the enforcement of the Federal Food and Drugs Act of 1906, and of the Insecticide Act of 1910. Some of the methods are provisional only, not having been subjected as yet to sufficient trial to justify final adoption, but they are none the less recognized by the Federal Courts. They are also recognized by the legislatures of some states and by some public organizations, and are followed rather generally wherever applicable. The materials for which methods are provided in the forthcoming publication are:

Baking Powder	Organic and Inorganic Phosphorus in Foods, Feeding Stuffs, and Drugs
Beer	
Cereal Products	
Cocoa and Cocoa Products	Phosphoric Acid
Coffee	Potash
Coloring Matter	Saccharine Products
Condiments other than Spices	Soils
Dairy Products (Adulteration)	Spices
Dairy Products (General)	Sugars (see also I-4-a, below)
Fats and Oils (Edible)	Tanning Materials
Feed Adulteration	Tea
Flavoring Extracts	Testing Chemical Reagents
Foods, Feeding Stuffs, and Drugs	Vegetables (Canned)
Foods (General)	Vinegars
Fruits and Fruit Products	Water in Foods and Feeding Stuffs
Heavy Metals in Foods	Water (Potable, mineral, industrial, irrigation, from the chemical point of view. See also II-4, p. 469)
Inorganic Plant Constituents	Wine
Insecticides	
Liquors (Distilled)	
Meat and Fish	
Medicinal Plants and Drugs	
Nitrogen: Separation of Nitrogenous Substances: Milk and Cheese, Meat Proteins	

3—UNITED STATES GOVERNMENT SPECIFICATIONS FOR PORTLAND CEMENT—Established by order of the President of the United States, April 30, 1912, and published in *Circ. 33* of the Bureau of Standards. The specifications and methods of testing are obligatory upon all branches of the Federal Government in testing Portland cement intended for government use, and they are subject to modification from time to time as necessity arises.

4—METHODS OF THE UNITED STATES TREASURY DEPARTMENT

(a)—*Sugar and Molasses*: Treasury Department Document No. 2470 (1907), Division of Customs. Regulations governing weighing, taring, sampling, classification, and polarization of imported sugars and molasses.

There is an International Commission for Uniform Methods of Sugar Analysis whose methods are followed by the European countries represented on the commission. In the United States their use is wholly optional, notwithstanding that this country has representatives upon the commission from governmental as well as industrial ranks. A summary of the methods of the International Commission is given in Wiechmann's "Sugar Analysis," J. Wiley & Sons, New York, 1914.

(b)—*Denatured Alcohol*: Regulation No. 30—Revised (Appendix), Bureau of Internal Revenue.

(c)—*Alcohol*: In Revised Statutes 3249 the legal specific gravity of proof spirits is defined as 0.7939 at 60° F. This statute practically compels the chemists of the Bureau of Internal Revenue to use this specific gravity in all their work on alcohol. In Treasury Document No. 34543, the use is authorized of the alcoholometric table No. 7, as given in the Gaugers' Manual of 1913. There are slight variations from earlier editions of the table.

(d)—*Sampling of Ores and Crude Metals*: Treasury Depart-

ment Document No. 35216 prescribes regulations under Subsection 1 of Paragraph N of Section 4, Tariff Act of October 3, 1913. As to assay of the materials covered by the regulations, it is directed merely that this shall be by "the wet assay, without deduction." The procedure for determining moisture in imported ores is briefly outlined. Treasury Document No. 35219 extends the use of the "wet assay" to lead-bearing ores.

(e)—*Tea*: Treasury Documents Nos. 34256 and 34411 give the latest directions for the testing of tea by the Read method.

(f)—*Number of Yarn in Cotton Cloth*: Treasury Document No. 34255. An addition of 8.5 per cent is to be made to the bone-dry weight in ascertaining the number of yarn in cotton cloth, instead of 7 per cent as formerly.

II—METHODS NOT HAVING LEGAL RECOGNITION BUT APPROVED BY SCIENTIFIC OR TECHNICAL ORGANIZATIONS

1—METHODS RECOMMENDED BY THE AMERICAN CHEMICAL SOCIETY, Charles L. Parsons, *Secretary*, P. O. Box 505, Washington, D. C.

(a)—*Glycerine*: THIS JOURNAL, 3 (1911), 679. Methods for glycerine were formulated by a committee of the American Chemical Society acting in coöperation with British, German, and French committees or representatives. In the United States the methods are not generally employed, there being no organization of soap manufacturers or glycerine distillers, but in England, where there is a powerful organization, the acetin method recommended by the committee is followed in all commercial transactions. The writer is unable to say what is the practice in Germany and France.

(b)—*Resin in Shellac*: *J. Am. Chem. Soc.*, 29 (1907), 1221.

(c)—*Copper (Battery Assay)*: THIS JOURNAL, 7 (1915), 546.

(d)—*Spelter (Zinc)*: *Ibid.*, 7 (1915), 547.

2—METHODS RECOMMENDED BY THE AMERICAN SOCIETY FOR TESTING MATERIALS, Edgar Marburg, *Secretary*, University of Pennsylvania, Philadelphia, Pa. Year Book, 1915.

(a)—*Methods Adopted as Standard*: Plain Carbon Steel (p. 201); Alloy Steels (p. 225); Spelter (p. 345); Cement (p. 375) (previously approved by the American Society of Civil Engineers and the American Railway Engineering Association); Raw Linseed Oil from North American Seed (p. 417); Boiled Linseed Oil from North American Seed (p. 420); Raw Chinese Wood Oil (p. 423); Turpentine (p. 428); Soluble Bitumen (p. 444); Penetration of Bitumen (p. 446); Oil and Asphaltic Compounds (Loss on Heating) (p. 447); Cotton Rubber-Lined Hose (Analysis of Rubber Lining) (p. 449).

(b)—*Methods Adopted as Tentative*: Pig and Cast Iron (p. 519); Paint Thinners other than Turpentine (p. 567); Bleached Shellac (Moisture) (p. 571); White Pigments (p. 579); Coal (p. 591—Large Scale Sampling) (p. 596—Laboratory Sampling and Analysis); Creosote Oil (p. 625).

The method for laboratory sampling and analysis of coal was formulated jointly by committees of the American Society for Testing Materials and the American Chemical Society, revising the methods originally put forth by the latter.

The tentative methods for Pig and Cast Iron are intended to replace the methods heretofore in common use by foundrymen¹ and were in fact originally intended to serve as basis for discussion of methods for international use, representatives of Great Britain, Germany, and the United States participating under the auspices of the International Association for Testing Materials.

The method for cement is essentially that proposed originally by a committee (on Uniformity in the Analysis of Methods for the Portland Cement Industry) established by the New York Section of the Society of Chemical Industry, the procedure having been first published in the *Journal of the Society of Chemical Industry*, 21 (1902), 12, and a year later in the *Engineering News and Engineering Record*.

¹ *Trans. Am. Foundrymen's Association*, 16 (1907), 44.

The method for cement under I-3 (p. 468) is also based upon the same original procedure, but has undergone more modification than that approved by the American Society for Testing Materials.

3—METHODS RECOMMENDED BY THE AMERICAN FOUNDRY-MEN'S ASSOCIATION, Richard Moldenke, *Secretary*, Watchung, N. J.

Coke: Trans. Am. Foundrymen's Association, 20 (1911), 559. These methods are under revision by the above Association, coöperating with the American Society for Testing Materials.

4—METHODS RECOMMENDED BY THE AMERICAN PUBLIC HEALTH ASSOCIATION. Office 289 Fourth Avenue, New York City.

Water (from the sanitary point of view): "Standard Methods for the Examination of Water and Sewage," 1912, 2nd Edition. To appear in revised form in 1916. The methods cover physical, chemical, microscopical, and bacteriological examination. The methods for the third edition have been compiled and revised in coöperation with a committee of the American Chemical Society and representatives of the Association of Official Agricultural Chemists (see I-2, *ante*, for the reference to the publication by the latter organization). It is expected that they will also be approved by the American Chemical Society.

5—METHODS RECOMMENDED BY THE AMERICAN LEATHER CHEMISTS' ASSOCIATION, H. C. Reed, *Secretary-Treasurer*, 227 Fulton St., New York City.

Journal American Leather Chemists' Association, 10 (1915), 110: Methods official in the Association for 1915 cover analysis of vegetable matters containing tannin, sampling of tanning materials, and analysis of leather. There is also a provisional method for sulfonated oils.

6—METHODS RECOMMENDED BY SOCIETIES INTERESTED IN COTTON PRODUCTS.

Methods of Analysis of Cotton Seed Products, printed in the following pamphlets:

(a)—Report of the Proceedings of the Sixth Annual Meeting of the Society of Cotton Products Analysis, G. C. Hulbert, *Secretary*, Augusta, Ga.

(b)—Minutes of the meeting of the Chemists' Committee of the Interstate Cotton Seed Crushers Association at Asheville, N. C., August 10, 1914, F. N. Smalley, *Secretary*, Savannah, Ga.

(c)—Proceedings of the Twenty-first Annual Session of the Texas Cotton Seed Crushers Association, Robert Gibson, *Secretary*, Dallas, Texas.

(d)—Methods of Analysis of the New York Produce Exchange, W. A. Storts, *Chairman*, Cotton Seed Products Committee of the New York Produce Exchange, New York City.

The first (a) of the above is the latest publication that contains the Interstate Cotton Seed Crushers Association's official methods, including minor changes and additions adopted by the Association in September, 1915.

7—METHODS RECOMMENDED BY THE AMERICAN RAILWAY ENGINEERING ASSOCIATION. Office, 900 South Michigan Avenue, Chicago, Ill.

(a)—*Creosote Oil*: Manual American Railway Engineering Association, 1911, p. 441.

(b)—*Zinc in Treated Timbers: Ibid.*, p. 451.

(c)—*Cement: Ibid.*, p. 478. The method is that recommended by the Committee on Uniformity in Technical Analysis of the New York Section of the Society of Chemical Industry. See also I-3 (p. 468) and II-2 (p. 468).

III—METHODS IN USE IN LABORATORIES OF CERTAIN INDUSTRIAL ESTABLISHMENTS

The number of industrial organizations that have standardized methods of analysis for use in their business is unknown, but is probably not at all large. A few of the more notable instances are here given.

1—METHODS OF THE UNITED STATES STEEL CORPORATION FOR THE SAMPLING AND ANALYSIS OF:

(a)—*Gases*: Pamphlet. Also *Metallurgical and Chemical Engineering*, 9 (1911), 302, 356.

(b)—*Iron Ores*: Pamphlet, 1914, superseding that of 1909 and the reprints of that year in the technical press.

(c)—*Pig Iron*: Pamphlet, 1912. Also *Eighth International Congress of Applied Chemistry*, 1 (1912), 91, and *THIS JOURNAL*, 4 (1912), 801.

(d)—*Plain Carbon Steels*: Pamphlet, 1915.

(e)—*Alloy Steels*, Pamphlet, 1915.

(f)—*Coal and Coke*, including the by-products. In preparation.

(g)—*Ferro-Alloys and Bearing Metals*. In preparation.

(h)—*Slags, Fluxes, and Miscellaneous Materials*. In preparation.

The pamphlets are to be had at the price of one dollar (\$1.00) each from Mr. Camp, *Chairman*, Chemists' Committee, Carnegie Steel Company, Pittsburgh, Pa.

2—METHODS OF THE UNDERWRITERS' LABORATORIES, under the direction of the National Board of Fire Underwriters. Principal office, 207 East Ohio St., Chicago, Ill.

(a)—*Rubber Compounds Used for Electrical Insulation*. Pamphlet, 1915.

(b)—*Rubber Compounds Used for Rubber-Lined Fire Hose*. Pamphlet, 1914.

(c)—*Rigid Conduit*. In press. Contains chemical methods of determining the quantity of zinc per square foot and the copper sulfate test method.

3—RAILROADS.—The Pennsylvania Railroad was probably the first railroad to include in its specifications methods by which purchases should be tested and it has a very complete list of such methods.

ACKNOWLEDGMENTS

To the many gentlemen who have been of help to me in the preparation of this paper, colleagues in the Bureau of Standards, fellow workers in the Agricultural and other Federal Departments, and others in university and industrial life, my cordial thanks are tendered.

BUREAU OF STANDARDS, WASHINGTON

NOTES AND CORRESPONDENCE

ON THE EXTRACTION OF RADIUM, ETC., BY THE U. S. BUREAU OF MINES

Editor of the Journal of Industrial and Engineering Chemistry:

I have read with interest the letter of February 16th, by Dr. Charles H. Viol, of the Standard Chemical Company, page 284 of the March issue of your Journal. I am especially interested to know that Dr. Viol concedes that some of the statements issued by the Bureau may have been altered or abbreviated in the public press, but I regret that I feel it necessary

to add that no one has so fostered misstatement as Dr. Viol himself and other employees of the company which he represents. To attempt to show up all the errors and misstatements they have issued is quite unnecessary and beyond the limit of space which you can allow me. I shall accordingly confine myself to two instances only—the article referred to above and one other which appeared in "*Radium*," the proprietary publication of the Standard Chemical Company, of which Dr. Viol is editor.

In this publication (page 54, November, 1915, issue) the following appeared, only such portion being reprinted as is pertinent to the point at issue:

"THE COST OF RADIUM"

"Below we quote in full a letter from L. O. Howard, of Salt Lake City, to the editor of *Mining and Scientific Press*, which was published in that journal September 25, 1915:

"Editor—Sir: On page 406 of your issue of September 11, it was stated that the fact the Bureau of Mines has reduced the cost of producing radium to \$36,050 per grain of bromide will perhaps make a visit to the radium booths interesting."

"Assuming this statement to be correct, except for the supposedly typographical error which substitutes *grain* for *gram*, we are again subject to the skillful exaggeration which the Bureau used so successfully in its campaign against the radium producers last year. This statement was connected with the fact that radium was selling at \$120,000 per gram. * * * * * The price at which radium is sold is given in terms of radium element whereas the cost that you report is given in terms of the salt, radium bromide. * * * * *"

In the latter part of July Dr. Viol had been sent the original statement by Secretary Lane to which Mr. Howard refers and which read as follows:

"The cost of one gram of radium metal produced in the form of bromide during March, April, and May of the present year was \$36,050."

Dr. Viol acknowledged the receipt of this statement and expressed his interest in it. On reading the statement in "*Radium*," I wrote Dr. Viol and called his attention to what I supposed to be an unintentional error, to the original statement sent him, and to his acknowledgment thereof—only to receive his reply, that the letter of Mr. Howard was published in his periodical with his knowledge and approval. When Mr. Howard's attention was brought to the misstatement he very courteously acknowledged his error and offered to publicly correct it. Up to the present time, however, Dr. Viol has made no correction in "*Radium*" of this gross misrepresentation nor has he ever published any original statement whatsoever issued by the Bureau of Mines regarding the mining or plant operations of the Bureau or referred thereto without falsification. I must accordingly assume that he intentionally publishes what he knows to be untrue.

Dr. Viol in an article on "The Radium Situation in America" *Radium*, page 106, March, 1915, says:

"By taking the cost of production on the basis of a mg. of hydrous bromide (for which the present selling price is \$64.32 per mg.) and comparing their figures on this basis with the present market price of radium element (\$120 per mg.), the Bureau of Mines officials are able to secure very startling comparisons."

The Bureau of Mines has invariably used the terms "radium element" or "radium metal," and the "comparisons" of bromide to element have originated in the imagination of Dr. Viol or in the misstatements of reporters for newspapers who have been unfamiliar with scientific terms.

On page 108 of the same issue Dr. Viol says:

"Repeated requests by members of the Congressional Committee for the written agreement between the Bureau of Mines and the National Radium Institute brought forth the promises that the agreement would be made a matter of record. So far, however, it has not been made public."

The full agreement was printed on page 195 of the very document from which Dr. Viol was quoting and had been in print for over a year.

The rest of the article makes interesting reading to those familiar with the situation. His extended quotations are quite characteristic of his journal.

It has not been the policy of the Bureau of Mines to authorize replies to any attacks in the public press or in periodical literature, although many have been made by employees of the company which Dr. Viol represents. In the present instance, however, the article appears in a journal which reaches all

parts of the world and is a public and permanent record in all the large libraries. To the many chemists in this country interested in the radium industry and to whom the *raison d'être* of Dr. Viol's letter is well known, no reply is even now necessary. The *JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY*, however, will be consulted in the future for references to radium, and many unfamiliar with conditions may accept Dr. Viol's statements as facts. Therefore, for the sake of the history of the industry these statements should be corrected. It is not, however, my intention to enter into any argument of a controversial nature. Fortunately, Dr. Viol himself and others of his company are on record, especially in testimony given before the Senate and House Committees on Mines and Mining, although those hearings are not readily available to any one searching the literature.

THE COST OF MINING

At the hearings before the Committee on Mines and Mining, House of Representatives, January 19 to 28, 1914, practically all of the chief producers of uranium ore and chief brokers were present and gave testimony. The following testimony was given regarding the cost of mining:

Pages 62 and 65, *Hearings before H. R. Committee*, Mr. J. M. Flannery, President of the Standard Chemical Company, testified:

"The average cost of mining carnotite ore would be \$15 or \$20 a ton; sacking and hauling, \$22.50; freight to Pittsburgh, \$12 per ton."

Page 166, *same Hearings*, Thos. F. V. Curran testified that the mining costs averaged \$42 per ton and transportation costs to Placerville \$20 per ton, giving a total ore cost laid down in Placerville of \$62 per ton.

Page 267, *same Hearings*, a signed statement from K. D. Hequembourg gives the following figures:

	Per ton average
Development work.....	\$ 6.00
Ore mined, sorted, sacked, etc.....	20.00
Packing to wagon road.....	5.00
Wagon haul to railway.....	20.00
Loading and unloading.....	1.50
Assaying.....	3.00
Total average per ton.....	\$55.50

"Costs depend largely on size, continuity and grade of ore body and the experience of the men sorting the ore to the grade for shipping. Above prices are based on sorting to a grade of 2 per cent or less of U_3O_8 contained. If a higher grade is wanted, the cost per ton would be materially higher for the items of 'mining' and 'development.'"

I believe these costs of mining were underestimated, but they are the best we have. In view of this testimony, the cost of the ore from the mines operated by the National Radium Institute appears high rather than low as claimed by Dr. Viol. The Maggie C claim, operated by the National Radium Institute, was one of the four or five most extensive pockets found in the Paradox region. It was, however, no more extensive than claims such as the Last Chance, Copper Prince, etc., owned and mined by others. Mining on the Maggie C claim has been more costly than on some of the smaller pockets worked by the National Radium Institute, where much less barren rock had to be moved.

