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TABLE OF CONTENTS

EDITORIALS:

| | |
|-------------------------------------|---|
| Election Results..... | 2 |
| Special Meeting of the Council..... | 2 |
| The Fruits of Service..... | 3 |
| Notes..... | 4 |

GAS OFFENSE IN THE UNITED STATES—A RECORD ACHIEVEMENT.....

| | |
|---|----|
| THE WORK OF THE TECHNICAL DIVISION, CHEMICAL WARFARE SERVICE, A. E. F. Col. Raymond F. Bacon..... | 13 |
|---|----|

| | |
|---|----|
| THE TWO HUNDRED AND FIFTIETH ANNIVERSARY OF CHEMICAL INDUSTRY IN AMERICA. C. A. Browne..... | 16 |
|---|----|

| | |
|---|----|
| CHEMICAL MARKETS OF THE WEST INDIES. O. P. Hopkins..... | 19 |
|---|----|

ORIGINAL PAPERS:

| | |
|---|----|
| Effect of Phosphine and Hydrogen Sulfide on the Oxidation of Ammonia to Nitric Acid. Guy B. Taylor and Julian H. Capps..... | 27 |
| Some Notes on Acetylsalicylic Acid. Henry L. Dahm..... | 29 |
| The Vulcanization of Rubber at Constant Temperature and by a Series of Increasing Temperatures. G. D. Kratz and Arthur H. Flower..... | 30 |
| The Determination of Free Carbon in Rubber Goods. A. H. Smith and S. W. Epstein..... | 33 |
| A Rapid and Accurate Method for Butter Analysis, Suitable for Factory Control Work. Edward F. Kohman..... | 36 |
| Utility of Blanching in Food Canning: Effect of Cold Shock upon Bacterial Death Rates. Eva M. Bruett..... | 37 |
| The Nature of the Recombined Potash in Cement Mill Dust. Albert R. Merz and William H. Ross..... | 39 |

LABORATORY AND PLANT:

| | |
|--|----|
| Results of Further Coöperative Work on the Determination of Sulfur in Pyrite, Check Sample No. 4. H. C. Moore..... | 45 |
| A Paper Tearing-Resistance Tester. H. N. Case..... | 49 |
| Absorption Pipettes. E. Van Alstine..... | 51 |
| New Reflux Condenser. James J. Bajda..... | 52 |
| Melting Point of Rosin. T. Linsey Crossley..... | 52 |

ADDRESSES:

| | |
|---|----|
| The Future of the American Dye Industry. W. H. Nichols..... | 53 |
| The Problems of the Dyestuff Industry. F. W. Taussig..... | 55 |

FOREIGN INDUSTRIAL NEWS:

| | |
|--|----|
| New Vegetable Oil; German Aircraft; British Optical Glass Industry; Italian Chemical Industry; Alcohol from Seaweed; Switchgear; Alloys of Lead and Magnesium; British Board of Trade..... | 57 |
|--|----|

| | |
|--|----|
| AN INSTITUTE FOR COÖPERATIVE RESEARCH AS AN AID TO THE AMERICAN DRUG INDUSTRY..... | 59 |
|--|----|

SCIENTIFIC SOCIETIES:

| | |
|--|----|
| Report of the Committee on the Analysis of Commercial Fats and Oils; American Institute of Chemical Engineers; The John Scott Legacy Medal and Premium; The Perkin Medal Award; The Nichols Medal..... | 69 |
|--|----|

NOTES AND CORRESPONDENCE:

| | |
|---|----|
| Don'ts for Would-be Writers of Scientific Articles for the Public Press; Chemical Nomenclature; An International Sugar Scale; The 1918 Directory—American Chemical Society; Ramsay Memorial Fund..... | 71 |
|---|----|

| | |
|------------------------|----|
| WASHINGTON LETTER..... | 74 |
|------------------------|----|

| | |
|---------------------|----|
| PERSONAL NOTES..... | 76 |
|---------------------|----|

| | |
|-----------------------|----|
| INDUSTRIAL NOTES..... | 78 |
|-----------------------|----|

| | |
|------------------------------|----|
| GOVERNMENT PUBLICATIONS..... | 80 |
|------------------------------|----|

BOOK REVIEWS:

| | |
|--|----|
| The Treasures of Coal Tar; Metallurgical Calculations; The Metallurgists' and Chemists' Handbook; Colour and Its Relation to Chemical Constitution; Nomon: Sugar Technologists' Edition..... | 85 |
|--|----|

| | |
|-----------------------|----|
| NEW PUBLICATIONS..... | 87 |
|-----------------------|----|

| | |
|--------------------|----|
| MARKET REPORT..... | 88 |
|--------------------|----|

EDITORIALS

ELECTION RESULTS

The following have been elected officers of the AMERICAN CHEMICAL SOCIETY for the term of office beginning January 1, 1919.

President: William H. Nichols.

Directors: W. D. Bigelow,
W. R. Whitney.

Councilors-at-Large: E. C. Franklin,
B. C. Hesse,
G. N. Lewis,
Geo. D. Rosengarten.

SPECIAL MEETING OF THE COUNCIL

On Saturday afternoon, December 14, 1918, there assembled in Rumford Hall, Chemists' Club, New York City, one of the most largely attended meetings of the Council ever held. In response to the stimulation of Dr. Hesse's article in the November issue of THIS JOURNAL and the call of the Secretary, it was evident from the outset that there was to be no dearth of suggestions from the Local Sections. The total number of these suggestions mounted to the high figure of one hundred and thirty-three. Plainly, it was physically impossible to give to each of these matters in one session of the Council the consideration it deserved. The proceedings therefore developed largely into a grouping of the suggestions and reference of these groups to appropriate committees for thorough consideration and report to the next meeting of the Council. Upon certain matters of general importance, however, definite action was taken.