PRICE OF ORE

At both the Senate and House Hearings referred to, extended testimony was given regarding the market price of ore:

Page 50, *H. R. Hearings*, Mr. Thos. R. Henahan testified that the round figures for the present price (January, 1914) of 2 per cent ore, Placerville, were about \$80 per ton.

Page 150, Mr. O. B. Willmarth testified that \$50 a ton at the mine was a fair average price for 2 per cent uranium ore.

Page 165, Mr. Thos. F. V. Curran testified, referring to ore shipments, "We get for it (delivered in France) at the present time about \$3.30 a pound of U_3O_8 ."

Page 267, Mr. K. D. Hequembourg in a signed statement gave the prices received by miners at railway as follows:

PRICES BASED ON PER CENT URANIUM OXIDE

Per cent U ₃ O ₈	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4
Price per ton, net.	\$45	\$60	\$80	\$90	\$105	\$120

"The grade most frequently shipped is about 2 per cent. Very few shipments have been found in the 2 1/4 per cent grade. The miner had great difficulty in getting a tonnage of the 2 per cent grade."

The Report of the Mines and Mining Committee, February 3, 1914, on these hearings, found as follows:

"Many foreign agents have been in this country seeking supplies for shipment abroad and a much stronger demand for ores has caused prices to advance so that ore containing 2 per cent uranium oxide readily brings \$80 per ton at the railroad at Placerville, Colo."

Mr. A. M. Wilson, of Nucla, one of the largest individual producers, wrote Secretary Lane, February 2, 1914, page 59, *Senate Hearings*, that the prices offered him at that time f. o. b. Placerville, Colo., were as follows:

"Per cent Uranium oxide	Price offered by Standard Chemical Co.	Price offered by German broker
2.....	\$ 64.00	\$ 80.00
2 1/2.....	82.50	110.00
3.....	110.00	138.00
4.....	148.00	200.00

No offer by the Standard Chemical Co. on any ore under 2 per cent U₃O₈."

Page 109, *Senate Hearings*, W. L. Cummings, another producer of carnotite, testified that February 17, 1914, the price of ore had been advancing and that he was then paid \$2 per pound U₃O₈ f. o. b. Placerville, Colo. (\$80 per ton of 2 per cent ore.)

Page 128, *Senate Hearings*, written statement, February 17, 1914, from David Taylor, a large ore broker: "For a standard ore 2 per cent uranium oxide the market price is about \$125 per ton delivered in Europe on a basis of complete payment on a valuation usually less than the American valuation at probably 6 months from the date of shipment."

The price of ore advanced slightly between February and August when the European war began. The price quoted by the Standard Chemical Company to producers as late as July 10, 1911, for ore delivered at the railroad station Dolores, Colorado, was \$98 per ton for 2 to 2.24 per cent, incl., and \$114 per ton for 2.25 to 2.49 per cent, incl. These prices average approximately \$2.35 per pound U₃O₈. The contract which they offered contained the following clause:

"The buyer shall be under no obligation to take or pay for any ore running less than 1.75 per cent uranium oxide."

It further contained the clause:

"The 'seller' has sold to the Standard Chemical Company, hereinafter called the 'buyer,' all carnotite ores on the dumps, or hereafter mined or produced, on the following described mining claims."

If the contract was legal this practically tied the seller up to furnish all of the ore he might in future produce, at the prices named, to this company.

Dr. Viol, with his usual desire for accuracy, quotes on page 284 of *THIS JOURNAL*, March, 1916:

"Before the war carnotite containing 2 per cent U₃O₈ was sold to French buyers at \$3.30 per lb. U₃O₈, and offers went as high as \$4.00 for this ore."

As his company was actively purchasing ore, Dr. Viol must have known that the statement of Mr. Curran (half again as high as any other) which he selected for quotation was exaggerated. The magnitude of the exaggeration should, however, not trouble Dr. Viol, who testified before the House Committee on Mines and Mining (page 116) that in his opinion radium could be extracted from ordinary soils commercially.

It will probably interest Dr. Viol still further to learn that there was a misunderstanding between Mr. Curran and the purchaser of the ore, who bought on the basis of the radium content "One hundred francs per mg. of hydrous radium bromide delivered in France for all ore running over 6-10 mgs. (*Senate Hearings*, p. 73)." Mr. Curran supposed that he was selling on the basis of radium actually present in the ore, while the purchaser was buying on the basis of the radium he was able to extract. As the extraction was later found to be less than 70 per cent, the net price received for the ore, deducting

freight to France, insurance, dust losses in transportation, etc., was essentially in accord with the testimony of the other ore dealers.

It was distinctly pointed out in *Bull.* 104 of the Bureau of Mines just what effect an increase in the market price of ore would have on the cost of radium produced by the Bureau of Mines process. This again Dr. Viol conveniently forgets in his article in *THIS JOURNAL*. There has been no market price for ore since the war in Europe began, as there have been no purchases until the National Radium Institute recently bought some lots that had been held in storage for many months. The Institute then became, until quite recently, the only corporation making offers for ore.

EFFICIENCY OF EXTRACTION

In view of Dr. Viol's statements that nothing has been gained by the Bureau of Mines process, although that process has succeeded in producing at a plant in Colorado several grams of radium at a cost of approximately \$37,000 per gram, with an efficiency averaging above 85 per cent, and indeed over 90 per cent, on many carload lots, the following predictions and statements taken from the *Hearings* referred to above may prove enlightening:

Page 54, *House Hearings*, Mr. J. M. Flannery, President Standard Chemical Company, testified:

"We worked on it 3 years and endeavored to develop a process for the extraction of radium from these ores, and found it a very difficult and costly proposition. We have spent to-day, including our property and all, up to the first of January, \$650,000, divided about as follows:

\$100,000 for properties; \$225,000 or \$230,000 for labor and materials used in the process; and for plants, machinery, equipping the mill, etc.

We have, up to the first of January, 1914, produced 2 g. of radium, the market price of which is \$120,000 a gram, or a total of \$240,000. We figure this radium has cost us about \$480,000 and we received for it about \$240,000; not any more."

Page 65, Mr. Flannery further states: "It would be practically an utter impossibility to produce in the State of Colorado radium at anywhere near the price we can produce and sell it. I think it would cost more than \$100,000 a gram for anybody to-day to go into Colorado and undertake it."

Page 93, Mr. Flannery: "I want to say from my knowledge of the extraction of radium as it goes to-day, that if they have not a process as good as one I know of, those claims (claims leased by the National Radium Institute) they have will never produce 7 grams of radium."

Page 19, *Senate Hearings*, Mr. Flannery stated: "I said that with the knowledge they have now I don't think they could go out and build a plant and equip it, and with that \$450,000 produce a gram of radium."

Page 22, *Senate Hearings*, Mr. Flannery stated: "This work has cost the Standard Chemical Company thus far \$700,000 without as yet yielding any profit."

Page 23, *Senate Hearings*, Mr. Flannery: "It took the Standard Chemical Company two and three-quarter years to work out such a process at an expenditure of approximately \$400,000 for this alone."

Page 29, Mr. Flannery: "We spent approximately \$700,000 up to Jan. 1, 1914, and we have realized out of that expenditure only \$300,000 for our total production of radium."

On page 118, of *Radium*, for March, 1915, Dr. Viol, referring to the work of the Bureau of Mines, states:

"One thousand tons of picked ore would probably average not much better than 2 per cent U₃O₈ and would contain *en toto* about 9,500 mgs. radium bromide. On this basis it would require about 74 per cent efficiency in extraction if even 7 g. of bromide are to be obtained. This is an efficiency that will be difficult to obtain, and it is very doubtful whether the government will ever receive any radium from the 1,000 tons of ore."

Page 119, *Radium*—"Certainly those results hardly justify the belief in the statement that 7 g. of radium (bromide) will be produced by the Bureau of Mines by the end of 1915 at a cost of \$40,000 per gram of radium element, as the statement would lead one to expect. It is a trite saying that the government production of anything is notoriously inefficient, slow and expensive."

The efficiency of extraction secured by the Standard Chemical Company has never been definitely stated, but can be calculated from the following testimony. It varies from 1,000 tons of 1 per cent U_3O_8 ore to 400 tons of $1\frac{1}{2}$ per cent ore, required to produce 1 g. of radium, being an efficiency varying from 26 to 65 per cent. Most of the statements show an efficiency of extraction by this company approximating 55 to 60 per cent. The extraction figures of a number of foreign plants have been reported to the Bureau of Mines, and no one of them has obtained an efficiency of more than 70 per cent.

Page 66, *House Hearings*, Mr. Flannery testified: "If you purchase a mine of 1 per cent ore it would take you somewhere between 1,000 and 1,600 tons. If you purchase a mine of 2 per cent it would probably take 400 to 500 tons (to produce 1 gram of radium). That has been found out by actual spending of money so far as we are concerned." This would indicate a radium extraction of less than 50 per cent.

Page 105, *House Hearings*, Dr. Viol stated: "To produce that quantity of radium chloride, containing a gram of radium element, would require from 350 to 400 tons, or even more—it depends, of course, on the quality of your ore, but as a minimum it would require from 350 to 400 tons of carnotite ore."

Page 107, Dr. Viol stated, referring back to his previous statement that the quality of the ore would have to be "somewhere around 1.5 or 2 per cent—that is, taking the ore as we get it."

On $1\frac{1}{2}$ per cent ore, 400 tons would be an efficiency of 65 per cent; 2 per cent ore, 350 tons would show an efficiency of 55.7 per cent.

As before stated, the radium extraction efficiency of the Bureau of Mines process has averaged above 85 and, indeed, above 90 per cent on many carload lots.

Dr. Viol's statement regarding the Bureau of Mines extraction of vanadium on page 284 of THIS JOURNAL is incorrect, although he quotes correctly on page 285. The facts are that between 29 and 30 per cent of the vanadium has been recovered in merchantable form as iron vanadate and that 85 per cent of the uranium has been recovered, not as crude sodium uranate, but as high-grade black oxide of uranium.¹ While it is true that the Bureau's process in its regular course does not obtain as large a proportion of the vanadium as might be wished, *Bull. 104* carefully points out that vanadium was sacrificed at this point in order to increase the radium extraction. Nothing was said about the further treatment of the residues to obtain the vanadium they contained, for at that time the work had not been done. Dr. Viol will, however, be relieved to know that the vanadium can be easily and profitably extracted from the residues. The method will be described in a later bulletin.

In regard to the operations of the company with which he is connected, Dr. Viol testified before the House Committee (page 106), regarding the value of the by-products from the uranium ore, as follows: "We have not gotten a cent from that. Our ore is a rather low-grade uranium and vanadium ore. It is an expensive proposition to recover vanadium from low-grade ore."

On page 284 of THIS JOURNAL, Dr. Viol states:

"When it was evident that the National Radium Institute was in the field to buy ore, the State Commissioner of Mines in Colorado made public announcement advising the miners to hold their ore for at least \$2.50 per lb. U_3O_8 ."

In this statement Dr. Viol refers to a telegram printed in the *Norwood Post* which was sent under date of December 3, 1915, and signed "CARROLL." Mr. Fred Carroll is the mining commissioner of Colorado, but he did not send the telegram. This he has definitely stated to the Bureau and afterwards in

¹ An error which inadvertently crept into *Bull. 104* may be corrected here. In describing the electric furnace used in experiments on uranium oxide it was stated, page 66, that "the iron pot, cooled with water externally, was used as one electrode and container, the other electrode being made of Acheson graphite." The facts are that the iron pot was simply a container and two Acheson graphite electrodes were used in the form of a double arc therein. The voltage on each arc would therefore be approximately one-half that to be expected from the data on page 67 of the bulletin.

the *Norwood Post*. Mr. Carroll's public denial Dr. Viol conveniently overlooked. The author of the telegram is unknown.

Dr. Viol is quite correct in his statement that it is highly desirable that low-grade ores obtained in connection with the mining of the higher grade ores should be directly and profitably treated. This was one of the chief reasons why the Bureau of Mines undertook its radium investigations. He was present at my lecture at the Chemists' Club in New York on December 17, 1915, and, as usual, correctly quotes me in part only. The Bureau of Mines is using a slightly modified Raymond mill for the concentration of the low-grade ore obtained in connection with regular mining operations. At the Chemists' Club, Dr. Viol stated that ore which he had treated averaged 1.7 per cent (not 1.6 per cent as he now states) uranium oxide and that his company had up to that time extracted 14 grams of radium element. In reply to his question, I answered in the presence of 100 or more of my colleagues that the concentration experiments on low-grade ore were successful, that we were able to treat ore containing 0.8 of 1 per cent uranium oxide, concentrating 6 tons to 1 and obtaining a concentrate of approximately 3 per cent U_3O_8 and that the concentrate so obtained would cost us less per pound of uranium oxide laid down in Denver than the regular ore we had been operating upon. I further stated that methods had been developed for treating this concentrate direct and although it was harder to filter, the difficulty had been overcome by special pressure filters. I further publicly stated that so far as his contention was concerned the Bureau of Mines method could not treat 1.7 per cent ore successfully. I was prepared to say that there was no question if he would furnish the same amount of 1.7 per cent ore, which they had used in producing 14 grams of radium element, at the highest price per ton at which they had purchased a single car-load of this grade of ore, it would be a simple matter to treat the ore for a cost not exceeding \$35,000 per gram of radium element extracted and in my opinion some 16 to 18 grams of radium element could be recovered therefrom instead of the 14 actually produced.

I am rather surprised to note that Dr. Viol acknowledges that the mill for low-grade ore his company built on the San Miguel River in the Paradox, which uses air separation and which cost, according to the statements of the president of his company, approximately \$100,000, has not been a success—especially as the successful concentration mill built by the National Radium Institute has cost less than \$9,500 including repairs. So far as I am able to determine, there are three reasons for this difference in cost and in results. One is the technical control of the mill of the National Radium Institute; another, certain auxiliary arrangements preventing losses of carnotite dust; and the third is that this mill is small and is planned to be moved from one center of low-grade ore to another so that hauling charges to the mill will be minimized.

If statements made to me by persons familiar with conditions in the Paradox are correct, the transportation charges to the large mill built by Dr. Viol's company must be a large item of the cost of treating the 6 tons of ore necessary to yield 1 ton of concentrates. If the details reported to me are correct, the cost of haulage is itself nearly as much as the total cost of concentration at the mill of the National Radium Institute. In my opinion the failure, if such, to obtain commercial results has been due to business reasons of this kind and not to any essential fault in the method of air separation involved which, as Dr. Viol states, was much the same in both instances.

I wish to assure Dr. Viol and any others interested in the production of radium that the treatment of the concentrate from low-grade ores obtained incidental to mining higher grade ores and heretofore wasted, presents no real difficulties. It can be treated successfully by itself. However, the radium

producer who wishes to obtain the greatest profit from a carnotite deposit will continue to separate as much high-grade ore as possible from the low-grade in order to save radium values, for there is a considerable loss of carnotite in any process of mechanical concentration. The most efficient method of operating by the Bureau of Mines process will be to directly treat without concentration all ore rich enough to stand transportation costs to some plant near to the source of the necessary chemicals. There should be mixed with this 20-mesh ore, when treated, the carnotite dust obtained by concentrating at the mine the low-grade ore obtained.

BUREAU OF MINES, WASHINGTON
March 22, 1916

CHARLES L. PARSONS

ON SYNTHETIC PHENOL RESINS

Editor of the Journal of Industrial and Engineering Chemistry:

The account of the presentation of the Perkin Medal by the New York Section of the Society of Chemical Industry at the Chemists' Club to Dr. Leo Hendrik Baekeland January 21, 1916, as described in THIS JOURNAL for February, 1916, from pp. 177 to 190, contains some inaccuracies which have crept into the presentation address and should be corrected, if we are to preserve an accurate record of the scientific and industrial development of synthetic phenol resins. These inaccuracies refer particularly to the discoveries in the art of phenol condensation products.

One method of producing these resins was developed by Dr. Baekeland and the resulting resin he named "Bakelite." This improvement consisted in adding to equal volumes of phenol and commercial formaldehyde (40 per cent) a basic condensing agent in the proportions of less than one-fifth of a mol. of the basic condensing agent per mol. of phenol used. The basic condensing agent was added at the beginning of the reaction. As difficulty was experienced in preventing the escape of formaldehyde at times, counter-pressure was used at the same time that heat was applied to prevent the escape of the formaldehyde gas and to prevent bubbling.

The two steps which resulted in the production of bakelite consisted in adding the basic condensing agent in certain proportions at the beginning of the reaction, in place of adding the basic condensing agent after the reaction had proceeded for a short time in an acid solution as Luft had done, and in the use of increased heat and counter-pressure where it was necessary to prevent the escape of formaldehyde and in this way also preventing porousness or bubbling in the mass due to formaldehyde and water escaping. Luft used *an acid condensing agent at the beginning of his reaction, he washed out the acid completely and added a basic condensing agent to finally transform the resin.* Dr. Baekeland deviates from Luft's process in one step only. Luft added an acid at the beginning of the reaction and later washed out the acid and added a basic condensing agent, while Dr. Baekeland adds the basic condensing agent at the beginning of the reaction; Luft's process is more rapid and gives the same type of insoluble resins.

With regard to the amount and kind of basic condensing agent which could be used, it will be interesting in this connection to quote Dr. Baekeland's patent No. 942,809, applied for October 15, 1907, renewed application September 17, 1908, and patent granted December 7, 1909. On p. 2, col. 1: "It is therefore essential that the proportion of base should not exceed certain definite limits, and the maximum permissible proportion has been found to be less than one-fifth of the equimolecular proportion of phenolic body present. If larger proportions of base be used there are formed in the mass such amounts of disturbing bodies as serve to render the product technically inferior or worthless for the purposes of this invention."

In view of this point it seems rather remarkable that Dr.

C. F. Chandler in his presentation address should have made the statement found on p. 179, col. 2, line 26: "Instead of formaldehyde, other substances which have the same functions may be utilized, as, for instance, methylal "paraform and HEXAMETHYLENETETRAMINE."

Dr. Baekeland's scientific and patent publications do not show that he was aware that hexamethylenetetramine could be combined directly with phenol until long after we had performed such reaction and the fact was quite generally known. Dr. Baekeland's main process explicitly states that less than one-fifth mol. of the condensing agent must be used per mol. of phenol, and if the nitrogen in the hexamethylenetetramine be calculated and regarded (for argument's sake) as a condensing agent, then hexamethylenetetramine contains 300 per cent more than the maximum permissible proportion for the purpose of his invention. If the nitrogen is not regarded as a condensing agent, then no condensing agent is added. In either case, the use of hexamethylenetetramine clearly does not fall within the Doctor's specific improvement on the well-known wet formaldehyde process. The use of hexamethylenetetramine in the presence of water was mentioned in Wetter's British patent No. 28009 applied for December 19, 1907, and granted July 20, 1908, in which he states: "the 40 per cent formalin may be replaced by the polymerization products as well as by substances which yield formaldehyde, such for example as hexamethylenetetramine;" and, the U. S. Patent Office has ruled against the patentability of claims which would cover such use in wet solution.

The case was argued exhaustively by the contestants in person before the Patent Examiners and the patent office has taken the position and ruled that Dr. Baekeland was not entitled to make claims in which hexamethylenetetramine and phenol are used in the anhydrous condition giving as the *only* by-product ammonia and presenting such a reaction as is completely anhydrous. We may mention here that there is not even a trace of water formed when phenol crystals are used, and *no trace of formaldehyde is formed at any time during the anhydrous process.*¹

The decision of the U. S. Patent Office was rendered November 11, 1914, on the subject of synthetic resins, interference No. 34995, quoting from the last paragraph: "The claims submitted above cannot be made by Baekeland. . . . because they have elected to claim a process involving the presence of water and because their specifications afford no indication of a distinction between a process in which water is present and one from which water is excluded."

In fact it appears the Doctor was not only not aware of the use of hexamethylenetetramine but even warns against the excess use of ammonia lest hexamethylenetetramine be formed which he mentioned as a detrimental substance. To quote from his patent No. 942,809 granted December 7, 1909, col. 2, line 95: "The proportion of bases used as condensing agents has a preponderant influence on the nature of the ultimate products. *For instance, if a large amount of ammonia be used, hexamethylenetetramine is formed, which is a crystalline body of definite chemical properties.* Likewise, if large amounts of caustic soda be used there are obtained alkaline derivatives of phenol-alcohol. It is therefore essential that the proportion of base should not exceed certain definite limits, and the maximum permissible proportion has been found to be less than one-fifth of the equimolecular proportion of phenolic body present. *If larger proportions of base be used there are formed in the mass such amounts of disturbing bodies as serve to render the product technically inferior or worthless for the purposes of this invention.*"

To quote Dr. Chandler further on p. 181, col. 1, line 6: "the action of ammonia in presence of formaldehyde in this process is entirely similar to that of the use of hexamethylenetetramine." This cannot possibly be true, as the formaldehyde and ammonia

¹ THIS JOURNAL, 6 (1914), 3.

would leave 60 per cent of water present in the reaction which is troublesome at any time. Further it would be impossible to use formaldehyde and a small amount of ammonia in the same way in the reaction where phenol resins are hardened by the action of hexamethylenetetramine. The use of free formaldehyde and a small amount of ammonia makes a resin with a blinding, stifling odor of formaldehyde which can not possibly be used commercially, while the use of hexamethylenetetramine gives an odorless, molding compound which can be used anywhere with the greatest ease. Indeed, it is significant that the phenol condensation products, used for molding, to-day, show the presence of more than two and one-half per cent of ammonia, which indicates that if the ammonia be reckoned as a supposed condensing agent it is used in at least double a fifth of a mol. of the condensing agent to one mol. of phenol.

In Dr. Baekeland's patent No. 1,038,175 on a divisional application filed July 6, 1911, and granted September 12, 1912, lines 78 to 90, Dr. Baekeland adds: "If this base be ammonia, it will immediately react with formaldehyde to form hexamethylenetetramine, as pointed out in my prior U. S. Patent No. 942,809 issued December 7, 1909. So that the technical effect is the same whether hexamethylenetetramine be introduced as such or as a mixture of ammonia and formaldehyde." But this second date of application is subsequent to the work which the writer did in the University of Kansas on hexamethylenetetramine and the patent itself is granted subsequent to many of the patents issued to Aylesworth on the hardening of phenol resins with hexamethylenetetramine, and further in view of the decision of the patent office rendered Nov. 11, 1914, which stated that there was no indication in any of Dr. Baekeland's application that water had been excluded, it becomes impossible to contend further that the Doctor was aware of such a reaction as the use of phenol and hexamethylenetetramine in the anhydrous condition previous to our discoveries.

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ON THE PRODUCTION OF ALUMINUM

Editor of the Journal of Industrial and Engineering Chemistry:

I have noticed in the technical press, references to an address made by Dr. C. F. Chandler and printed in your Journal. The address contains the following:

"Chas. M. Hall, a Perkin medalist, had brought out his beautiful and simple process for extracting aluminum from alumina in 1886, and had given a practically new metal to the world to replace copper, tin, and zinc in many arts."

To the best of my knowledge the above is entirely incorrect. I left the employ of the Cowles Electric Smelting Company January 1, 1887. Hall had at that time not yet come with this Company. I believe he started to work in July, 1887. Romaine Cole was then, and had been for some time, with the company.

When Hall and Cole broke away from the company they attempted to use external heat only and did not produce any aluminum until (1889) they appropriated Cowles' ideas which Heroult and Minet had already appropriated and produced aluminum. Now, as I remember it, using external heating, neither Hall nor Heroult in Europe ever evolved a process that gave an ounce of pure aluminum or that was in any wise different from what Gratzel had been doing three or four years previous at Bremen, where he was employing externally heated crucibles with cryolite and alumina.

In the *Journal of Franklin Institute*, Feb., 1886, pages 118 and 119, there occurs the following:

"The future of the process is one of great promise, and will undoubtedly lead to the production of cheap and pure aluminum itself within a very brief period. Indeed, 'The Cowles Electric Smelting Company' asserts, on the back page of its pamphlet, that it expects to put the pure metal on the market within a year. When you are informed that we can charge iron, man-

ganese, tin, copper, nickel, etc., with a very high percentage of metallic aluminum in this furnace, and that, also, without any base metal in the furnace, we can saturate the charcoal contained therein with metallic aluminum, most of which will be in a state of mechanical mixture with the carbon; and further, that we have produced specimens of aluminum 99 per cent pure in at least three different methods by the electric furnace; and that notwithstanding all this we have not made much of an effort in this direction, the majority of you will agree that the great problem of producing pure and cheap aluminum is practically solved. How cheap this method will be you may judge from the fact that, at our Lockport works, which will have a capacity of only two or three tons per day, we expect to produce the aluminum in bronze with the little silicon contained in it at a cost not to exceed 40 c. per lb., or with copper at 12 c. per lb., the bronze will really cost but about 15 c. per lb.

"In truth, 'The Cowles Electric Smelting and Aluminum Company' is founded upon the faith that ere long we shall be marketing pure aluminum at a cost not exceeding 50 or 60 c. per lb. An appreciation of how cheap this would be, can be had from the fact that one lb. of aluminum would go about as far as three and one-half of copper, it being that much more bulky, and in reality it would be about as cheap as copper at 18 c. per lb., without counting its vast superiority over copper for many purposes on account of its greater lightness and resistance to corrosive influence."

[NOTE—Since the above paper was filed with the Secretary of the Institute, it was found possible to prolong the length of the "heat" of the furnace for five hours, and increase the charges to over 100 pounds in weight, and during the same week a button of cast aluminum, five ounces in weight, was separated from the matrix of carbon, in which it was reduced by a process so simple and economical, that the production of pure aluminum from its oxide by the agency of heat and carbon only, is now demonstrated beyond all question.—E. H. C.]

Cowles at this time was working on aluminum from alumina.

If you are interested in the history of the Cowles, Cole and Hall controversy which took so many years in the courts, and concerning which I believe I talked with you personally (as I was called in from time to time on it and therefore interested), I would refer you to my brother, Cecil L. Saunders, Ithaca, N. Y., who has a large number of letters from Hall to Cole, written during these early years, the contents of which will clear the matter for all time.

Romaine Cole was my brother's brother-in-law, and these letters came to my brother upon Romaine's death, and it is a pity that they were not produced many years before to have settled that tedious heart breaking litigation. I hope the letters will be used.

The above is simply an attempt to set the records straight.

PHILADELPHIA
February 14, 1916

WM. E. SAUNDERS

ON THE HISTORY OF ALUMINUM

Editor of The Journal of Industrial and Engineering Chemistry:

The correct history of the production of aluminum will be interesting to your readers, and a portion of this correct history is found in the excellent translation by Dr. Leonard Waldo, of New York, of the volume entitled "The Production of Aluminum, Etc.," by Adolphe Minet (Officer of public instruction, and Editor of "L'Electrochimie," Paris), in the chapter by Dr. Waldo on "Aluminum in the United States" wherein Dr. Waldo, referring to those "Masters of Fire" the Cowles brothers (Alfred and Eugene) states as follows:

"The testimony of these gentlemen in the long continued patent litigation forms the most important source of history in this connection. A sketch in the notebook of Mr. Eugene H. Cowles dated June, 1883, and bearing the title "Proposed Electric Furnace for Working Pecos Ores," contains the essentials of the later patented forms for the smelting of aluminum alloys. The mass of mixed ores for reduction by incandescent heat, the posing inclined carbon terminals, the vents at the top of the furnace, and the tap hole for withdrawing the molten charge, *all are present.*"

Here then was the invention of the incandescent electric furnace and the process of internal heating used therewith whereby aluminum and all high heat products are made.

In fact early in 1886, The Franklin Institute, of Philadelphia, in a long and exhaustive report, awarded the Cowles brothers two gold medals and the Scott legacy premium for their inventions relating to aluminum and among other things set forth, this extended report states as follows:

"This process is applicable to the reduction of all kinds of ores but particularly to those unreducible by other means.

"The committee is of the opinion that the Messrs. Cowles and their associates deserve the highest commendation for their inventions, furnishing, as they do, a distinctly new and important metallurgical process."

On presentation of this report to the session of the Franklin Institute the following was adopted.

"Amended to incorporate a recommendation for the award of the John Scott Legacy Premium and Medal to the inventors for their electric smelting furnace; and of the Elliott Cresson Medal, for the invention of a new process in the metallurgical arts for the reduction of refractory substances: and as so amended, adopted."

H. R. HEYL, *Chairman*
Philadelphia, April 7, 1886."

The advance by the Cowles brothers in the production of aluminum, as far back as 1885, is shown by Dr. T. Sterry Hunt of Montreal, Canada, in a paper read by him at the Halifax meeting in 1885 of The American Institute of Mining Engineers as follows:

"But it was reserved to Eugene and Alfred H. Cowles, of Cleveland, Ohio, to take a new step in the metallurgic art by making the (internal) heat thus produced a means of reducing the oxides not only the alkaline metals, but of calcium, magnesium, manganese, *aluminum*, silicon and boron, with an ease that permits the production of these elements, and their alloys with copper and other metals on a commercial scale."

Dr. T. Sterry Hunt in the same paper stated that he had just spent a number of days in the Cowles brothers' works in Cleveland, in investigations, and in actual direction of one of their furnaces (see pp. 101 to 104 of Exhibits in the aluminum litigation).

In the spring of 1887, Charles M. Hall applied to the Cowles Electric Smelting and Aluminum Company for a position in said company's works, he claiming to have an electric process for the production of aluminum which he wished to develop, and on his representations he was employed in July, 1887, and remained with said company until July 27, 1888, and was given the freedom of the Cowles Company's plant in his experiments and work. At the very beginning of his connection with the Cowles Company in July, 1887, and frequently thereafter the Cowles Company notified Hall that in the Cowles original applications for patents the reduction of alumina with cryolite was mentioned, using therewith an *internally* heated furnace and that they had used that process long before they ever knew of or met the said Hall, and that if Hall proposed to use the alumina-cryolite-*internally* heated process, he would be trespassing on what the Cowles Company claimed as its own. Hall thereupon disclaimed any such use, claiming that his (Hall's) process was by the use of other substances in an *externally* heated crucible. Hall worked with his stated method a full year at the Cowles Company's plant and never in all that time was he able to, nor did he, produce one ounce of aluminum.

At the expiration of Hall's employment, July 27, 1888, Hall went to Pittsburgh, Pa., and organized a company to perfect a process and manufacture aluminum.

Hall continued his external heating process in Pittsburgh for months, and all without success, and until the officers and stockholders of his company bitterly complained at his failure and thereupon Hall changed to the Cowles process of *internal* heating, as shown in Hall's letter to Romaine C. Cole, dated *Pittsburg, January 8, 1889*, wherein he states he had trouble and that "The electrolyte hardened at the bottom of the pot because it was not hot enough to keep it from hardening." Hall then changed to *internal* heating and states "that has been almost overcome by using carbon sticks which are up in the bath and very hot, for negative electrodes instead of the pot, is avoided entirely."

Also in Hall's letters to Cole dated *January 13, 1889*, and *June 30, 1889*, Hall shows his said change in his method of heating (see complainant's Exhibits of Hall's letters to Cole in the aluminum litigation referred to herein).

When Hall started his company at Pittsburgh and failed to produce aluminum, he secretly hired the said Romaine C. Cole (who was then a metallurgical expert in the employ of the Cowles Company) and also several other employees, heads of departments of the Cowles Company, away from the Cowles Company.

Hall had written the said Cole as follows: "Simple cryolite plus alumina, quickly spoils and is no good."

Hall also later wrote Cole¹ as follows:

"Bradley has recently had a patent issued on 'Fusing and Electrolyzing by the Electric Current.' He has broad claims in the office which may or may not be rejected *which would cover our commercial method of working, and his applications date back to 1883.*

"What makes it more important is that we know that some of Bradley's claims still in the office are allowed."

"Yours hastily,

CHARLES M. HALL"

But Hall, on being shown by the said experts he had hired away from the Cowles Company, the proper way to use said process of alumina and cryolite in conjunction with *internal heating*, as stated to Hall, by the Cowles Company as said Company's process, under patent owned by said Cowles Company and so stated while Hall was in the employ of said Cowles Company in 1887 and 1888. Thereupon, in 1889 Hall adopted said process bodily and it was for the use of *this identical process* that Hall's Company (The Pittsburg Reduction Company, now the Aluminum Company of America) was defeated and enjoined from further manufacturing aluminum, by the U. S. Circuit Court of Appeals, sitting in the City of New York, in the suit of The (Cowles) Electric Smelting and Aluminum Company, against said Hall's Company, in which case the Court held as follows:

"The process patented to Hall adopts *external* heat to produce fusion" (125 Federal Reporter, 934).

As to the patent owned by the Cowles Company, the Court held:

"Its process is not confined to cryolite or aluminum: it relates to all ores or compounds of aluminum and all other refractory ores of like type. Cryolite is mentioned as an illustration in the specification but it might as well have mentioned alumina or any other similar ore. That there is nothing in the patent or out of the patent, requiring the limitation to cryolite seems too plain for debate. The process may be used with cryolite alone or alumina alone or *both together* whether applied synchronically or successively. *In either case the essential features of the process are appropriated*" (125 Federal Reporter, 935).

On the issuing of said injunction there was done what is stated on page 1081 of the December (1915) number of THIS JOURNAL, namely:

"A settlement was arrived at between the two companies wherein the Hall Company paid the Cowles Company a large sum for past infringement and a royalty on all aluminum to be produced up to the end of the life of the Bradley (Cowles Company's) patent. The Bradley patent being held to dominate the Hall patent and process, made it impossible for the Hall Company to continue in business without coming to an agreement with the Cowles Company."

All of the foregoing are matters of record, and clearly show that Hall was *not* the inventor of the "process for extracting aluminum from alumina," and laymen, who are not familiar with the full facts fall into the error of believing and stating that Hall was the inventor of the process for so producing aluminum, as did Dr. C. F. Chandler who is quoted in the February, 1916, numbers of several technical journals as using the following language in a presentation address of the Perkin Medal to Dr. Baekeland before the Society of Chemical Industry, to wit:

¹ See complainant's "Exhibits in the Aluminum Litigation."

"Charles M. Hall, a Perkin Medalist, had brought out his beautiful and simple process for extracting aluminum from alumina, in 1886, and had given a practically new metal to the world to replace copper, tin and zinc in many arts."

Simple justice demands that such errors should be corrected. For above it is shown that Hall never made an ounce of aluminum before 1889, for in a letter to Leonard Waldo, Esq., dated "Oberlin, O., August 29, 1888," set forth in the exhibits in said litigation, Hall states as follows:

"I am not doing anything at present regarding the production of pure aluminum, but am waiting mainly to get my patent matters in better shape. My patents are not yet issued and are, if I may use the expression 'in the woods.'"

As shown heretofore by Hall's letter to Cole, Hall admitted that the Bradley patent dominated his process, and the U. S. Circuit Court of Appeals also so found and held, as quoted from the Court's opinion above, and it is therefore clear and unanswerable that Dr. Chandler's erroneous and unsupported statement is to be held as naught; and should any further proofs be desired reference is also hereby made to Charles M. Hall's admissions in his cross-examination, between pages 724 and 753 of defendant's testimony in the aforesaid case, and also to all the admissions by Hall in all the letters set forth as exhibited in said case.

FRANCIS C. McMILLIN

General Counsel for the (Cowles) Electric Smelting
and Aluminum Company

111 BROADWAY, NEW YORK CITY
March, 1916

NOTE ON THE DETECTION OF FAULTY SIZING IN HIGH-GRADE PAPERS

Editor of the Journal of Industrial and Engineering Chemistry:

Reference is made by Herzberg¹ to the test for the detection of faulty sizing in high-grade papers,² in which he states that the method is not new and is similar to that of Klemm.³

Herzberg has apparently overlooked the actual principle upon which the method is based.

In the proposed method the paper is carefully drawn over the surface of an iron tannate ink and allowed to drain and dry. This procedure differs considerably from that of Klemm, in which the paper is allowed to float for a longer period of time and the excess ink subsequently blotted off. The inked as well as the reverse side of the paper is judged for uniformity of color, the time it takes should the ink strike through, and whether it has come through uniformly. From this appearance it is possible with experience, to judge the sizing quality.

Should it be desired to test a paper for its writing quality only, Klemm claims that ten minutes' floating on the ink, examining both the wire and top side, is sufficient. The appearance of the inked and reverse sides is noted for the characteristics above mentioned, and if the ink does not penetrate the sheet, it is considered properly sized for all practical purposes.

Should it be desired to make further distinctive tests Klemm says it is only necessary to float the paper for intervals of 2, 5, 10, 20, 30 and 60 mins. and examine as before, from which most instructive results can be obtained.

In the proposed method the new and distinctive feature is in the examination of the individual fibers under a magnifying glass to observe the absorbed ink. It is upon the absorption of the ink by the fibers and not upon the appearance of the surface as a whole that the accuracy of this test depends and upon which claim for its originality and superiority is based.