The full value of the meeting, therefore, will depend ultimately upon the character of the committee work between now and the Spring meeting of the Council. Too often the committee work of the Society is not taken by the individual as a very severe requisition upon his time, thought and energy. To the committees to be appointed to handle the material presented to this special meeting of the Council there is given opportunity to perform a distinct national service, for the presentments of the AMERICAN CHEMICAL SOCIETY with its more than twelve thousand members should carry great weight in molding national thought as to chemistry as an integral part of the Nation's activities. With committee work carried out in this spirit, it can confidently be predicted that the spring meeting of the Council will be historic.

Following a continuous four-hour session, the president, Dr. Wm. H. Nichols, entertained the Council at a delightful dinner in the dining room of the Chemists' Club. Dr. Nichols proved an ideal host and his genial spirit pervaded the jovial gathering. At the conclusion of the dinner, he acted as toastmaster and with a perfect stream of raillery and camaraderie called upon a number of the members for informal remarks. The responses demonstrated that all had caught the spirit of the occasion.

BUSINESS TRANSACTED

At the business session of the Council it was unan- imously voted to hold a Spring meeting in 1919. The matter of time and place was referred to the Ad- visory Committee with power to act. Soon after adjournment it was evident that the committee would receive a number of invitations.

The attention of the Council was called to the im- portant Report on Engineering Education issued by the Carnegie Foundation. In the compilation of that Report the Society was represented by Professor H. P. Talbot and Dr. Clifford Richardson. The Presi- dent was requested to appoint a committee of three to act in coöperation with and to be advisory to the Society for the Promotion of Engineering Education in matters pertaining to the training of chemical engineers.

The Directors were requested to arrange, if finances justified it, for the annual publication in *Chemical Abstracts* of a formula index.

Following an interesting talk by Dr. John Johnston, secretary of the National Research Council, the Council favored coöperation with that body in the coördination of research. A committee of five will be appointed to work out the details.

The Council likewise voted for coöperation with British chemical organizations and with the National Research Council in the compilation and publication in the English language of standard reference works on chemistry. The committee charged with this matter was requested to report at the Spring meeting. In case of an emergency requiring prompt action the committee will report to the Directors.

Much interest was aroused by the report of the Committee on Duty-Free Importations by Educational Institutions. The Council expressed itself as heartily favoring the abrogation by Congress of this feature of the tariff legislation, confident that its presence on the statute books has retarded the development of American sources of supply of laboratory material, and equally confident that American manufacturers would respond in such manner as to insure our educa- tional institutions against a repetition of such condi- tions as resulted in 1915 from the blockade of German ports.

The Committee on Coöperation between Universities and Industries made an informal report, calling at- tention to the imminent danger to both universities and industries from a continuation of the efflux of the best teachers from the universities to industrial re- search staffs, favoring industrial research fellowships and requesting the appointment of auxiliary sub-com- mittees in Local Sections for the working out of specific local questions and for general coöperation with the main committee. The President was authorized to appoint such sub-committees.

Dr. W. R. Whitney made an impressive appeal for

endorsement of national aid to research. The Council expressed itself as favoring the principle of federal aid to scientific and industrial research and authorized the President to appoint a committee to cooperate in the allocation of federal grants, to investigate the several proposals now pending, and to make recommendations to the Advisory Committee, which in turn was given power to act.

The introduction of the metric system throughout the country as rapidly as possible was urged. The Society's Committee on Merchant Marine was requested to emphasize the importance of this change in our system of weights and measures as an aid in developing foreign commerce.

A prolonged discussion was held concerning the future of chemistry in the War Department. All were agreed that it would be a calamity if our future army should lack this invaluable aid to its military efficiency. The Advisory Committee was requested to consider the advisability of appointing a special committee to consider all phases of this matter and to confer with the officials of the War Department. To the Advisory Committee was also referred the matter of urging the War Department to compile a complete record of the researches conducted by the Chemical Warfare Service and, in so far as public interest permits, to publish this material.

Announcement was made of the action of the Directors in appointing Mr. John Walker Harrington to take charge for the Society of the important work of developing its policies as to popular presentation of chemistry to the daily press. Mr. Harrington is an experienced newspaper writer of high rank and his technical ability will prove of great value in connection with the popular bulletins contributed by the members of the Society.

Many of the suggestions of the Local Sections were grouped and referred to appropriate committees for report at the Spring meeting. Finally, in order to cover the whole ground, an Omnibus Committee, with Dr. A. D. Little as chairman, was appointed to consider the responsibilities of the Society in the many great questions of reconstruction now engrossing the attention of the Nation.

THE FRUITS OF SERVICE

This morning New York City was awakened by a din of noises from sirens and steam whistles welcoming back to America her soldiers returning from the battlefields of France. It was a joyous welcome to men who richly deserved it. In the midst of the tumult our mind turned to the many chemists in laboratories and plants throughout the country, some in uniform and some wearing not even this badge of distinction, whose scientific and technical skill had contributed so profoundly to the safety of the men at the front through perfected gas masks, smoke screens, flares, rockets, and similar devices, and to the preparation on so vast a scale of offense weapons such as propellants, high explosives, detonators, poison gases,

improved steel for guns, light metals and dopes for aeroplanes. And we wondered whether or not the country appreciated what these men of the laboratories had done. Did it realize how these men at the behest of leading men of the profession had voluntarily foregone their eager desire to join in the great movement to the western battle front while the military authorities were gradually being roused to the important part which they and no substitutes must perform in this war? These men had worked on the production of toxic gases during the experimental days; many a lifelong scar will bear its silent witness of the risks incurred, while others of this number made the supreme sacrifice.