The possible results which Klemm may obtain by his procedure do not approach the refined distinctions in sizing quality between two well-sized papers that the proposed method will

bring out. Uniformity of color is not the best criterion for distinguishing the sizing quality. The depth of color of the inked surface is far more differentiating, as has been mentioned in *Circular 107*. Furthermore, in the procedure of Klemm there are many factors which may influence the results, such as the amount of ink, the evaporation, the formation of the sheet, the moisture in the paper, its weight, loading, and thickness. The proposed method is largely independent of the variations which may be caused by these factors as it deals entirely with the appearance of the fibers on the surface of the paper, and as has been stated, "Upon examining the inked surface with a magnifying glass it will be found that a well-sized paper will show no indication of the fiber having absorbed the ink, * * *"

The experiences of many who have used this method properly have shown it to give distinctions in the quality of sizing where other methods have failed.

LEATHER AND PAPER LABORATORY
BUREAU OF CHEMISTRY, WASHINGTON
March 14, 1916

C. FRANK SAMMET

METHOD FOR DETERMINATION OF HARDNESS

Editor of the Journal of Industrial and Engineering Chemistry:

Referring to the note "Method for Determination of Hardness," THIS JOURNAL, 8 (1916), 281, the writer begs to state that the method described is not a French invention, but is the product of American brains. It is covered by U. S. Patent No. 1,125,912, issued January 19, 1915, to Messrs. Albert Ringland and Frank H. Schoenfuss, of Philadelphia. This patent covers "The method of ascertaining the Brinell hardness of a piece to be tested, which consists in placing a ball between said piece and a standard piece of known Brinell hardness, applying a force to the assemblage to produce a ball depression in each piece and then comparing the depressions and thereby ascertaining the Brinell hardness of the piece to be tested."

It will readily be seen that this method is a very clever scheme to extend the application of the accurate Brinell method to metal pieces which cannot be placed into the Brinell machine; it permits accurate Brinell hardness determinations of metal masses of practically any size or shape, and in any place or structure. The proportion of the two ball indentations used for comparative measurements is an absolutely direct one, independent of the pressure applied. It is varying directly as the spherical areas of the two impressions, consequently varying directly as the squares of the diameters of each impression. On basis of this proportion, a table can be easily worked out, which will give the Brinell hardness for any readings.

HERMAN A. HOLZ

50 CHURCH STREET, NEW YORK
March 15, 1916

COPIES OF JANUARY AND FEBRUARY ISSUES OF OUR JOURNALS WANTED

Editor of the Journal of Industrial and Engineering Chemistry:

Owing to the rapid increase in membership of the American Chemical Society, the early issues of the 1916 journals are already practically exhausted. Two hundred and seventy (270) more members have been elected in the early months of this year than in 1915; accordingly, the plans for publication were underestimated and the Secretary is now advertising for these numbers.

Members not binding their journals will convey a great favor by returning to the Secretary's office any January and February issues of any of the Society's publications that they can spare. The numbers especially wanted are the January and February issues of both the *Journal of the American Chemical Society* and *Journal of Industrial and Engineering Chemistry*, and the January 20, 1916, issue of *Chemical Abstracts*.

CHARLES L. PARSONS, Secretary

Box 505, WASHINGTON, D. C.
March 24, 1916

¹ *Mitt. kgl. Material-prüfungsamts*, 11 (1915), 130.

² Bureau of Chemistry, *Circ.* 107.

³ *Handbuch der Papierkunde*, 1910, 312.

PERSONAL NOTES

Harry Clary Jones, professor of physical chemistry at Johns Hopkins University, died suddenly at his residence in Baltimore on April 9th, aged 51 years. Professor Jones received his Ph.D. degree from Johns Hopkins in 1892 and later studied in Leipzig, Amsterdam and Stockholm. He returned to Johns Hopkins in 1895 as an instructor in physical chemistry and in 1904 he became a professor. Prof. Jones was a member of the American Chemical Society, the American Physical Society, the American Philosophical Society, and the Washington Academy of Sciences. He was Langstreth medalist of Franklin Institute in 1913.

The Willard Gibbs Medal, founded by William A. Converse, of Chicago, has been awarded to Dr. Willis Rodney Whitney, director of research laboratories of the General Electric Company, Schenectady, N. Y. The presentation will be made on May 19th, in connection with the meeting of the Chicago Section of the American Chemical Society, when Dr. Whitney will make an address on "Incidents of Applied Research."

Arthur D. Little, of Boston, has been retained by the Canadian Pacific Railway to establish a central organization for research work to carry out Lord Shaughnessy's proposal for a scientific investigation of Canada's mineral, metal, hydroelectric and chemical resources, and to stop waste in forests, mines and mills. The new organization will be known as the Canadian Research Bureau.

The United States Civil Service Commission announces the following open competitive examinations: *Assistant petroleum chemist*, for men only, salary \$1,800 per annum, on May 16, 1916; *assistant alloy chemist*, for men only, salary \$1,620 per annum, on May 17 and 19, 1916; *laboratory aid in chemistry and physics*, for men and women, salary \$600 to \$900 per annum, on May 3 and 4, 1916; *chemist*, for men only, salary \$1,200 a year, on June 7, 1916. Further information may be had from the United States Civil Service Commission, Washington, D. C.

Dr. Charles Holmes Herty, president of the American Chemical Society, delivered an address on "Chemistry as an Aid to the Efficiency of Democracy," before the Indiana Section of the A. C. S., on April 21st.

Columbia University will hereafter confer the degree of Master of Science upon graduate engineering students who satisfactorily complete the graduate course in Highway Engineering. From 1911 to 1915, the graduate engineering students who have specialized in Highway Engineering have been candidates for the degree of Master of Arts.

Mr. Walter E. Lummus, distillation engineer, of Boston, has recently incorporated his company which is now known as The Walter E. Lummus Company, and has moved from 88 Broad Street to 173 Milk Street, Boston, where he has taken more than twice the space formerly occupied and has added to his staff in order to properly handle the increasing business. Mr. Lummus provided increased manufacturing facilities last year.

The Dorr Company, with offices in New York, Denver and London, is successor to The Dorr Cyanide Machinery Company, taking over the patents and commercial business of its predecessor. John V. N. Dorr is president of The Dorr Company.

Arthur Lowenstein has resigned his position as technical director of Morris & Company, and is now engaged in practice as a consulting chemical engineer at 1723 First National Bank Building, Chicago.

Alfred W. Bosworth, associate chemist at the New York Agricultural Experiment Station, has been appointed biological chemist for the Boston Floating Hospital.

A fire on March 24th, believed to have been due to a blazing burner, damaged the Harrison Chemical Laboratory building at the University of Pennsylvania to the extent of \$1,000.

Horace Bowker, of Boston, has been elected a director of the American Agricultural Chemical Company, succeeding the late W. H. Bowker.

The Franklin Institute has awarded the Elliott Cresson Medal to Dr. Robt. Gans, of Germany, for his Permutit.

Grinnell Jones has been appointed assistant professor of chemistry in Harvard University.

Dr. Otto Diels, of Berlin, has been called to the chair of chemistry at Kiel.

Dr. R. Willstätter, professor of chemistry at Berlin, has been elected a foreign member of the Swedish Academy of Sciences.

Sir Thomas H. Holland, F.R.S., professor of geology in the University of Manchester, has been appointed chairman of a commission which the British Government is forming to survey the economic resources and industrial possibilities of India, with a view to promoting business after the war.

Mr. C. S. Gibson, of Sidney Sussex College, England, has been appointed assistant to the professor of chemistry at the University of Cambridge.

The authorities of Oxford University, England, intend shortly to change the system of examination for an honors degree in chemistry. It is proposed that research be introduced as an essential towards the obtaining of a degree.

Mr. Ivan Levenstein, of the well-known Manchester firm of aniline dye manufacturers, died on March 15th at his residence in Cheshire, England, at the age of 70 years.

Mr. A. V. Hill, Humphrey Owen Jones lecturer in physical chemistry at the University of Cambridge, has been elected a fellow of King's College.

The eighth semi-annual meeting of the American Institute of Chemical Engineers will be held in Cleveland, Ohio, June 14-17, 1916.

The plant of the Carcolite Chemical Company, at Copper Hill, Tenn., which is controlled by the Tennessee Copper Company, is to be rebuilt. It was recently destroyed by fire, the loss exceeding \$250,000.

Dr. E. C. Bingham, who for the past few years has been professor of chemistry in Richmond College, Richmond, Va., is spending the year 1915-16 in the Bureau of Standards, Washington, D. C.

Dr. Garrett Ryland has been made professor of chemistry at Richmond College, Richmond, Va.

Mr. M. F. Lindsley spoke on "The History, Characteristics and Methods of Manufacture of Modern Explosives," before the regular meeting of the Cincinnati Section of the A. C. S., on April 12th.

Dr. Frederick H. Wagner, of the Bartlett, Hayward Company, gave an illustrated lecture on "Coal Gas Residuals," at the 13th regular meeting of the Maryland Section of the A. C. S., on April 15th.

GOVERNMENT PUBLICATIONS

By R. S. McBRIDE, Bureau of Standards, Washington

NOTICE—Publications for which price is indicated can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Other publications can usually be supplied from the Bureau or Department from which they originate. Consular Reports are received by all large libraries and may be consulted there, or single numbers can be secured by application to the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington. The regular subscription rate for these Consular Reports mailed daily is \$2.50 per year, payable in advance, to the Superintendent of Documents.

GEOLOGICAL SURVEY

Ground Water in Lasalle and McMullen Counties, Texas. ALEXANDER DEUSSEN AND R. B. DOLE. Water Supply Paper 375-G, from Contributions to the Hydrology of the United States, 1915, pp. 141-73; published February 17, 1916. This report includes a discussion of the general characteristics of water and the relation of the quality to geologic strata and the geographic position. The desirable characteristics of water for domestic use, for irrigation, and for boiler use are discussed and a tabulation of analyses of water from these districts is included.

DEPARTMENT OF AGRICULTURE

Milling and Baking Tests of Wheat Containing Admixtures of Rye, Corn Cockle, Kinghead and Vetch. R. C. MILLER. Department Bulletin 328. 24 pp. Paper, 10 cents. "The results of these tests show that the presence of more than 2 per cent of any of these impurities in wheat as milled has detrimental effects on the milling and baking qualities."

Utilization of American Flax Straw in the Paper and Fiber-Board Industry. JASON L. MERRILL. Department Bulletin 322. 24 pp. Paper, 5 cents. This report gives an account of recent work regarding utilization of straw from American seed-flax. It is of interest to chemists and manufacturers as well as to flax farmers.

Fermented Milks. L. A. ROGERS. Department Bulletin 319. 31 pp. Paper, 5 cents. This bulletin describes the various forms of fermented milks, discusses their food value and gives a bibliography on the subject.

The Milling of Rice and Its Mechanical and Chemical Effect upon the Grain. F. B. WISE AND A. W. BROOMELL. Department Bulletin 330. 31 pp. Paper, 10 cents.

The Present Status of the Pasteurization of Milk. S. HENRY AYERS. Department Bulletin 342. 16 pp. Paper, 5 cents.

The Utilization of Cherry By-Products. F. RABAK. Department Bulletin 350. 24 pp. This article describes investigation made to determine methods for the application of materials now waste products in the cherry industry. Applications for fixed and volatile oil, meal and juice are discussed.

Boron: Its Absorption and Distribution in Plants and Its Effect on Growth. F. C. COOK. Journal of Agricultural Research, 5 (Feb. 7), 877-90.

Relation between the Properties of Hardness and Toughness of Road-Building Rock. PREVOST HUBBARD AND F. H. JACKSON, JR. Journal of Agricultural Research, 5 (Feb. 7), 903-7.

Nitrogen Content of the Humus of Arid Soils. FREDERICK J. ALWAY AND EARL S. BISHOP. Journal of Agricultural Research, 5 (Feb. 14), 909-16.

Some Factors Influencing the Longevity of Soil Microorganisms Subjected to Desiccation, with Special Reference to Soil Solution. WARD GILTNER AND H. VIRGINIA LANGWORTHY. Journal of Agricultural Research, 5 (Feb. 14), 927-42.

Apparatus for Measuring the Wear of Concrete Roads. A. T. GOLDBECK. Journal of Agricultural Research, 5 (Feb. 14), 951-4.

A Method of Correcting for Soil Heterogeneity in Variety Tests. FRANK M. SURFACE AND RAYMOND PEARL. Journal of Agricultural Research, 5 (Feb. 28), 1039-50.

Chemical Testing of Milk and Cream. ROSCOE H. SHAW. Unnumbered publication from the Bureau of Animal Industry; issued February 17, 1916. 38 pp. This report gives complete simple laboratory instructions for determination of fat, total solids, specific gravity and acidity of milk and cream and gives directions for calculating total solids by formula and for the detection of preservatives. A list of chemicals and apparatus necessary for this analytical work is given. The whole constitutes a virtually primer of milk-testing methods.

BUREAU OF MINES

Economic Methods of Utilizing Western Lignites. E. J. BABCOCK. Bulletin 89. 67 pp. Paper, 15 cents. "The purpose of this bulletin is to present a summary of the results thus far obtained in the work done at the college of mining engineering and at the mining substation of North Dakota, and to indicate the prospects that the results hold out for the future development of the lignite fields of the West.

"In this work special attention has been paid to the production of gas and its utility and economy for heating, lighting, and power purposes and the manufacture of briquets. In addition, many other improvements in methods of burning and utilizing lignite have been attempted. As the Federal Government controls great tracts of land underlain with lignite, it has a direct interest in the utilization of this fuel, and the Bureau of Mines, in its investigations of fuels belonging to or for the use of the Government, has cooperated in the study of lignite.

"What has been accomplished in this experimental work leads to the belief that great improvements can be made in the methods of utilizing lignite and in the manufacture of cheap gas for power and other purposes, and that the making of high-grade fuel briquets can be put on a commercially satisfactory basis. The result will be that not only will lignite be much more serviceable and much more generally used, but an immense quantity of slack and coal that would otherwise be wasted will be saved.

"Furthermore, by the process described in this bulletin, large quantities of gas, especially valuable for power purposes, may be obtained at a low cost, as the work thus far carried on indicates that this gas can be used successfully with an internal combustion engine for the production of electricity so as greatly to reduce the cost of power production and thus make possible a wide utilization of cheap electricity for industrial purposes."

The methods of handling lignite and of briquet manufacture and testing which have been found most desirable are described, including the machinery and commercial equipment needed for this work.

Manufacture of Gasoline and Benzene-Toluene from Petroleum and Other Hydrocarbons. W. F. RITTMAN, C. B. DUTTON AND W. E. DEAN. Bulletin 114. 268 pp. Paper, 35 cents. (The free supply of this publication is exhausted, copies can be secured only through the Superintendent of Documents

at the price named.) For an extended abstract of this Bulletin see THIS JOURNAL, 8 (1916), 351-61.

The full paper includes an extended bibliography of the subject which has been compiled by M. S. Howard.

BUREAU OF STANDARDS

Value of the High-Pressure Steam Test of Portland Cements. R. J. WIG AND H. A. DAVIS. Technologic Paper 47. 34 pp. Paper, 15 cents. "The investigation reported in this paper was made to establish, if possible, a relationship between the behavior of Portland cements in high-pressure steam and their physical properties under normal conditions of use and exposure, and to determine what value, if any, the high-pressure steam test has as a means of detecting unsoundness which might cause a weakening or disintegration of the cement or concrete.

"For practical work under normal conditions of construction, the results of this investigation fail to show that the high-pressure steam test is of value as a means of determining the ultimate soundness of concrete."

Standard Test Specimens of Zinc Bronze. Part I. Preparation and Specifications. C. P. KARR. Technologic Paper 59. Pp. 1-45. Paper, 25 cents. "For the present investigation the following tests were finally decided upon to be carried out in connection with the methods of preparing the alloy:

"1—Experiments to determine the best form of test block and test piece.

"2—Tests to determine the best casting temperature, to be made after the best form of test block and test piece have been determined.

"3—Tests of the following sorts on all the bars cast for the tests Nos. 1 and 2 above: (1) Tensile test, including the determination of elongation, reduction of area, and tensile strength, and recording of the stress-strain curve; (2) compression test; (3) study of microstructure; (4) thermal analysis.

"With the exception of the compression tests, this program has been carried out as planned.

"The operations of casting and molding, etc., as well as the experiments on the variations in foundry practice, are described in considerable detail, so that the exact bearing of the results obtained may be the more readily appreciated, and for the reason, well known to practical foundrymen, that minute variations in seemingly insignificant details are often crucial in determining the resulting properties of the cast metal."

Appendix A gives complete set of suggested specifications for preparation of standard zinc bronze test bars.

Part II. Microstructure. HENRY S. RAWDON. Technologic Paper 59. Pp. 47-67. Included with above publication, in paper, 25 cents. "The general conclusion from the study of the microstructure is that the presence of oxides is a much more potent source of mechanical weakness of the alloy in its cast condition than any of the other causes enumerated. From the standpoint of microstructure, the variations in methods of casting, pouring temperature, etc., are to be regarded primarily as means for the production of sound oxide-free material and to confer no mysterious properties upon the alloy. The frequent occurrence of oxides in this series, prepared under careful supervision and using precautions for avoiding such contaminations, suggests the abundance of such inclusions in similar alloys as prepared commercially. The failure of such cast alloys for many purposes is most probably to be ascribed to the presence of oxide films rather than to any other cause."

From this investigation the following conclusions are drawn:

"(a) The addition of the small percentage of zinc does not affect the theoretical microstructure of the alloy.

"(b) The method of casting, pouring temperature, etc., affect the structure only indirectly by influencing the rate of cooling, amount and distribution of inclusions, etc.

"(c) The microstructure offers an explanation for the characteristic appearance of the tensile bars after testing.

"(d) Of the various microstructural features affecting the physical properties, oxide films must be considered to exert the greatest influence, by far.

"(e) The changes of microstructure accompanying annealing are explained and illustrated."

Determination of Carbon in Steels and Irons by Direct Combustion in Oxygen at High Temperatures. J. R. CAIN AND H. E. CLEAVES. Technologic Paper 69. 10 pp. Paper, 5 cents. Published practically in full, THIS JOURNAL, 8 (1916), 321-4.

PUBLIC HEALTH SERVICE

Vitamines and Nutritional Diseases. A. SEIDELL. Public Health Reports, 31 (Feb. 18, 1916), pp. 364-9. Available also as a reprint. This article reports on a stable form of vitamine, which is efficient in the prevention and cure of certain nutritional deficiency diseases. The source of the material is the waste brewers' yeast which appears to be rich in the valuable constituents.

Publicity of Formulas of Package Medicines. MARTIN I. WILBERT. Public Health Reports, 31 (March 17, 1916), pp. 711-14. This is a discussion of recent legislation and the nature of requirements which are effective in affording reasonable publicity as to the exact composition of proprietary drugs. It is argued that the value of published formulas is so great as to fully justify this publicity.

SANITARY LEGISLATION

Poisons and Habit-Forming Drugs. MARTIN I. WILBERT. Public Health Reports, 31 (Feb. 25, March 3 and 10, 1916), pp. 468-511, 551-610, and 651-703. This is a long report which consists of a digest of laws and regulations, which have been enacted during 1914 and 1915 in the United States, regulating the possession, use, sale, and manufacture of poisons and habit-forming drugs. The material is presented as a third supplement to Public Health Bulletin 56. The preceding supplements are available as reprints of the Public Health Service Nos. 146 and 240.

Selling Foodstuffs Containing Arsenic. Public Health Reports, 31 (March 3, 1916), p. 550. This is a report on the case of Weeks v. United States, 224 Fed. Rep. 69, in which the United States Circuit Court of Appeals decided that a conviction was justified for selling shellac varnish for use in glazing cheap candies even though it appeared improbable to the person selling the material that the quantity of arsenic was sufficient to be injurious to the health. The sales company claimed that the quantity was not sufficient to be deleterious to health under any ordinary conditions but the findings of the jury as to this question were of the opposite import. It was held that the jury should properly determine this question.

Regulation of Industries in which Poisonous Fumes or Dusts May Be Produced. Illinois Legislature Act, June 29, 1915. Public Health Reports, 31 (March 17, 1916), pp. 746-51. This regulation makes certain provisions as to the prevention of industrial diseases which result in factories and elsewhere because of the fumes and dust produced. The requirements are of interest to chemical works affected.

Efficacy of Antiseptic Dressing for Floors. Louisiana Board of Health Regulation, January 18, 1915. Public Health Reports 31 (March 17, 1916), p. 759. This regulation specifies that manufacturers and dealers submitting floor dressing for

use in schools must give to the State Board of Health satisfactory evidence from reputable bacteriologists and must submit a guarantee that the materials are efficient for the purposes for which they are sold.

Production, Care, and Sale of Milk and Milk Products. Revised Regulations of Louisiana Board of Health, June 15, 1915. Public Health Reports, 31 (Mar. 17, 1916), pp. 755-8.

Standards for Viruses, Serums, Toxins, and Analogous Products. Regulation 104, Minnesota Board of Health, adopted November 14, 1915. Public Health Reports, 31 (March 24, 1916), p. 793. This regulation forbids the use of any of these products for therapeutic purposes, if their efficacy has been disapproved by the United States Public Health Service.

Labelling Articles Containing Wood Alcohol. Act of the Rhode Island Legislature, adopted March 12, 1915, Chap. 1183. Public Health Reports, 31 (March 24, 1916), p. 814. The conditions under which methyl alcohol can be used in articles sold for external or internal use are prescribed.

COMMERCE REPORTS—MARCH, 1916

A plant for the production of soda ash and by-products is to be established in Holland. (P. 833.)

Manganese ore is now being shipped from Colon, Panama, to the United States. (P. 839.)

The provisions of the recent Japanese law for the subsidizing of companies for manufacturing dyes and drugs are given. (P. 874.)

Efforts are being made to develop, under government supervision, the mining resources of Hupeh Province, China, especially iron, coal, lead and copper. (P. 887.)

In a recent British process, wool is being dyed various shades of yellow and khaki color, by treatment with nitric acid (about 5 per cent HNO₃) at a temperature of 180° F., and subsequent immersion in alkali, or alkaline mordants. (P. 898.)

Among the native drugs exported from Siam are gum, benzoin, gamboge, cutch, cardamoms, licorice, turmeric, and sesame. (P. 916.)

The Chilean nitrate industry continues to improve. (P. 918.)

The saving and collection of rags and old paper are urged in order to relieve the present shortage of paper stock. (P. 929.)

Efforts are being made to develop the production of tanning extract from Brazilian mangrove. (P. 935.)

An experimental electric copper smelter with a capacity of 12 tons of ore per day is being tried out in Newfoundland. (P. 950.)

Owing to the demand for natural dyes, the production of cutch, used for both dyeing and tanning, is increasing in Borneo. (P. 958.)

The price of camphor in Japan shows a marked increase. (P. 979.)

A serious shortage of wood pulp exists in Spain. (P. 981.)

Barrels for the shipment of sugar are being made in Hawaii from fiber board produced from bagasse. (P. 984.)

A proposal is made to cast sewer pipes and bricks directly from molten lava in Hawaii. (P. 994.)

Conditions in the cement industry of Silesia are distinctly unfavorable. (P. 998.)

Recommendations of a committee of the British Board of Trade include protective tariff upon paper, silverware, cutlery, glass and earthenware. (P. 1000.)

The new mining law of Chosen (Korea) restricts new claims

to Japanese subjects; and foreigners acquiring old claims must have their head office in Chosen. (P. 1003.)

It is predicted by the U. S. Geological Survey that the oil shales of Colorado, Utah, and Wyoming will provide a large part of the gasoline and other oils for this country. (P. 1007.)

Abundant quantities of rock-crystal are available in Brazil. (P. 1070.)

The Bureau of Standards is investigating the danger involved in the filtration of gasoline through chamois, etc., due to the production of an electrical charge, which may give rise to a spark. (P. 1125.)

A decrease in the output and consumption of coal in British Columbia is attributed to the increasing use of imported fuel oil. (P. 1126.)

Calcium carbonate made in this country has been found to be a satisfactory substitute for English whiting for use in ceramic glazes and bodies. New domestic sources for glass pot and crucible clays have been discovered. (P. 1131.)

The U. S. Geological Survey will have this year twelve parties studying the mineral and water power resources of Alaska. (P. 1133.)

The mineral production of Canada in 1915 shows an increase for all metals except silver; and a decrease in building materials. (P. 1136.)

In stating the opportunities for labor-saving machinery in the Chilean nitrate beds, the present methods of operation are desired. (P. 1144.)

A new English method for recovery of grease and potash from wool scouring liquors involves separation of the free grease by centrifuging and repeated use of the liquor till it contains 6-8 per cent of potash, when it is evaporated for recovery of the potash. (P. 1172.)

The German Government is taking measures to increase the sugar beet cultivation in that country. (P. 1187.)

In order to provide a supply of tungsten, the British Government has taken over all stocks of tungsten ores in British colonies. (P. 1191.)

The new edition of the U. S. Pharmacopoeia will make use of the metric system exclusively. (P. 1208.)

The greatly increased production and export of porcelain, etc., from Japan has necessitated the introduction of improved methods and machinery. (P. 1218.)

Normally most of the platinum output of Colombia is exported to England, but in 1915 over 11,000 ounces were exported to the United States. (P. 1219.)

Recent observations of the Bureau of Standards upon concrete roads confirm their previous conclusion, that concrete expands in winter and spring owing to increase of moisture content, and contracts in summer due to loss of moisture. (P. 1223.)

Large quantities of dyewoods are available in Santo Domingo, especially fustic and logwood. (P. 1254.)

Supplements issued in March are 5a France, 23b British Columbia.

STATISTICS OF EXPORTS TO THE UNITED STATES. (Pp.)

FRANCE—Sup. 5a	BRITISH COLUMBIA— Sup. 23b	STRAITS SETTLEMENTS —1175
Albumen	Gold	Benzine
Aluminum	Cascara	Gambier
Bones	Fertilizer	Gum copal
Chemicals	Fire-brick	Gum damar
Pottery	Glycerine	Gutta jelutong
Drugs	Hides	Gutta-percha
Glassware	Rubber	Mangrove bark
Glue	Lime	Rubber
Glycerine	Copper ore	Tin
Hides	Potash	
Soap	Whale oil	
Platinum, etc.		
Saffron		

BOOK REVIEWS

Transactions of the American Institute of Chemical Engineers. Vol. VII (1914). Office of the Secretary, Cooper Union, New York, N. Y. Published by the Institute through D. Van Nostrand Company, New York, 1915. 8vo. iii + 308 pp.

The seventh volume of these Transactions is somewhat larger than its predecessor. This is because of the greater average length of the papers published and because an unusual number of illustrations are included in the volume. Many of these have never been previously published elsewhere and cover operations hitherto unpictured. The volume is printed on a better surfaced paper than customary with the series and, therefore, does justice to the illustrations. In other respects it is built and arranged like the preceding one except that some committee reports are included, for the first time in three years. In this case they are the previously omitted reports of progress of the Institute's Committee on Chemical Engineering Education.

The following addresses, reports and papers read before the Institute are contained in the publication:

- "Some Professional Obligations," M. C. Whitaker.
- "Distribution of Industrial Opportunities," G. O. Smith.
- "Report of the Committee on Chemical Engineering Education."
- "The Present Status of the Chemical Engineering Work of the American Institute of Chemical Engineers."
- "Report of the Committee on Chemical Engineering Education."
- "The Need of Revised Chemical Statistics," B. C. Hesse.
- "The Application of Physical Chemistry to Industrial Processes," W. F. Rittman.
- "The Use of Hydrometallurgical Apparatus in Chemical Engineering," J. V. N. Dorr.
- "Studies on Filtration," J. W. Bain and A. E. Wigle.
- "Scrubber for Chemical Laboratory Vacuum System," C. Baskerville.
- "Shoddy and Carbonized Waste," L. J. Matos.
- "Chemistry of the Bleaching of Cotton Cloth," J. C. Hebden.
- "Ozone in Ventilation," J. C. Olsen and Wm. H. Ulrich.
- "The Present Patent Situation," M. Toch.
- "The Development of the Rotary Kiln and Its Application to Various Chemical and Metallurgical Processes," R. K. Meade.
- "A Combination Water Softener and Storage Tank," L. M. Booth.
- "Feldspar as a Possible Source of American Potash," A. S. Cushman and G. W. Coggeshall.
- "The Hardwood Distillation Industry in America," E. H. French and J. R. Withrow.
- "Painting Defects, Their Causes and Prevention," G. W. Thompson.
- "Code of Ethics."

This volume illustrates like its predecessors the Institute's varied interests. The address of the retiring president, Mr. Whitaker, on "Some Professional Obligations," bears much food for thought and should be read by every chemist as well as chemical engineer. The need of revised chemical statistics, greatly accentuated by present conditions, is clearly emphasized by Dr. Hesse and it is to be regretted that the Institute was unable to secure the services of Dr. Hesse as chairman of its committee to assist in ameliorating the present condition of chemical statistics. The paper by Dorr on the possibilities in the use of his well-known hydrometallurgical apparatus in chemical engineering will mark a new epoch in chemical engineering progress. This will take time and patient development but bids so fair that we have wondered for years why chemical engineers in certain lines did not give these devices more attention. The paper by Thompson is in his well-known thorough style. A distinct contribution to the bleaching problem is made by Hebden. The other papers in the list are enrichments of the literature and should encourage others to open their hearts and tell the details of their industries in turn for the benefit of general development.

JAMES R. WITHROW

The Metallography and Heat Treatment of Iron and Steel. By ALBERT SAUVEUR. Second Edition. 486 pp., 438 illustrations. Sauveur & Boylston, Cambridge, Mass.: Price, \$6.00.

This second edition of Sauveur's "Metallography of Iron and Steel" is a complete revision, some fifty pages of text and

about 100 new illustrations having been added. The first 85 pages deal with apparatus for the metallographic laboratory and their manipulation, the methods of preparation and of etching specimens, etc.

Chapter IV, on pure metals, takes up their structure, the effect of strain and of annealing, and explains very clearly the amorphous cement theory of Beilby and Rosenhain, Twinning, Neumann lines. Next the structure of pure iron is explained, followed by chapters on wrought iron, low-carbon, medium, and high-carbon steel. Of very great interest is the chapter on the impurities in steel. Some 50 pages discuss the critical points of iron and steel, their causes and effects. Next comes the structure of cast steel, the effect of hot and cold work, the annealing and hardening and the tempering of steel with a short, clear presentation of the various theories of hardening. Cementation and case-hardening are followed by an excellent discussion of alloy steels. Cast iron, its impurities and their effects on structure; malleable cast iron and its course of changes are then dealt with. On page 396, in discussing the proximate chemical analysis of cast iron of 2 per cent Si, the whole of this is set down as FeSi, instead of Fe₂Si. All of the manganese is taken as combining with the S and the carbon to form MnS and Mn₃C: some of it finds its way into the ferrite of the pearlite, we believe.

Chapter XXV—the constitution of metallic alloys—is very elementary, dealing only with the copper-nickel (or Pt-Au) and the silver-copper type curves. The Sb-Pb curve is given with the eutectic at 228° C. instead of 247° C.

The chapter on the equilibrium diagram of the iron-carbon alloys is brief and to the point. One obvious error occurs in explaining the freezing of a hypo-eutectic cast iron, Fig. 411, by saying that it begins to solidify at 1230° C., when crystals of iron containing 1.7 per cent C (saturated austenite) begin to form! Again, the statement that the eutectic is composed of minute crystals of saturated austenite and minute crystals of cementite, is hardly acceptable—a mechanical mixture, of course, with a typical eutectic structure, but not of minute crystals surely.

Taken as a whole the book is a good one, and gives a broad presentation of the metallography of iron and steel in a simple, straightforward manner. With such a book at hand, no one interested in iron and steel, their properties and treatment, can excuse his ignorance of metallography by saying it is too abstruse for anyone outside of a college. It is a book for the practical man just as much as for the worker in the college laboratory. Taken in sections, there is but one criticism of any weight, and that deals with the chapter on the constitution of metallic alloys. This is too short for a book of the size. The main type diagrams could easily be explained, with examples such as Fe-Mn: Fe-Ni: Fe-Cu: Fe-Si: Fe-Phos; and lastly Fe-FeS. In fact, a page on the simplest case of ternary alloys used to explain the phosphide eutectic in high phosphorus cast iron could also be added.

Professor Sauveur is to be congratulated on giving us a book that is interesting, practical and useful.

WILLIAM CAMPBELL

Nahrungsmittel chemie in Vorträgen. Herausgegeben von DR. W. KERP. Leipzig: Akademische Verlagsgesellschaft, 1914. Price in paper, M. 26.50; bound, 28 M.

This volume of 579 pages reports the lectures delivered in the first *Fortbildungskursus* for German food chemists (March,

1912). The topics, authors, and distribution of space are as follows:

General outline of food legislation and control in Germany (Kerp), 32 pages; Application of modern physicochemical theory to food chemistry (Paul), 78 pages; Recent studies of cell metabolism by chemical methods (Abderhalden), 14 pages; Biological differentiation of the proteins with special reference to forensic blood and flesh investigation (Uhlenhuth), 48 pages; Problems of the day in food chemistry (Kerp), 32 pages; Recent developments in the legal aspects of food chemistry (Juckenack), 30 pages; Customs- and impost-problems for the food chemist (Fritzweiler), 20 pages; Control of the milk industry (Mai), 16 pages; Biology of milk (Weigmann), 32 pages; Recent methods for the investigation of edible fats and oils (Heiduschka), 19 pages; Wine problems (Kulisch and Gunther), 112 pages; Brandy (von Buchka), 8 pages; Recent methods for the examination of honey (Friehe), 33 pages; Water and sewage (Grünhut), 93 pages; Forensic chemistry and microscopy (Popp), 27 pages.

Kerp points out that the latest of the laws controlling commerce in commodities of popular consumption in Germany, the wine law of 1909, was enacted just 30 years later than the fundamental food law of 1879. He then proceeds to review the development of the food industry in Germany during that period (with statistics for the year 1909-10) and to outline the food laws and the functions of the food chemist. Under problems of the day in food chemistry he discusses the use of preservatives in food, the renovation of butter, refined vegetable fats, the coating of rice, the bleaching of flour, the greening of vegetables by means of copper salts, the glazing of coffee and the problem of substitutes in foods and beverages. Paul reviews the ionization theory, especially in its application to analytical methods and the interpretation and expression of results, beginning with Arrhenius and ending with such problems as the selection of indicators, the determination of "free" and "bound" sulfurous acids in foods, and the method of stating results of a mineral water analysis.

The scope of the other chapters is sufficiently indicated by their titles.

General criticisms of the volume are scarcely feasible because of the diversity of topics upon which it touches and the differences of method and style among the numerous authors who have independently written the separate chapters which compose the book. The fact that these were originally prepared especially as lectures to be delivered by and to official German food chemists adds interest and weight to the work as a presentation of the German viewpoint. It remains to be seen in what way and to what fact this viewpoint will be permanently modified as the result of the friendly attitude toward the *Ersatz* made necessary by war conditions in Germany.

As a means of comparing the problems of the German food chemist with our own, and as indicating the judgment of the German committee in charge as to the subject matter most needed in a *Fortbildungskursus* for food chemists, as well as for its summaries of recent advances in certain lines of food analysis, the work should be of distinct interest to chemists engaged in the food industries or in food control.

H. C. SHERMAN

Explosives, Their Manufacture, Properties, Tests and History.

By ARTHUR MARSHALL, A.C.G.I., F.I.C., F.C.S., Chemical Inspector, Indian Ordnance Department, Naini Tal, India, 1915. P. Blakiston's Son & Co., Philadelphia. 624 pages, 137 illustrations. Price, \$7.00 net.

This book is probably the most comprehensive general work on the subject of explosives that has been published in English, and contains much of interest and value to the manufacturer

or chemist in the explosives industry, as well as to the student. It is largely a collection of well-chosen facts from the best literature on the subject, including most of the best material published in the journals in recent years. The author's general treatment of the subject shows excellent insight into the many topics discussed, and indicates both a practical knowledge of the industry and a thorough familiarity with the literature on the subject. References to original articles are liberally supplied—a fact which greatly increases the value of the book—and it is gratifying to note the numerous references to American work.

A thorough review of this book would cover many pages, and it is therefore impossible to enter into any great detail in this review. The author has given his attention chiefly to subjects which have not been already fully discussed in other books. Thus, he has considered only briefly the details of manufacture and practical use of explosives, but has elaborated on such subjects of present-day interest as the stability of nitrocellulose, developments in physical and chemical testing of explosives, improvements in means of initiating explosive reactions, etc. A review of the early history of explosives and their development up to the present time occupies 39 pages. The manufacture of black powder (34 pp.) and its raw materials, and the manufacture of nitric and sulfuric acids (20 pp.) are discussed only briefly. Of interest to explosives manufacturers is the unfortunately too brief discussion of mixed and waste acids, their handling and recovery. The usual processes of nitrating cellulose and nitrocellulose, including the displacement process, are described in detail, and the most recent knowledge of stabilization well presented. Nitroglycerin, its raw materials, properties and manufacture (40 pp.), and smokeless powders, their composition, manufacture and requirements, including shot-gun powders (34 pp.), are given due consideration. Under Solvents special attention is given to the subject of acetone, its manufacture, impurities and recovery from cordite, presenting facts not available in the literature. The discussion of blasting explosives (34 pp.) includes nitroglycerin explosives, chlorate explosives and ammonium nitrate explosives. The suitability of various explosives for purposes of peace and war is briefly treated in 15 pages. Under Properties of Explosives (82 pp.) is found a summary of the latest work on the thermochemistry of explosives, a very good discussion of the rate of detonation of explosives, and a description of recent investigations of detonating compositions. All of the important physical tests for explosives are described. Special explosives (40 pp.) treats of safety and detonating fuses, detonators, and "safety explosives" for coal mining, describing the tests made at all of the U. S. and European testing stations: 22 pages are devoted to the proper construction and protection of factory buildings, magazines, etc.