To all of these men, American chemists, who more than "made good" in a chemical war, all honor be given! Through the conservation of trained men, resulting from their sacrifice of personal inclination, this country was enabled to assemble and utilize efficiently the greatest corps of chemists in any of the allied countries, as is abundantly attested by foreign official representatives whose timely warnings, however, were of greatest aid in effecting this conservation of trained men.

It was our good fortune to be present at the dinner tendered Major General Sibert by the commissioned officers of the Chemical Warfare Service. It was a jolly affair, redolent with good fellowship. The spontaneous tributes to the commanding officer bore eloquent witness to the affectionate ties which had been formed.

These men had matched their wits against the Germans and had prepared material which rendered the enemy's efforts harmless and insured to our armies the means by which he would be overwhelmed. Some day when the full story of the war is told, the facts will become known as to why this mighty mass of material for offense was not delivered at the front where our men were calling for it; and when the tale is told there will be no discredit to the chemist for he was more than ready with his part.

But these rollicking chemists at the dinner tables knew that the end of their work was in sight. Soon they would return to normal duties. As we watched the riot of fun, thoughts flew in upon us.

Is this branch of the Service to be discontinued?

None present desired or seemed to have any idea that he would be expected to continue in the Service. In the curtailment of army activities and in the rapid progress of demobilization of forces not needed for occupation of enemy territory, it is to be hoped that this strong branch of our permanent army will not be totally abolished. Even though the elimination of poison gas warfare be agreed upon at the peace conference, there is vital work still to be conducted on chemical lines for both army and navy. If we are to have military and naval adjuncts to our Government, they should be supported by the best of chemical intelligence. Secretary Baker has called attention in his annual report to the desirability of making permanent the Chemical Warfare Service. He should

act promptly in perfecting the permanent organization, for it will be difficult to gather together again the picked men of this Service after they have returned to civil life. General Sibert can perform a distinct national service before his announced retirement by urging the same speed in action as he urged upon his own men in the manufacture of mustard gas.

Another thought came as we watched the diners. What about the return of these men to civil life? Will the way be easy or hard? For many of them former positions are waiting. For others the path is not so clear, for substitutes have been employed, at least for the year. Particularly is this true in many universities where finances are sadly cramped because of decrease in tuition fees and earnings from invested funds. Certainly we all should join hands in making this return involve as little as possible of sacrifice on the part of these men who have done their full part by our country in a time of great national stress.

To the undergraduates and the men drawn from graduate student ranks we would urge a return at all costs to their universities for the completion of their scientific training. This training has been sharply interrupted by the call of the war period, but the experience gained by both professors and students in connection with war work should infuse a fresh and even more vigorous spirit into educational work and should give to the country eventually a class of men into whose hands the future development of chemistry should worthily fall. In this connection the situation presents an admirable opportunity for the display of the spirit of coöperation on the part of the industries toward the universities by the establishment of a large number of scholarships and fellowships, even though these be only temporary, which will enable the immediate refilling of university ranks.

To those returning chemists who had previously completed their university courses, it need only be pointed out that practically no recruits have come into the ranks during the past year, and that the chemical industry of the country, with all strictly war work ended, will be greater than before the war.

Doubtless some hardships will be endured during the next six months of readjustment. This is to be deplored, but it is by no means a misfortune confined to chemical ranks. It is a part of the price. Certainly this country will need in the great program of peace days every chemist whose training is sound, whose judgment is well balanced, and whose faith in his country is an unquenchable flame.

NOTES

A new use is suggested for the ultramicroscope—to find a chemist among the host of American specialists who accompanied to Paris our official representatives charged with the responsibility of formulating a treaty of peace with that country which makes of chemistry its strong right arm in times of peace and war. This suggestion is sympathetically passed on to the president

of the Chemical Alliance, Inc., for reflection during his leisure moments.

Welcome to *The Octagon*, the official organ of the Lehigh Valley Section, and also to *The Blast Lamp*, published by the Kem Klub of Hunter College (for young women), New York City! That women are entering the field of chemistry in dead earnest is shown by the following extract from the latter publication.

The preparation is long and difficult. Chemistry alone is not sufficient. One must have a working knowledge of calculus and one must know a good deal of physics.

As to women in research this naïve confession is made:

It is said that the true spirit of research is natural curiosity, and certainly women possess that.

Knowing the delightful personality and inherent modesty of Mr. Charles H. MacDowell, of the War Industries Board, we are confident that he blushed with confusion when he read in a recent Washington press story the following:

Experts headed by Charles H. MacDowell, chief of the Chemicals Division of the Board, Mr. Baruch said to-day, are meeting with success in the development of new processes of manufacture of standardizing present processes. At the same time they are fostering the use of German formulas for obtaining in America soluble potash, aniline dyes, optical glass, and chemical apparatus, fine and pharmaceutical chemicals, and clay for graphite crucibles.

The Committee has voted the award of the Perkin Medal this year to Dr. F. G. Cottrell of the U. S. Bureau of Mines, for his work on electrical precipitation. This decision will be unanimously acclaimed.

The Nichols Medal, awarded for the most noteworthy contributions appearing during the year in the publications of this Society, will not be awarded this year. Too much of the best research is still locked up for reasons of war. The contest for this medal next year should be a hummer.

The recent great gathering of business men at Atlantic City expressed itself in no uncertain terms on the subject of pivotal industries, as follows:

Conditions brought upon us by the European War at its beginning, as well as our national necessities after we entered the war, made it of the highest importance that a number of industries should at once be developed in the United States. Large investments, both of capital and skill, have since been placed in these enterprises. Upon the production of some of them, relatively small in themselves, the continuation of some of our largest industries has depended. Some of the recently developed industries have national importance in fields much broader than the markets of their products; for they may serve, for example, to promote scientific research, which will add to national efficiency, resources, and wealth in many distinct ways.

It becomes essential, therefore, that the Government should at once proceed to ascertain the industries which have been developed during the European war and ascertain those the maintenance of which is indispensable for the safety of our industrial structure and our military establishment.

When these pivotal industries have been ascertained, means suitable in view of their nature and situations should at once be provided for their encouragement and preservation.

GAS OFFENSE IN THE UNITED STATES A RECORD ACHIEVEMENT⁽¹⁾

At the Chemists' Club after luncheon one day about sixteen months ago, Dr. B. T. Brooks showed me a newspaper clipping in which was stated the chemical nature of the new gas to whose remarkable properties rather mysterious references were being made in the cable dispatches from the western battlefield. At that time the farms lying on Gunpowder Neck, between the Pennsylvania Railroad and the Bush River, some twenty miles north of Baltimore, were under normal cultivation. In response to the urging of British and French Commissioners, relatively small bodies of American soldiers had been dispatched to France, chiefly for moral effect and as an evidence of our determination to participate physically in the rolling back of the great wave of Teutonic military force which threatened the whole world. Not yet had the Nation thoroughly awakened to the imminent peril and the gigantic program ahead of us.

country had ever known. Methods of production of toxic material developed on a laboratory scale were quickly expanded to large-scale production, and errors of indecision and shifting plans, which tried the Nation's soul in other cases, found no place here. Promptly the decision was made as to what toxic gases should be supplied our Army, then all efforts were devoted to accomplish production on such a scale as would provide for any army that might be raised, in any quantity it might demand.

That the efforts were abundantly successful, is witnessed by the fact that at no time have ship-room or shell been adequate to require operation of the great plant at maximum capacity. The chemist had done his part.

Such things do not happen by accident, a master spirit guides so successful an undertaking through the mazes of preliminary construction to the finished plant with its steady output of

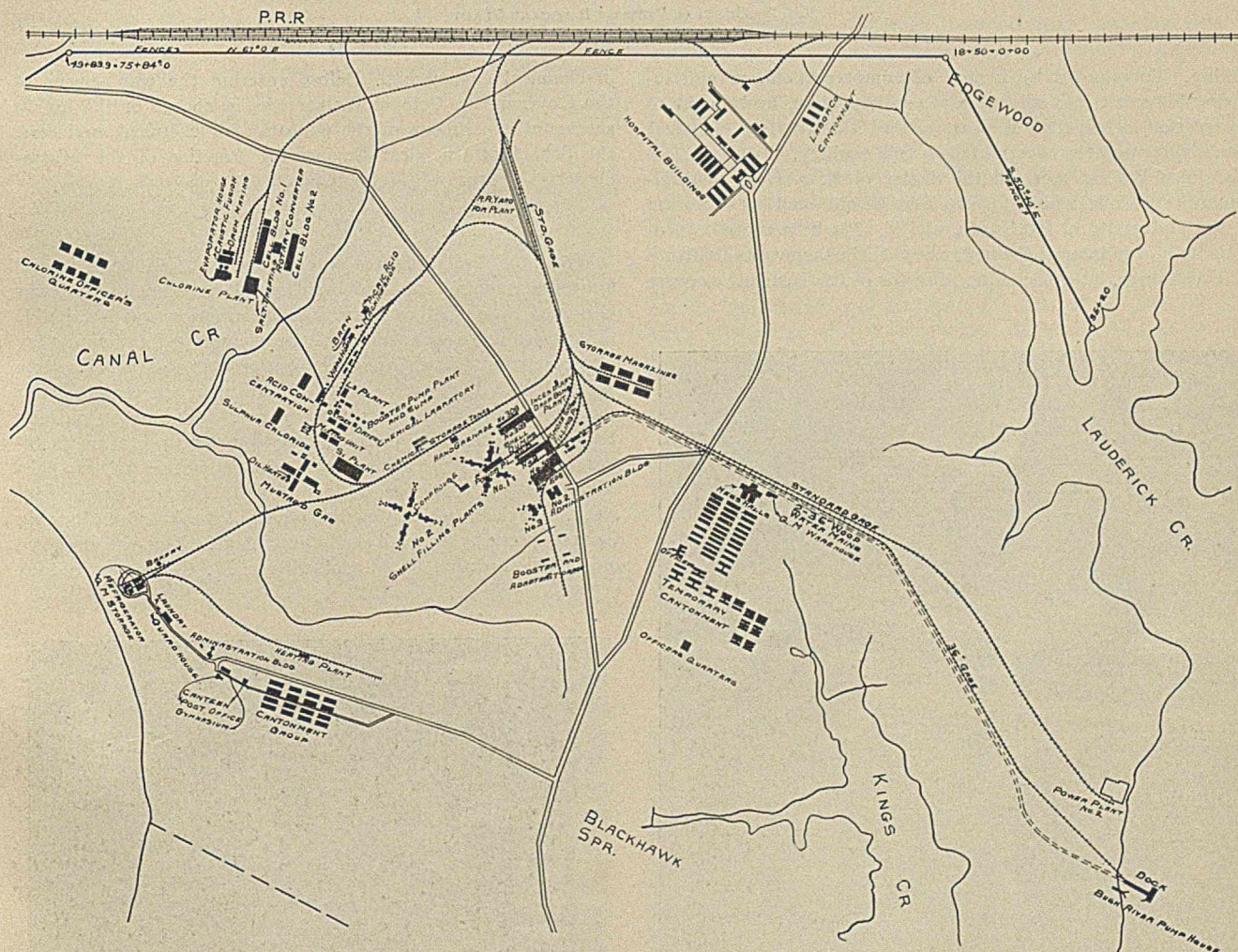


FIG. 1.—MAP OF U. S. FILLING PLANT, GUNPOWDER RESERVATION

In the intervening time an enormous plant has sprung into being, almost as if by magic. Difficulties of procurement of material, of transportation, of labor, and of construction were overcome, in spite of the hardships of the severest winter the

needed material. He would be the last to admit it, but it needed little questioning of men of all ranks at the plant to recognize that it was the indomitable will, the lovable personality, and the unflinching "pep" of Colonel William H. Walker, the commanding officer, which were responsible for the success of this great under-

¹ Editorial correspondence, November 7, 1918.