Under Stability and Stability Tests (27 pp.) is a good discussion of the decomposition of smokeless powders, its retardation by the use of various stabilizers, and the more commonly used stability tests. In the section devoted to Materials and their Analysis, the author has attempted to discuss in 53 pages the general methods for testing most of the materials used in the manufacture of explosives, and the preparation and properties of many of them. The list includes acids, solvents, glycerin, cotton, nitroglycerin, nitrocellulose, azides, fulminates, and nitrosubstitution compounds. Many important points are necessarily treated only briefly. An appendix contains the Imperial German Railway Commission's regulations regarding tests of explosives for safety in transportation, and also some excellent thermochemical tables.

The entire book is exceptionally free from typographical errors and is excellently illustrated.

C. G. STORM

NEW PUBLICATIONS

By IRENE DeMATTY, Librarian, Mellon Institute of Industrial Research, Pittsburgh

- CORRECTION:** The Metallography and Heat Treatment of Iron and Steel. ALBERT SAUVEUR. The price of \$4.00 quoted in THIS JOURNAL, 8 (1916), 393, should read \$6.00. The publishers are Sauveur & Boylston, Cambridge, Mass., and not the McGraw-Hill Book Co.
- Ammonia:** The Thermodynamic Properties of Ammonia. F. G. KEYES AND R. B. BROWNLEE. 4to. 73 pp. Price, \$1.00. John Wiley & Sons, New York.
- Analysis:** Outline of the Methods of Qualitative Chemical Analysis. R. J. CARNEY. 6th Ed. Svo. 37 pp. Price, \$0.20. G. Wahr, Ann Arbor.
- Atom:** The Universe and the Atom; the Ether Constitution, Creation and Structure of Atoms. MARION ERWIN. 12mo. 314 pp. Price, \$2.00. D. Van Nostrand Co., New York.
- Coal and Coke.** F. H. WAGNER. Svo. 413 pp. Price, \$4.00. McGraw-Hill Book Co., New York.
- Concrete and Reinforced Concrete.** W. L. WEBB AND W. H. GIBSON. 12mo. Price, \$1.50. American Technical Society, Chicago.
- Explosives:** Manual on Explosives. A. F. J. RAMSEY AND H. C. WESTON. Svo. 123 pp. Price, \$0.25. George Routledge & Sons, London.
- Galvanizing and Tinning.** W. T. FLANDERS AND OTHERS. Svo. 350 pp. Price, \$3.00. D. Williams Co., New York.
- Gas:** Das Gas als Warmequelle und Triebkraft. F. SCHAEFFER AND OTHERS. Svo. 249 pp. Price, \$3.00. R. Oldenbourg, Munich.
- Iron:** Die physikalische und chemische Grundlagen d. Eisenhuettenwesens. WALTHER MATHESIUS. Svo. Price, \$5.20. O. Spamer, Leipzig.
- Lathe Design, Construction and Operation.** C. O. E. PERRIGO. Svo. 469 pp. Price, \$2.50. Norman W. Henley Publishing Co., New York.
- Machine Design, Questions and Problems in.** F. D. FURMAN. Svo. 68 pp. Price, \$0.80. The Author, Hoboken, N. J.
- Metallurgists' and Chemists' Handbook.** D. M. LIDDELL. 16mo. 603 pp. Price, \$4.00. McGraw-Hill Book Co., New York.
- Organic Chemistry: Grundriss der Organischen Chemie.** CARL OPPENHEIMER. 9th Ed. Svo. 168 pp. Price, \$0.75. G. Thieme, Leipzig.
- Oxy-Acetylene Welding and Cutting.** H. P. MANLY. Svo. 215 pp. Price, \$1.00. Fred. J. Drake & Co., Chicago.
- Packing House and Cold Storage Construction.** H. P. HENSCHEN. Svo. 310 pp. Price, \$5.00. Nickerson & Collins Co., Chicago.
- Physiological Chemistry.** A. P. MATTHEWS. Svo. Price, \$5.25. Baillière, Tindall & Cox, London.
- Potassium Salts: Die Kalirohsalze, ihre Gewinnung und Verarbeitung.** W. MICHELS AND C. PRZIBYLLA. Svo. Price, \$4.60. O. Spamer, Leipzig.
- Power Plant Design.** E. F. MILLER. 4to. 178 pp. Price, \$1.50. Suffolk Engraving & Electrotyping Co., Boston.
- Rubber: Its Sources, Cultivation and Preparation.** HAROLD BROWN. 12mo. 245 pp. Price, \$2.00. D. Van Nostrand Co., New York.
- Rubber Industry of the Amazon.** J. F. WOODRUFFE. Svo. 435 pp. Price, \$5.50. G. E. Stechert & Co., New York.
- Salt and Alkali Industry, Including Potassium Salts and the Stassfurt Industry.** GEOFFREY MARTIN AND OTHERS. Svo. 108 pp. Price, \$1.90. Crosby Lockwood & Son, London.
- Steel: The Metallography of Steel and Cast Iron.** H. M. HOWE. Svo. 641 pp. Price, \$10.00. McGraw-Hill Book Co., New York.
- Steel and Its Heat Treatment.** D. K. BULLENS. Svo. 431 pp. Price, \$3.75. John Wiley & Sons, New York.
- Sulfuric Acid and Sulfur Products.** GEOFFREY MARTIN AND J. L. FOUCAR. Svo. 93 pp. Price, \$1.90. Crosby Lockwood & Son, London.
- Technical and Scientific German.** E. V. GREENFIELD. Svo. 284 pp. Price, \$1.00. D. C. Heath & Co., New York.
- Thermodynamics: Les theories statistiques en thermodynamique.** H. A. LORENTZ. Svo. 120 pp. Price, \$1.50. B. G. Teubner, Leipzig.
- Thermodynamics: Text Book of Mechanics.** Vol. 6. L. A. MARTIN, JR. 12mo. 313 pp. Price, \$1.75. John Wiley & Sons, New York.
- Water:** Harper's Hydraulic Tables for the Flow of Water. J. H. HARPER. 192 pp. Price, \$2.00. D. Van Nostrand Co., New York.
- Blast Furnace: The Raw Materials of the Blast Furnace.** J. E. JOHNSON, JR. *Metallurgical and Chemical Engineering*, Vol. 14 (1916), No. 6, pp. 318-323.
- Ceramics: Der Weltmarkt in keramischen Waren im Jahre 1915.** L. W. SCHMIDT. *Sprechsaal*, Vol. 49 (1916), No. 8, pp. 55-57.
- Chemical Testing in Sulfite Pulp Work.** R. B. WOLF. *Paper*, Vol. 18 (1916), No. 1, pp. 11-14.
- Coking and Caking Coal.** S. H. VIALI. *Power*, Vol. 43 (1916), No. 13, pp. 432-434.
- Colors: Das absolute System der Farben.** WILHELM OSTWALD. *Zeitschrift fuer physikalische Chemie*, Vol. 101 (1916), No. 2, pp. 129-142.
- Copper: Some Sources of Errors in the Iodometric Determination of Copper.** C. E. SMITH. *Metallurgical and Chemical Engineering*, Vol. 14 (1916), No. 7, pp. 379-380.
- Electrolytic Zinc.** H. A. B. MOTHERWELL. *Mining and Scientific Press*, Vol. 112 (1916), No. 12, pp. 401-403.
- Electrostatics of Flotation.** F. A. FAHRENWALD. *Mining and Scientific Press*, Vol. 112 (1916), No. 11, pp. 375-378.
- Flotation: Interfacial Tension in Flotation.** H. J. STANDER. *Engineering and Mining Journal*, Vol. 101 (1916), No. 13, pp. 576-578.
- Furnace Slag, Uses of.** HERBERT LANG. *Mining and Scientific Press*, Vol. 112 (1916), No. 13, pp. 443-445.
- Gas Producers, Operating Characteristics of.** FRANZ DENK. *Blast Furnace and Steel Plant*, Vol. 50 (1916), No. 4, pp. 177-178.
- Hydrogen: The Technical Production of Hydrogen and Its Industrial Application.** H. L. BARNITZ. *Metallurgical and Chemical Engineering*, Vol. 14 (1916), No. 7, pp. 391-395.
- Inorganic Chemistry: Experimentelle anorganische Chemie und Elektrochemie im Jahre 1915.** A. GUTBIER. *Zeitschrift fuer angewandte Chemie*, Vol. 29 (1916), No. 17, pp. 69-76.
- Internal Combustion Engines, Influence of Compression in.** R. E. MATHOT. *Power*, Vol. 43 (1916), No. 15, pp. 512-514.
- Leather: Neuere Kunstleder und Ersatzstoffe fuer Leder.** R. LAUFFMANN. *Kunststoffe*, Vol. 6 (1916), No. 4, pp. 41-43.
- Mineral Industry of Chile.** L. W. STRAUSS. *Mining and Scientific Press*, Vol. 112 (1916), No. 14, pp. 475-478.
- Natural Gas in Ohio.** J. A. BOWNOCKER. *Journal of the Cleveland Engineering Society*, Vol. 8 (1916), No. 5, pp. 313-332.
- Poli-Oil, a New Adulterant of Ghee-Indian Clarified Butter-Fat.** J. H. BARNES. *The Analyst*, Vol. 41 (1916), No. 480, pp. 72-73.
- Resins: Synthetische Harze.** ROBERT ELLER. *Kunststoffe*, Vol. 6 (1916), No. 4, pp. 45-47.
- Rubber Waste, The Reclaiming of.** A. H. KING. *Metallurgical and Chemical Engineering*, Vol. 14 (1916), No. 6, pp. 309-311.
- Sedimentation and Flocculation.** E. E. FREE. *Engineering and Mining Journal*, Vol. 101 (1916), No. 12, pp. 509-513.
- Selby Lead Smelter.** T. A. RICKARD. *Mining and Scientific Press*, Vol. 112 (1916), No. 15, pp. 505-510.
- Spelter Statistics for 1915.** W. R. INGALLS. *Engineering and Mining Journal*, Vol. 101 (1916), No. 14, pp. 606-611.
- Steel: Some Recent Developments in Tool-Steel Testing.** E. G. HERBERT. *American Machinist*, Vol. 44 (1916), No. 10, pp. 419-421.
- Steel Rails: Nick and Break Steel Rail Test.** R. W. HUNT AND C. W. GENNETT, JR. *Iron Trade Review*, Vol. 58 (1916), No. 13, pp. 709-719.
- Sulfur: Die Bestimmung des Schwefels in der Zinkblende.** H. KOELSCH. *Chemiker-Zeitung*, Vol. 40 (1916), No. 24, p. 174.
- Surface Condensers.** A. B. CLARK. *Power*, Vol. 43 (1916), No. 13, pp. 437-439.
- Tannin: Kunstgerbestoffe.** R. LAUFFMANN. *Kunststoffe*, Vol. 6 (1916), No. 1, pp. 1-4.
- Tungsten Ores: Recent Practice in Concentrating Colorado Tungsten Ores.** H. C. PARMELEE. *Metallurgical and Chemical Engineering*, Vol. 14 (1916), No. 6, pp. 301-304.
- Ultraviolet: Apparatus for Producing Ultraviolet Radiation.** W. S. ANDREWS. *General Electric Review*, Vol. 19 (1916), No. 4, pp. 317-319.
- Welding: Some Brief Descriptions of Welding Processes.** M. W. WARD. *Power*, Vol. 43 (1916), No. 14, pp. 478-479.
- Wood Flour.** F. W. KRESSMANN. *Metallurgical and Chemical Engineering*, Vol. 14 (1916), No. 7, pp. 372-374.
- Wool Fat, Recovery of.** E. E. AYRES, JR. *Metallurgical and Chemical Engineering*, Vol. 14 (1916), No. 6, pp. 317-318.

RECENT JOURNAL ARTICLES

- Analysis: Methods of Rapid Analysis.** L. B. PRINGLE. *Engineering and Mining Journal*, Vol. 101 (1916), No. 15, p. 650.
- Antimony in China.** F. L. COLE. *Mining and Scientific Press*, Vol. 112 (1916), No. 11, pp. 369-373.

WHOLESALE PRICES PREVAILING IN THE NEW YORK MARKET ON APRIL 20TH.

INORGANIC CHEMICALS

Acetate of Lime, gray.....	100 Lbs.	7.00	@	7.05
Alum, lump.....	100 Lbs.	4.25	@	4.75
Aluminum Sulfate, high-grade.....	100 Lbs.	5.00	@	6.00
Ammonium Carbonate, domestic.....	Lb.	9 1/2	@	10
Ammonium Chloride, gray.....	Lb.	8	@	9
Ammonium Phosphate, commercial, 98-100%.....	Lb.	—	@	—
Aqua Ammonium, 16°, drums.....	Lb.	2 1/4	@	2 1/2
Arsenic, white.....	Lb.	6 1/2	@	—
Barium Chloride.....	Ton	115.00	@	140.00
Barium Nitrate.....	Lb.	15	@	16
Barytes, prime white, foreign.....	Ton	24.00	@	26.00
Bleaching Powder, 35 per cent.....	100 Lbs.	6.75	@	8.00
Blue Vitriol.....	Lb.	17	@	20
Borax, crystals, in bags.....	Lb.	6 3/4	@	7
Boric Acid, powdered crystals.....	Lb.	11 1/4	@	15
Brimstone, crude, domestic.....	Long Ton	29.00	@	30.00
Bromine, technical, bulk.....	Lb.	4.75	@	5.25
Calcium Chloride, lump.....	Ton	11.75	@	12.00
Calcium Chloride, granulated.....	Ton	14.78	@	15.00
Caustic Soda, 74 per cent.....	Lb.	5 3/4	@	6
Chalk, light precipitated.....	Lb.	4 1/2	@	5 1/4
China Clay, imported.....	Ton	15.00	@	18.00
Feldspar.....	Ton	8.00	@	12.00
Fuller's Earth, foreign, powdered.....	100 Lbs.	80	@	1.05
Glauber's Salt, in bbls.....	100 Lbs.	70	@	85
Green Vitriol, bulk.....	100 Lbs.	1.25	@	1.50
Hydrochloric Acid, commercial, 18°.....	100 Lbs.	2.50	@	3.00
Hydrochloric Acid, C. P., conc., 22°.....	100 Lbs.	3.00	@	3.50
Iodine, resublimed.....	Lb.	5.00	@	6.00
Lead Acetate, white crystals.....	Lb.	15 7/8	@	16
Lead Nitrate.....	Lb.	17 1/2	@	18
Litharge, American.....	Lb.	9 1/4	@	—
Lithium Carbonate.....	Lb.	90	@	1.00
Magnesium Carbonate.....	Lb.	10	@	11
Magnesite, "Calcined".....	Ton	—	@	—
Nitric Acid, 36°.....	Lb.	6 1/4	@	7
Nitric Acid 42°.....	Lb.	8 1/2	@	9 1/4
Phosphoric Acid, sp. gr. 1.750.....	Lb.	28 1/2	@	30
Phosphorus.....	Lb.	35	@	1.00
Plaster of Paris.....	Bbl.	1.50	@	1.70
Potassium Bichromate, casks.....	Lb.	56	@	60
Potassium Bromide.....	Lb.	—	@	—
Potassium Carbonate, calcined, 80 @ 85%.....	Lb.	85	@	90
Potassium Chlorate, crystals, spot.....	Lb.	72	@	—
Potassium Cyanide, bulk, 98-99 per cent.....	Lb.	—	@	—
Potassium Hydroxide.....	Lb.	90	@	92
Potassium Iodide, bulk.....	Lb.	4.30	@	4.35
Potassium Nitrate.....	Lb.	—	@	—
Potassium Permanganate, bulk.....	Lb.	1.80	@	1.90
Quicksilver, flask, 75 lbs.....	Lb.	125.00	@	—
Red Lead, American, dry.....	Lb.	9 3/4	@	—
Salt Cake, glass makers'.....	Ton	13.00	@	—
Silver Nitrate.....	Oz.	40 2/3	@	—
Soapstone in bags.....	Ton	12.00	@	—
Soda Ash, 48 per cent.....	100 Lbs.	3.00	@	4.00
Sodium Acetate.....	Lb.	13 1/2	@	14.00
Sodium Bicarbonate, domestic.....	100 Lbs.	1.75	@	2.00
Sodium Bicarbonate, English.....	Lb.	3 1/2	@	3 5/8
Sodium Bichromate.....	Lb.	60	@	70
Sodium Carbonate, dry.....	100 Lbs.	4.00	@	4.25
Sodium Chlorate.....	Lb.	45	@	55
Sodium Fluoride, commercial.....	Lb.	18	@	20
Sodium Hyposulfite.....	100 Lbs.	2.25	@	2.50
Sodium Nitrate, 95 per cent, spot.....	100 Lbs.	3.40	@	3.50
Sodium Silicate, liquid.....	100 Lbs.	1.25	@	1.75
Sodium Sulfide, 30%, crystals, in bbls.....	Lb.	2	@	2 1/2
Sodium Sulfite, crystals.....	Lb.	7	@	8
Strontium Nitrate.....	Lb.	22	@	24
Sulfur, flowers, sublimed.....	100 Lbs.	2.30	@	2.70
Sulfur, roll.....	100 Lbs.	1.95	@	2.25
Sulfuric Acid, chamber, 60°.....	Ton	65.00	@	70.00
Sulfuric Acid, conc., sp. gr. 1.842.....	100 Lbs.	2.50	@	3.00
Sulfuric Acid, oleum (fuming).....	100 Lbs.	2.50	@	3.00
Talc, American white.....	Ton	15.00	@	17.00
Terra Alba, American, No. 1.....	100 Lbs.	75	@	80
Tin Bichloride, 50°.....	Lb.	16	@	16 1/4
Tin Oxide.....	Lb.	60	@	62
White Lead, American, dry.....	Lb.	8 3/4	@	—
Zinc Carbonate.....	Lb.	20	@	24
Zinc Chloride, commercial.....	Lb.	14	@	15
Zinc Oxide, American process.....	Lb.	8 5/8	@	8 7/8
Zinc Sulfate.....	Lb.	6 1/2	@	7 1/4

ORGANIC CHEMICALS

Acetanilid, C. P., in bbls.....	Lb.	2.50	@	2.55
Acetic Acid, 28 per cent, in bbls.....	Lb.	7 1/2	@	8
Acetic Acid, glacial, 99 1/2%, in carboys.....	Lb.	50	@	—
Acetone, drums.....	Lb.	40	@	50
Alcohol, denatured, 180 proof.....	Gal.	59	@	61

Alcohol, grain, 188 proof.....	Gal.	2.68	@	2.70
Alcohol, wood, 95 per cent, refined.....	Gal.	65	@	68
Amyl Acetate.....	Gal.	4.25	@	5.00
Aniline Oil.....	Lb.	80	@	—
Benzoic Acid, ex-toluol.....	Lb.	6.50	@	7.00
Benzol, 90 per cent.....	Gal.	85	@	90
Camphor, refined in bulk, bbls.....	Lb.	52	@	—
Carbolic Acid, U. S. P., crystals, drums.....	Lb.	90	@	—
Carbon Bisulfide.....	Lb.	8	@	—
Carbon Tetrachloride, drums, 100 gals.....	Lb.	20	@	—
Chloroform.....	Lb.	80	@	—
Citric Acid, domestic, crystals.....	Lb.	65	@	70
Cresol, U. S. P.....	Gal.	1.15	@	1.25
Dextrine, corn (carloads, bags).....	100 Lbs.	3.20	@	3.26
Dextrine, imported potato.....	Lb.	—	@	—
Ether, U. S. P., 1900.....	Lb.	15	@	20
Formaldehyde, 40 per cent.....	Lb.	11	@	12 1/4
Glycerine, dynamite, drums included.....	Lb.	63	@	—
Oxalic Acid, in casks.....	Lb.	73	@	—
Pyrogallie Acid, resublimed bulk.....	Lb.	2.50	@	—
Salicylic Acid.....	Lb.	4.25	@	—
Starch, cassava.....	Lb.	3 3/4	@	4 1/2
Starch, corn (carloads, bags).....	100 Lbs.	2.25	@	2.36
Starch, potato.....	Lb.	12	@	—
Starch, rice.....	Lb.	8	@	10
Starch, sago.....	Lb.	3 1/2	@	4
Starch, wheat.....	Lb.	5	@	6
Tannic Acid, commercial.....	Lb.	60	@	64
Tartaric Acid, crystals.....	Lb.	66	@	68

OILS, WAXES, ETC.