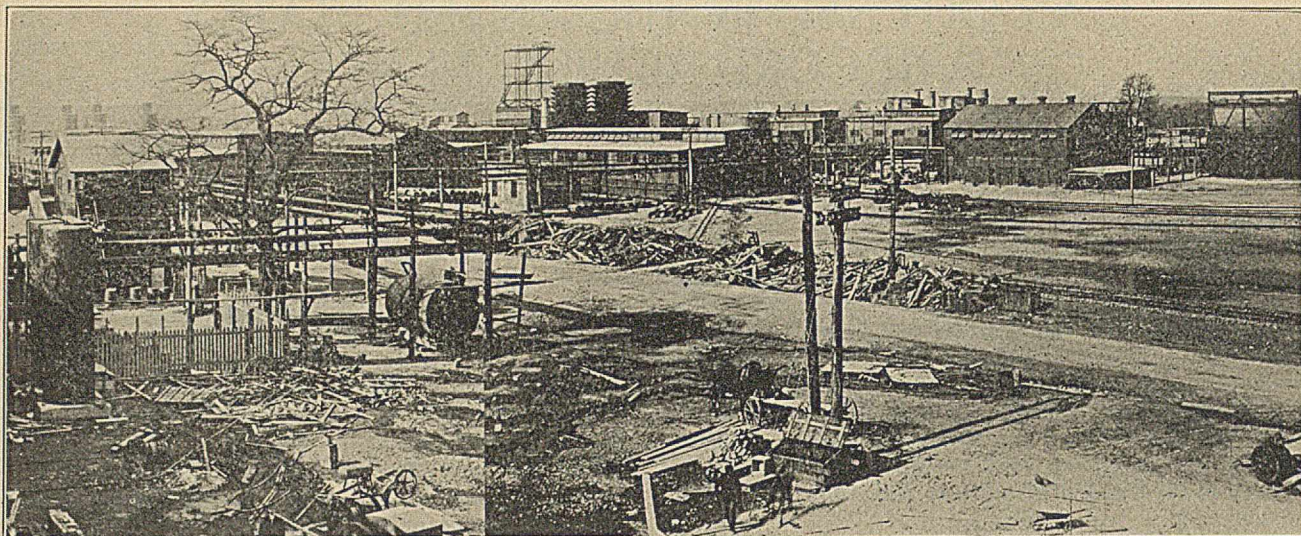


FIG. 2—GENERAL VIEW OF PHOSGENE PLANT

taking. Surrounded by a staff of competent officers and infusing his spirit into soldiers and civilians alike, he brought to completion in less than a year, one of the greatest chemical establishments ever constructed in this country.

Colonel Walker received the degree of B. S. from Pennsylvania State College in 1890. In 1892 he obtained his doctorate at the University of Göttingen, and in 1894 he accepted a professorship of industrial chemistry at the Massachusetts Institute of Technology, later becoming director of the Institute's course

in chemical engineering. Before entering the war service of the Government, Colonel Walker was in charge of the highly successful experiment in the education of chemical engineers, the School of Chemical Engineering Practice of the Massachusetts Institute of Technology.

HISTORICAL

When the United States entered the war, although it was known that poison gas had been used by the enemy and was also used by our Allies, very little information was obtainable in America as to what materials were employed and how they were prepared. The Ordnance Department was at this time charged with the responsibility of procuring all materials for the combatant departments of the Army. The Quartermaster's Department procured clothing, bedding, transportation facilities, etc., which had nothing to do with the actual fighting. In November 1917 it was decided to establish on Gunpowder Neck, Maryland, which was then a part of the Aberdeen Proving Ground property, a small shell-filling plant. This was designed under the direction of Lt. Col. Edwin M. Chance, who took

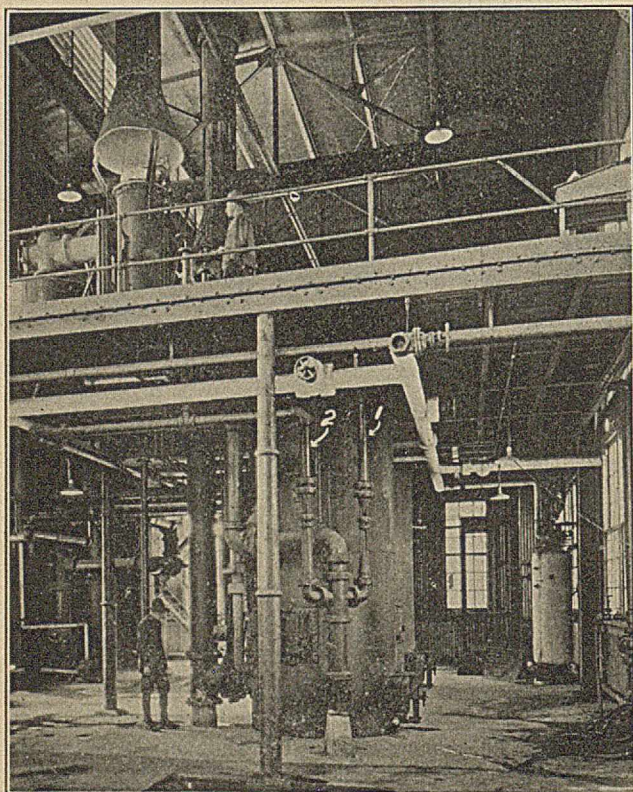


FIG. 3—CARBON MONOXIDE PRODUCER UNIT

1—Oxygen inlet

2—Carbon dioxide inlet

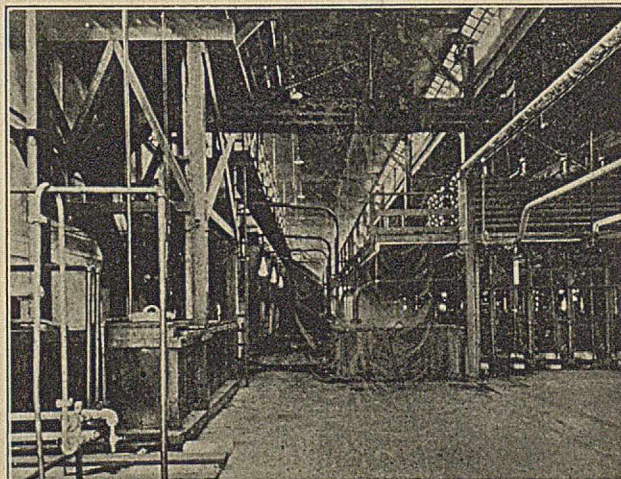


FIG. 4—PHOSGENE MIXER UNIT, 20 TONS PER DAY CAPACITY, COMBINING PURE CHLORINE AND CARBON MONOXIDE TO FORM PHOSGENE AND CONDENSING PRODUCT

charge of the construction work at Gunpowder Reservation, breaking ground early in November. The property taken for this purpose was at that time planted in wheat for the spring crops, and no provision for housing men or for transportation of any kind existed. Railroad facilities were extended to the Reservation from the Pennsylvania Railroad, and bunk-houses for a construction force were erected.

It was then the intention to have the toxic gas itself manufactured by chemical manufacturers throughout the country and shipped to Gunpowder Neck for filling. Owing to the facts, first, that the poison gas materials were new in the sense of not being an established industry; second, that no one would want to manufacture them after the war and therefore the plant would be obsolete; and third, the inherent danger of manufacturing toxic materials, it was soon determined that toxic materials could not be obtained throughout the country, however attractive were the offers, from a financial point of view, which the Government made. Early in December 1917, therefore, it was decided to erect on the site of the shell-filling plant such chemical plants as would be necessary to furnish the toxic materials required for filling the shell. Designs for the chemical plants were ready late in December 1917, and construction was started, notwithstanding the difficulties incident to a very severe winter. A water supply for manufacturing purposes was obtained by constructing two 36 in. mains from the Bush River. The capacity of the system is 24,000 gal. per min. A dock was erected, and industrial railroads throughout the Reservation were built.

Francis C. Frary and Sterling N. Temple, who were, previous to entering the Army, connected with the Oldbury Electrochemical Company, at Niagara Falls, had charge of the develop-

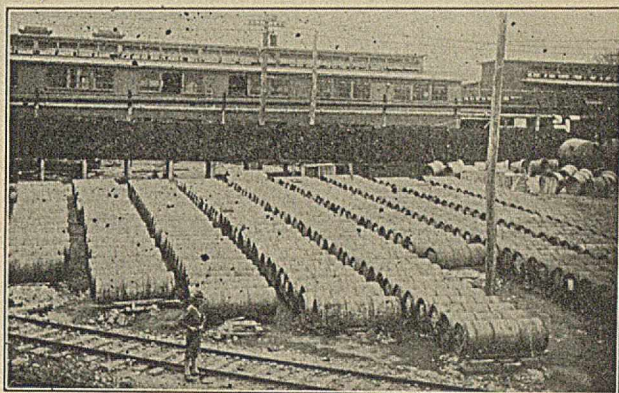


FIG. 6—LIQUID PHOSGENE READY FOR SHIPMENT OVERSEAS

ment of phosgene. Between October 1917 and the first of February 1918, gas warfare had assumed much greater importance in Europe. Representatives of the French and British Governments were sent to America and were of the greatest possible help, not only with the information as to methods which they supplied, but also in furnishing an incentive for the work. By this time it was obvious that the Government would be compelled to erect a large chlorine plant in order to supply this important raw material.

In January 1918 things were not going as satisfactorily as desired, so Colonel Walker, who was at that time Chief of the Chemical Service Section and Assistant Director of Gas Service (the office of Director of Gas Service and the Chemical Service Section are now both absorbed in the organization of the Chemical Warfare Service), was asked to take charge of the Gunpowder Neck project. He was immediately transferred to the Ordnance Department and made Commanding Officer of Gunpowder Reservation (now Edgewood Arsenal). The entire project was taken out of the Trench Warfare Section and was made a separate bureau of the Ordnance Department.

Under the leadership of Colonel Walker, things began to hum. At this time, the railroad transportation system of the country went to pieces. Nothing daunted, however, military guards were sent out to accompany each carload and shipment of materials, these guards seeing to it that the cars were constantly headed towards Edgewood Arsenal, and in case of breakdown,