Beeswax, pure, white.....	Lb.	47	@	55
Black Mineral Oil, 29 gravity.....	Gal.	12 1/2	@	13
Castor Oil, No. 3.....	Lb.	20	@	28
Ceresin, yellow.....	Lb.	10	@	14
Corn Oil, crude.....	100 Lbs.	9.75	@	10.00
Cottonseed Oil, crude, f. o. b. mill.....	Gal.	71	@	74
Cottonseed Oil, p. s. y.....	Lb.	10 1/2	@	11
Creosote, beechwood.....	Lb.	9.00	@	10.00
Cylinder Oil, light, filtered.....	Gal.	20	@	25
Fusel Oil, crude.....	Lb.	3.75	@	4.50
Japan Wax.....	Lb.	17	@	20
Lard Oil, prime winter.....	Gal.	97	@	99
Linseed Oil, raw (car lots).....	Gal.	76	@	—
Menhaden Oil, crude (southern).....	Gal.	—	@	—
Naphtha, 68 @ 72°.....	Gal.	38	@	—
Neat's-foot Oil, 20°.....	Gal.	98	@	99
Paraffine, crude, 118 & 120 m. p.....	Lb.	5	@	—
Paraffine Oil, high viscosity.....	Gal.	26	@	28
Rosin, "F" Grade, 280 lbs.....	Bbl.	5.05	@	—
Rosin Oil, first run.....	Gal.	32	@	—
Shellac, T. N.....	Lb.	23	@	24
Spermaceti, cake.....	Lb.	25	@	26
Sperm Oil, bleached winter, 38°.....	Gal.	78	@	79
Spindle Oil, No. 200.....	Gal.	19	@	19 1/2
Stearic Acid, double-pressed.....	Lb.	14	@	14 1/2
Tallow, acidless.....	Gal.	86	@	70
Tar Oil, distilled.....	Gal.	30	@	31
Turpentine, spirits of.....	Gal.	49 1/2	@	50

METALS

Aluminum, No. 1, ingots.....	Lb.	58	@	60
Antimony, ordinary.....	Lb.	40	@	41
Bismuth, N. Y.....	Lb.	3.15	@	3.25
Copper, electrolytic.....	Lb.	29 1/2	@	—
Copper, lake.....	Lb.	29 1/2	@	—
Lead, N. Y.....	100 Lbs.	7.50	@	—
Nickel, electrolytic.....	Lb.	50	@	—
Nickel, shot and ingots.....	Lb.	45	@	—
Platinum, refined.....	Oz.	90.00	@	—
Silver.....	Oz.	65 5/8	@	—
Tin.....	100 Lbs.	50.50	@	—
Zinc, N. Y.....	Lb.	19	@	—

FERTILIZER MATERIALS

Ammonium Sulfate.....	100 Lbs.	3.55	@	—
Blood, dried.....	Unit	2.80	@	—
Bone, 4 1/2 and 50, ground, raw.....	Ton	29.00	@	—
Calcium Cyanamid.....	Unit of Ammonia	2.55	@	—
Calcium Nitrate, Norwegian.....	100 Lbs.	—	@	—
Castor Meal.....	Unit	—	@	—
Fish Scrap, domestic, dried, f. o. b. works.....	Unit	—	@	—
Phosphate, acid.....	Unit	80	@	85
Phosphate rock; f. o. b. mine:				
Florida land pebble, 68 per cent.....	Ton	2.75	@	3.00
Tennessee, 78-80 per cent.....	Ton	5.00	@	5.50
Potassium "muriate," basis 80 per cent.....	Ton	400.00	@	—
Pyrites, furnace size, imported.....	Unit	15	@	15 1/2
Tankage, high-grade; f. o. b. Chicago.....	Unit	2.85	@	10

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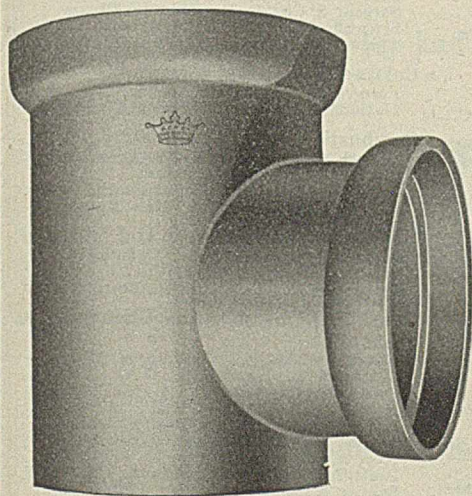
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Heil Chem. Co., Henry, St. Louis, Mo.
Lenz & Naumann, Inc., N. Y. C.
Palo Company, N. Y. C.
Sargent, E. H. & Co., Chicago, Ill.
Scientific Materials Co., Pittsburg, Pa.

Burners—Pyrites

Pratt Eng. & Mach. Co., Atlanta, Ga. & N.Y.C.

Burners—Sulphur

Pratt Eng. & Mach. Co., Atlanta, Ga. & N.Y.C.

Burners—Sulphur (Rotary)

Glens Falls Machine Works, Glen Falls, N. Y.

Calorimeters—Fuel and Gas

Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
Eimer & Amend, New York City.
Heil Chem. Co., Henry, St. Louis, Mo.
Lenz & Naumann, Inc., N. Y. C.
Palo Company, N. Y. C.
Sarco Co., Inc., New York City.
Sargent, E. H. & Co., Chicago, Ill.
Scientific Materials Co., Pittsburg, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

Capsules

Bausch & Lomb Optical Co., Rochester, N. Y.
Norton Co., Worcester, Mass.
Thermal Syndicate, Ltd., New York City.

Carboy Stoppers

Bausch & Lomb Optical Co., Rochester, N. Y.
Knight, Maurice A., Akron, Ohio.

Castings (Acid and Heat Resisting)

Bethlehem Fdy. & Mach. Co., So. Beth., Pa.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Jacoby, Henry E., N. Y. C.
Pacific Foundry Co., San Francisco, Cal.
Pratt Eng. & Mach. Co., Atlanta, Ga. & N.Y.C.

Castings (Chemical)

Bethlehem Fdy. & Mach. Co., So. Beth., Pa.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Jacoby, Henry E., N. Y. C.
Pacific Foundry Co., San Francisco, Cal.
Pratt Eng. & Mach. Co., Atlanta, Ga. & N.Y.C.
Stevens-Aylsworth Co., N. Y. C.
Werner & Pfeiderer Co., Saginaw, Mich.

Caustic Pots

Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Pratt Eng. & Mach. Co., Atlanta, Ga. & N.Y.C.

Caustic Soda

General Chem. Co., N. Y. C.
Hooker-Electrochemical Co., N. Y. C.

Cement Filler

Toch Brothers, N. Y. C.

Cement Testing Apparatus

Scientific Materials Co., Pittsburg, Pa.

Centrifugal Engineers

Sharples Specialty Co., The, West Chester, Pa.

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Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
DeLaval Separator Co., N. Y. C.
International Instrument Co., Cambridge, Mass.
Schaum & Uhlinger, Inc., Philadelphia.
Sharples Specialty Co., The, West Chester, Pa.
Tolhurst Machine Works, Troy, N. Y.

Charcoal

Booth Apparatus Co., Syracuse, N. Y.

Chemical Castings

Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Duriron Castings Co., New York City.
Pratt Eng. & Mach. Co., Atlanta, Ga. & N.Y.C.
Werner & Pfeiderer Co., Saginaw, Mich.

Chemical Glassware

Bausch & Lomb Optical Co., Rochester, N. Y.
Caloris Co., Millville, N. J.
Fry Glass Co., H. C., Rochester, Pa.
Griebel Instrument Co., Carbondale, Pa.
Corning Glass Works, Corning, N. Y.
Scientific Materials Co., Pittsburg, Pa.

Chemicals

Badische Company, New York City.
Baker & Adamson Chemical Co., Easton, Pa.
Baker Chemical Co., J. T., Phillipsburg, N. J.
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
Dearborn Chemical Co., Chicago, Ill.
Eimer & Amend, New York City.
General Chemical Co., New York City.
Heil Chemical Co., Henry, St. Louis, Mo.
Lenz & Naumann, Inc., N. Y. C.
Mallinckrodt Chem. Co., St. Louis, Mo.
Merck & Co., New York City.
National Aniline & Chemical Co., N. Y. C.
Palo Company, N. Y. C.
Pfizer & Co., Charles, New York City.
Powers-Weightman-Rosengarten Co., Phila., Pa.
Roessler & Hasslacher Chemical Co., N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburg, Pa.
Squibb & Sons, E. R., N. Y. C.
Thomas Co., Arthur H., Philadelphia.

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Lummus Co., The Walter E., Boston, Mass.
Pratt Eng. & Mach. Co., Atlanta, Ga. & N.Y.C.

Chemical Plants (Erected and Supervised)

Guarantee Construction Co., N. Y. C.
M. McNamara, Everett, Mass.
Pratt Eng. & Mach. Co., Atlanta, Ga. & N.Y.C.

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Baker Chem. Co., J. T., Phillipsburg, N. J.
Bausch & Lomb Optical Co., Rochester, N. Y.
Mallinckrodt Chem. Co., St. Louis, Mo.
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Hooker-Electrochemical Co., N. Y. C.

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Badische Company, New York City.
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Dorr Co., The, Denver, Col., & N. Y. C.

Classifiers or Washers

Dorr Co., The, Denver, Col., & N. Y. C.

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Pratt Eng. & Mach. Co., Atlanta, Ga. & N.Y.C.

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Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Lenz & Naumann, Inc., N. Y. C.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburg, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

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Norton Co., Worcester, Mass.
Scientific Materials Co., Pittsburg, Pa.
Thermal Syndicate, Ltd., New York City.

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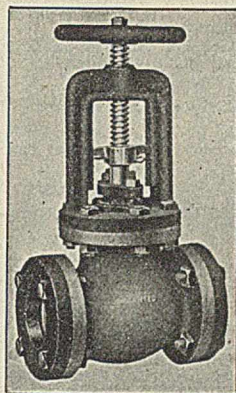
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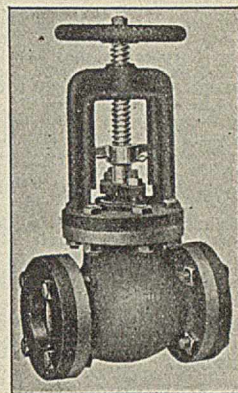
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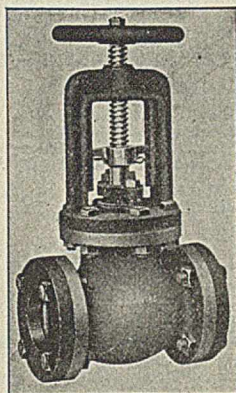


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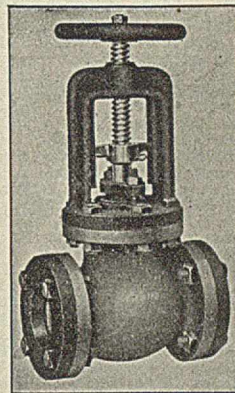
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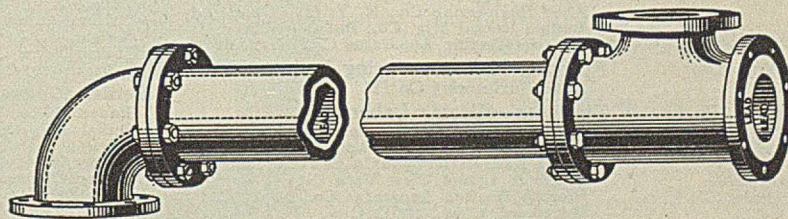
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 Sanborn Evaporator Co., N. Y. C.
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Carrier Engineering Corp., N. Y. C.

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 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Devine & Company, J. P., Buffalo, N. Y.
 Jacoby, Henry E., New York City.
 Stokes Machine Co., F. J., Philadelphia, Pa.
 Werner & Pfeiderer Co., Saginaw, Mich.

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 Eimer & Amend, New York City.
 Engelhard, Chas., New York City.
 Heil Chemical Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.

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 German-American Stoneware Works, N. Y. C.
 Pfaudler Co., Rochester, N. Y., Detroit, & N. Y. C.
 Scientific Materials Co., Pittsburgh, Pa.
 Stuart & Peterson Co., The, Burlington, N. J.
 Thermal Syndicate, Ltd., New York City.

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 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Devine Company, J. P., Buffalo, N. Y.
 Electric Heating Apparatus Co., N. Y. C.

Jacoby, Henry E., N. Y. C.
 Lummus Co., The Walter E., Boston, Mass.
 Pratt Eng. & Mach. Co., Atlanta, Ga. & N. Y. C.
 Sanborn Evaporator Co., New York City.
 Stokes Machine Company, F. J., Philadelphia, Pa.
 Swenson Evaporator Company, Chicago, Ill.
 Werner & Pfeiderer Co., Saginaw, Mich.
 Zarembo Company, Buffalo, N. Y.

Extracting Apparatus

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 Werner & Pfeiderer Co., Saginaw, Mich.

Extraction Cylinders

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 Steiger Terra Cotta and Pottery Works, San Francisco, Cal.
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Schutte & Koerting Co., Philadelphia.

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Sweetland Filter Press Co., N. Y. C.

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 Kieselguhr Co. of America, Los Angeles, Cal.

Filter Paper

Scientific Materials Co., Pittsburgh, Pa.

Filter Paper (Whatman)

H. Reeve Angel & Co., New York.

Filter Presses (Laboratory & Industrial)

Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco, Cal.
 International Filtration Corp., N. Y. C.
 Jacoby, Henry E., New York City.
 Kelly Filter Press Co., Salt Lake City, Utah.
 Lunzwitz, E. E., New York City.
 Shriver & Co., T., Harrison, N. J.
 Sperry & Co., D. R., Batavia, Ill.
 Sweetland Filter Press Co., The, N. Y. C.
 Swenson Evaporator Co., Chicago, Ill.
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General Filtration Co., Inc., Rochester, N. Y.

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 Buffalo Dental Mfg. Co., Buffalo, N. Y.
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 Heil Chemical Co., Henry, St. Louis, Mo.
 Hoskins Mfg. Co., Detroit, Mich.
 Lenz & Naumann, Inc., N. Y. C.
 Scientific Materials Co., Pittsburgh, Pa.

Furnaces—Pyrites

Pratt Eng. & Mach. Co., Atlanta, Ga. & N. Y. C.

Furnaces—Sulphur

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Glass Blowing

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 Braun-Knecht-Heimann Co., San Francisco, Cal.
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 Greiner Co., Emil, N. Y. City.
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 Palo Company, N. Y. C.
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 Scientific Materials Co., Pittsburgh, Pa.