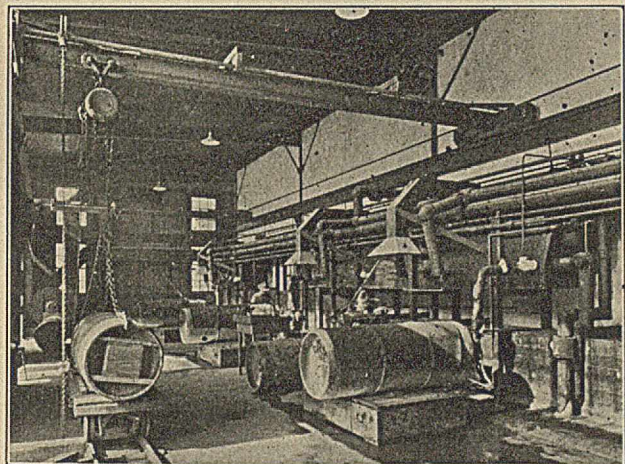


FIG. 5—FILLING LIQUID PHOSGENE INTO 1700-LB. CONTAINERS FOR OVERSEAS SHIPMENT

Adequate shipping facilities were provided by tapping the Pennsylvania Railroad on the one side, and on the other by water transportation through the Bush River to Chesapeake Bay. A 12 ft. channel about a quarter of a mile in length, was dredged through Bush River to the Bay. In order to obtain the greatest speed in the development of the processes necessary, the aid of such manufacturing concerns as were willing to undertake large-scale investigation was accepted. The two gases which it was then obvious would be required in large quantities were chlorpicrin and phosgene. The manufacture of chlorpicrin was begun on a relatively small scale at the plant of the American Synthetic Color Co., Stamford, Conn., while the manufacture of phosgene was undertaken at the plant of the Oldbury Electrochemical Company, at Niagara Falls, N. Y. The Trench Warfare Section of the Ordnance Department, under Lt. Col. E. J. W. Ragsdale (then Captain), assumed responsibility for these developments. Associated with him were Lt. Col. Wm. McPherson, Major D. J. Demorest, Major Wm. L. Evans, and Major Orland R. Sweeney, all of Ohio State University. Majors

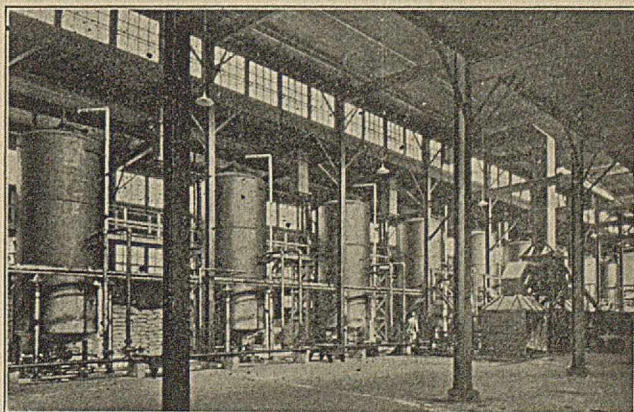


FIG. 7—CHLORPICRIN PLANT. MIXER IN LOWER RIGHT-HAND CORNER AND LINE OF TEN STILLS



FIG. 8—GENERAL VIEW OF MUSTARD GAS PLANT

1—Ethylene holders

2—Reactor houses

3—Sulfur chloride and mustard gas storage tanks

that repairs were quickly made. Later this practice had to be discontinued as it did not meet the approval of the Inland Traffic Service.

In July 1918, Edgewood Arsenal was withdrawn from the Ordnance Department and made a part of the Chemical Warfare Service under the able direction of Major General Wm. L. Sibert.

ORGANIZATION

Edgewood Arsenal was organized with the following departments:

- 1—Chlorine plant, complete, for manufacturing caustic soda and liquid chlorine.
- 2—A chemical plant for the manufacture of toxic materials.
- 3—A filling plant for filling the shell, Stokes mortar bombs, Livens projector drums, hand grenades, incendiary bombs, etc.
- 4—Construction, maintenance, and stores division.
- 5—Headquarters military organization.
- 6—Military medical hospital with ample facilities.
- 7—Executive office. This was moved from Washington to Baltimore, taking the two upper stories of McCoy Hall, one of the old Johns Hopkins University buildings. This executive office consists of sections for administration, purchase, finance, property, contracts, personnel, traffic, etc.

In addition to the officers in charge of the individual plants mentioned below, the following officers were in charge of general features of the work: Lt. Col. George Chahoon, Jr., assistant to the Commanding Officer and in charge of Administration and Contracts; Lt. Col. Wm. G. Gallowhur, executive officer in charge of Edgewood Plant; Lt. Col. E. B. Ellicott, Construction, Maintenance and Stores; Major Frank J. Wagner, Military Administration; Lt. Col. G. E. Lewis, in charge of Hospital.

While the plant at Edgewood was being completed, and in order to avoid having all the eggs in one basket, such manufacturing firms as were willing to enter into the production of toxic materials were utilized.

In general charge of these outside plants was Lt. Col. Wm. McPherson, assisted by Majors E. E. Free, C. R. Wraith, H. H. Hanson, and Capt. J. D. Rue.

The experimental plant for the manufacture of chlorpicrin at Stamford, Conn., was rented, enlarged, and operated by the Government with Lt. V. E. Fishburn in charge.

A plant for the manufacture of phosgene was built at the works of the Oldbury Electrochemical Company, Niagara Falls, N. Y., under the charge of Dr. F. A. Liddbury and Government officer in charge, Major Adrian Nagelvoort. Another plant for phosgene was erected at the plant of Frank Hemingway, Inc., at Bound Brook, N. J. Manufacturing here was in charge of Mr. Frank Hemingway and Government officer in charge, Lt. Wm. R. Chappell.

A plant for bromine was erected at the plant of the Dow Chemical Company, Midland, Michigan, Major M. G. Donk in charge.

A plant for chlorine was erected at the Charleston Chlorine Company's plant at Charleston, West Virginia. This plant was in charge of W. A. Guile, Jr., and Government officer, Lt. M. R. Hoyt.

Later, there were added the plant of Zinsser and Company, at Hastings-on-Hudson, N. Y., Major F. G. Zinsser in charge; the National Aniline and Chemical Company at Buffalo, N. Y., Mr. C. P. Hugo Schoellkopf in charge and Government officer Capt. A. W. Davison; and the Union Dye and Chemical Corporation, Kingsport, Tenn., Lt. E. M. Hayden in charge.