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 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
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Bausch & Lomb Optical Co., Rochester, N. Y.
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 Braun-Knecht-Heimann Co., San Francisco, Cal.
 Caloris Co., The, Millville, N. J.
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 Corning Glass Works, Corning, N. Y.
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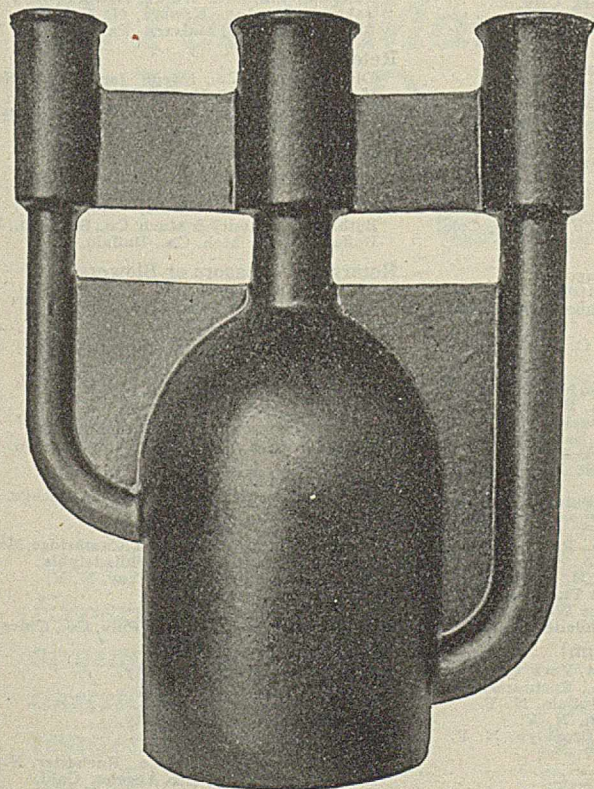
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Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburg, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.
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Schieren Co., Chas. A., N. Y. C.
- Lacquer**
General Bakelite Co., New York City.
- Lactic Acid**
Woolner & Co., Peoria, Ill.
- Leaching Cells**
Zaremba Co., Buffalo, N. Y.
- Lead Burning**
M. McNamara, Everett, Mass.
- Lead Lined Pipe and Accessories**
Schutte & Koerting Co., Philadelphia.
- Leather Belting (Regular Oak Tanned and Duxbak Waterproof; Round; Link)**
Schieren Co., Chas. A., N. Y. C.
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Dearborn Chemical Co., Chicago, Ill.
Dixon Crucible Co., Joseph, Jersey City, N. J.
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Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
General Filtration Co., Inc., Rochester, N. Y.
Stokes Machine Co., F. J., Philadelphia.
Werner & Pfeiderer Co., Saginaw, Mich.
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Abbé Engineering Co., New York City.
Pfauder Co., Rochester, N. Y., Detroit, & N. Y. C.
Pratt Eng. & Mach. Co., Atlanta, Ga. & N. Y. C.
Werner & Pfeiderer Co., Saginaw, Mich.
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Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
General Filtration Co., Inc., Rochester, N. Y.
Pratt Eng. & Mach. Co., Atlanta, Ga. & N. Y. C.
Raymond Bros. Impact Pulv. Co., Chicago, Ill.
Werner & Pfeiderer Co., Saginaw, Mich.
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Duriron Castings Co., N. Y. C.
Pratt Eng. & Mach. Co., Atlanta, Ga. & N. Y. C.
Werner & Pfeiderer Co., Saginaw, Mich.
York Electric & Machine Co., York, Pa.
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Scientific Materials Co., Pittsburg, Pa.
- Metallurgical Laboratory Equipment**
Scientific Materials Co., Pittsburg, Pa.
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Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
Eimer & Amend, New York City.
Heil Chem. Co., Henry, St. Louis, Mo.
Lenz & Naumann, Inc., N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburg, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.
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Bausch & Lomb Optical Co., Rochester, N. Y.
Heil Chemical Co., Henry, St. Louis, Mo.
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- Minerals, Metal & Chemicals (Rare)**
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Pfauder Co., Rochester, N. Y., Detroit, & N. Y. C.
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Pfauder Co., Rochester, N. Y., Detroit, & N. Y. C.
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Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
Lenz & Naumann, Inc., N. Y. C.
Scientific Materials Co., Pittsburg, Pa.
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- Optical Pyrometer**
Scientific Materials Co., Pittsburg, Pa.
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International Oxygen Co., N. Y. City.
- Oxygen Testing Apparatus**
International Oxygen Company, N. Y. City
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Parker, C. L., Washington, D. C.
Sleck, Herbert, Chicago, Ill.
Townsend, Clinton P., Washington, D. C.
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Pfauder Co., Rochester, N. Y., Detroit, & N. Y. C.
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Braun-Knecht-Heimann Co., San Francisco, Cal.
Eimer & Amend, New York City.
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Knight, Maurice A., Akron, Ohio.
Lenz & Naumann, Inc., N. Y. C.
Palo Company, N. Y. C.
Robinson Clay Products Co., Akron, O.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburg, Pa.
Steiger Terra Cotta and Pottery Works, San Francisco, Cal.
Thomas Co., Arthur H., Philadelphia.
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Knight, Maurice A., Akron, Ohio.
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Pfaudler Co., Rochester, N.Y., Detroit, & N.Y.C.
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Lummus, Walter E., Boston, Mass.
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German-American Stoneware Works, N. Y. C.
Pfaudler Co., Rochester, N.Y., Detroit, & N.Y.C.
Steiger Terra Cotta and Pottery Works, San Francisco, Cal.
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Stevens Brothers, N. Y. C.
- Tanks (Storage)**
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Caloris Co., The, Millville, N. J.
Carbondale Instrument Co., Carbondale, Pa.
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Greiner Co., Emil, New York City.
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Lenz & Naumann, Inc., N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.
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Bausch & Lomb Optical Co., Rochester, N. Y.
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Thwing Instrument Co., Philadelphia, Pa.
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German-American Stoneware Works, N. Y. C.
Jacoby, Henry E., New York City.
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Pratt Eng. & Mach. Co., Atlanta, Ga. & N.Y.C.
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Stokes Machine Co., F. J., Philadelphia.
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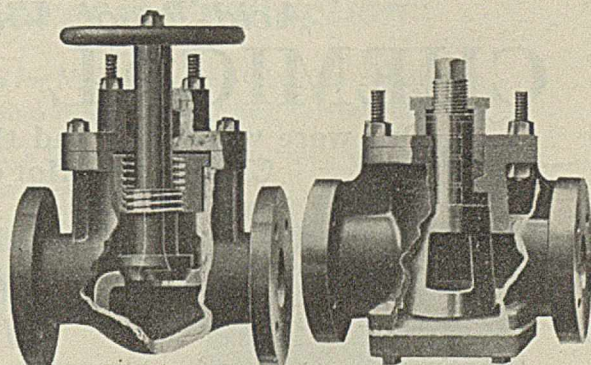
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Office, 50 Church Street, New York City

FACTORY, KEASBEY, N. J.

Acid-Proof, Vitrified, Salt-Glazed

CHEMICAL STONEWARE

Our ware will withstand the action of Acids, Alkalies and
Chemicals. Hot or cold, strong or weak



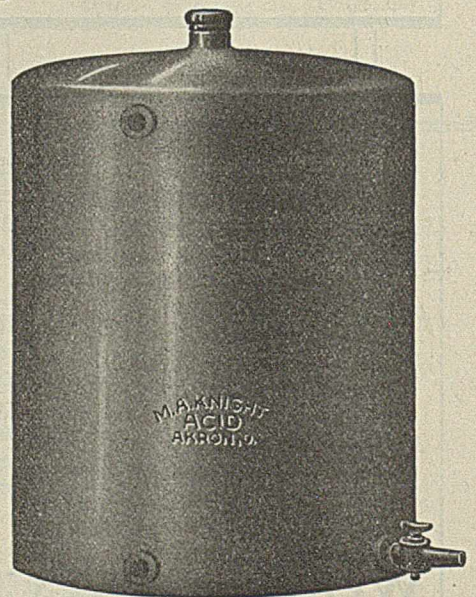
EARTHENWARE BURNER GUARDS
These guards concentrate and hold the heat,
and afford a strong support.
Made in two standard sizes and carried in stock.

It is the

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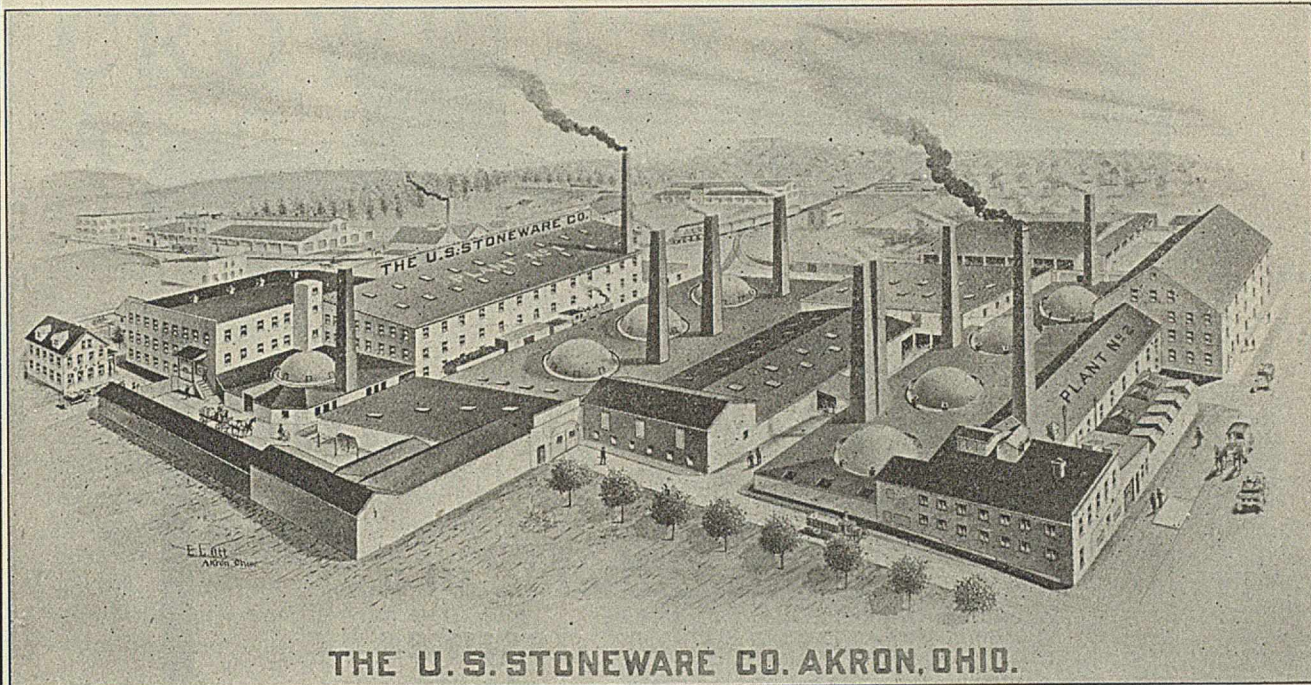
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glaze, enamel
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We make every de-
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For distilled water or acids.
Made in sizes to meet requirements, with
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MAURICE A. KNIGHT (P. O. Box 28) **East Akron, Ohio**



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- Acid-Proof Alkali-Proof*
- Phenomenal Growth of Business*
- Greatest Facilities. Largest Production*

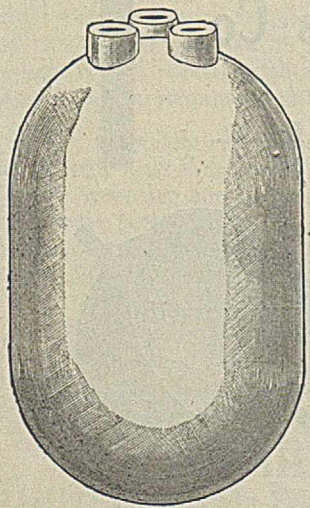
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We have therefore commenced the structure of a large power plant which will give us an increase of more than *four times* our present capacity.

Why this success? *Quality and prompt service* is the answer.

Not genuine product of our factory without { U.S. STONEWARE CO.
 this inscription burned in on every piece:— { MAKERS
 AKRON, O., U.S.A.

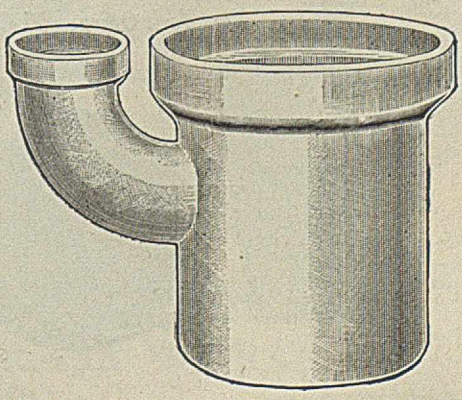
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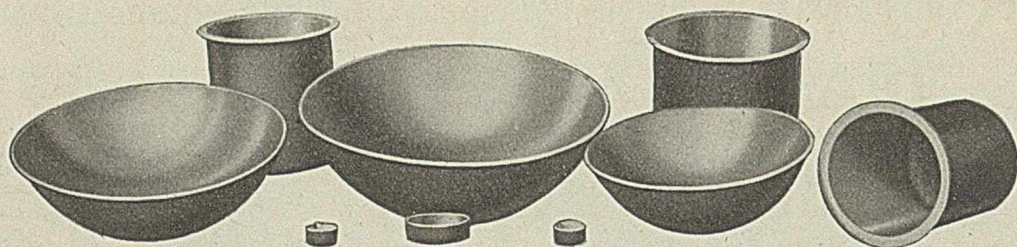


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Established 1865

Akron, Ohio, U. S. A.





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PLAIN WELDED TANKS not enameled

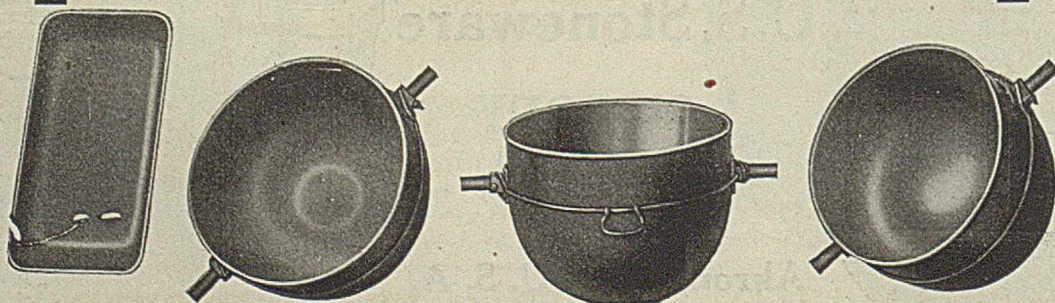
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Laboratory
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Special Shapes or Construction of Elyria Apparatus can be furnished to your order.

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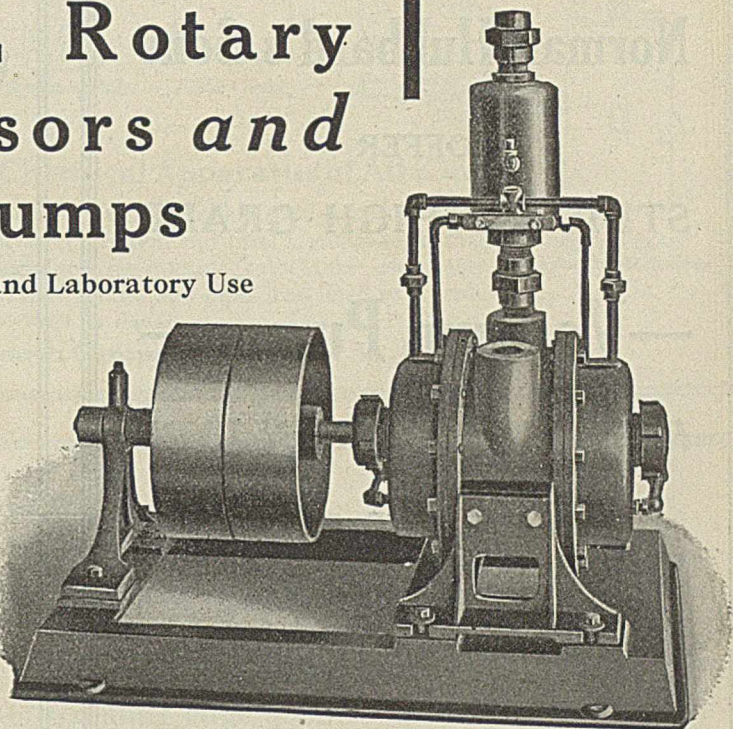


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Crowell Manufacturing Co.

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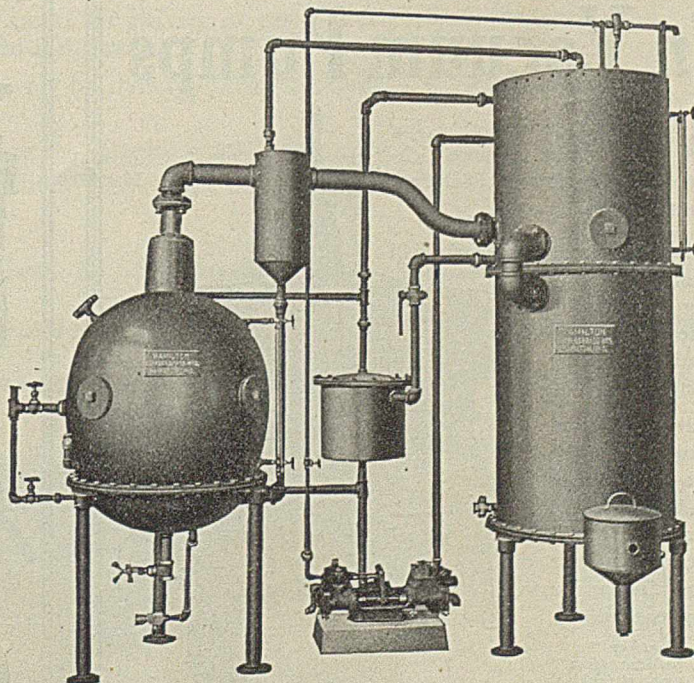
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The Hamilton Automatic Continuous Still is very strongly built throughout. Note the condenser has the same leg supports as the distilling vessel and that the bottom of condenser is flanged. The oval-shaped distilling vessel has many advantages you should investigate.

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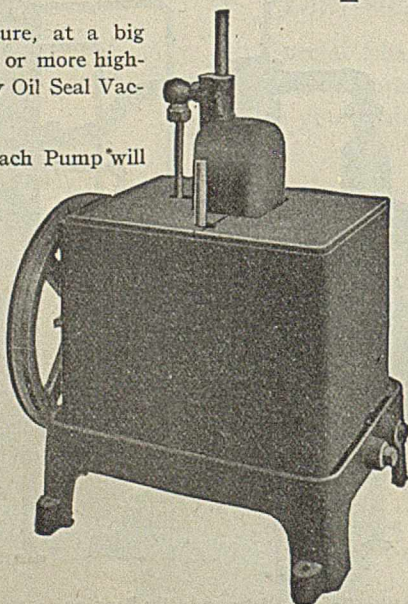
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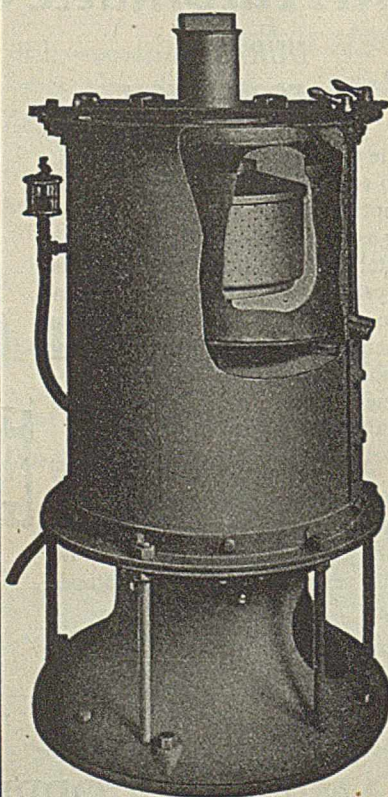
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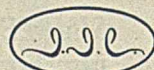


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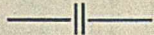
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