CHEMICAL PLANTS

Plants for phosgene, chlorpicrin, and mustard gas are all in operation, producing an amount of toxic material far in excess of that used in the shell-filling plant. European shipments of toxic gases in bulk began in June, and have been continued up to the present. The chemical plants are under the general charge of Major Dana J. Demorest, with Captain William E. Hoffman as constructing engineer.

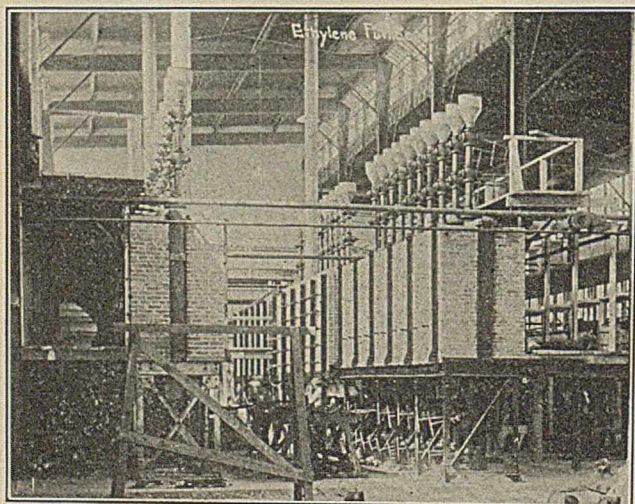


FIG. 9—ETHYLENE FURNACES

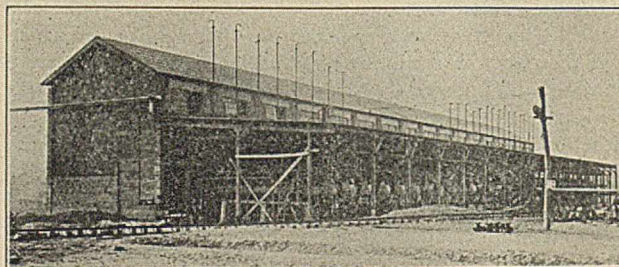


FIG. 10—SULFUR CHLORIDE PLANT

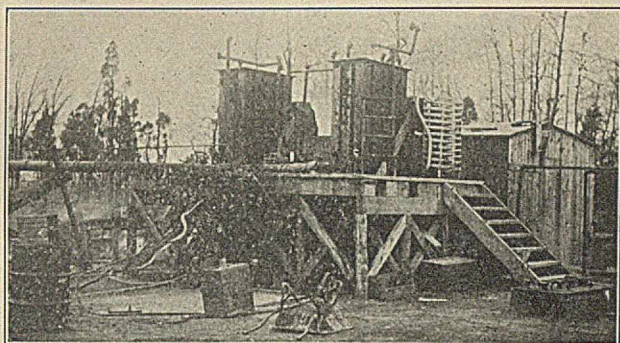


FIG. 11—FIRST MUSTARD GAS PRODUCER. IT OPERATED ON AN EXPERIMENTAL AND SEMI-COMMERCIAL SCALE

PHOSGENE

Phosgene is a lethal gas of high toxic power. It has a very severe delayed action upon the heart which frequently proves fatal after the immediate effects have apparently disappeared.

The method of manufacturing phosgene as used at Edgewood was worked out in the laboratory of the Oldbury Electrochemical Company under the immediate supervision of Dr. F. A. Lidbury by Dr. (now Major) Francis C. Frary and Mr. F. A. Stamps. The design of the plant at Edgewood as it now exists is the fruit of the efforts of Majors Frary, Temple, and Demorest. Instructions from Europe were to the effect that the carbon monoxide could be made best by first producing oxygen from liquid air and using pure oxygen in a small water-cooled producer to make pure carbon monoxide. Obviously the great heat of reaction of oxygen and carbon must be carried away by the water rapidly enough to insure life of the converter. By combining the endothermic reaction of carbon dioxide and carbon

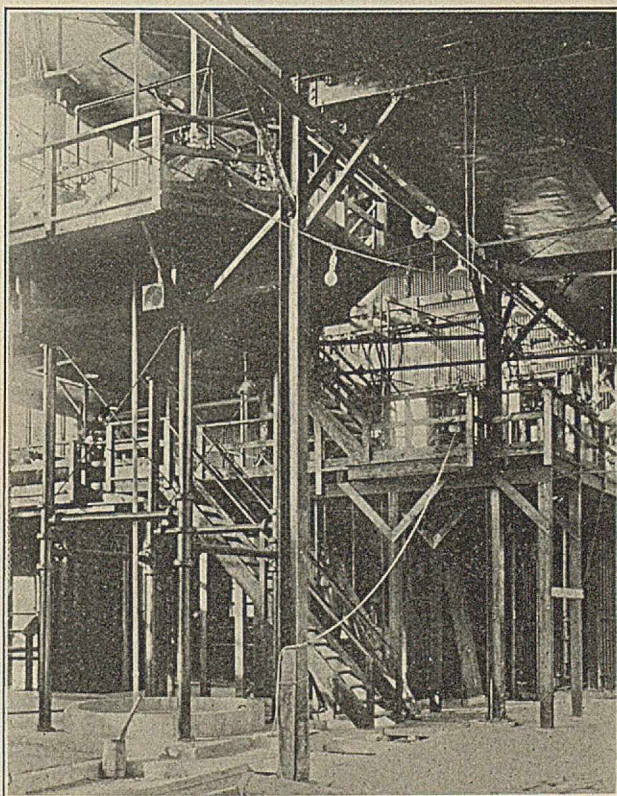


FIG. 12—GENERAL VIEW OF LATEST MUSTARD GAS UNIT. IT HAS PRODUCING CAPACITY OF 12 TONS OF GAS PER DAY

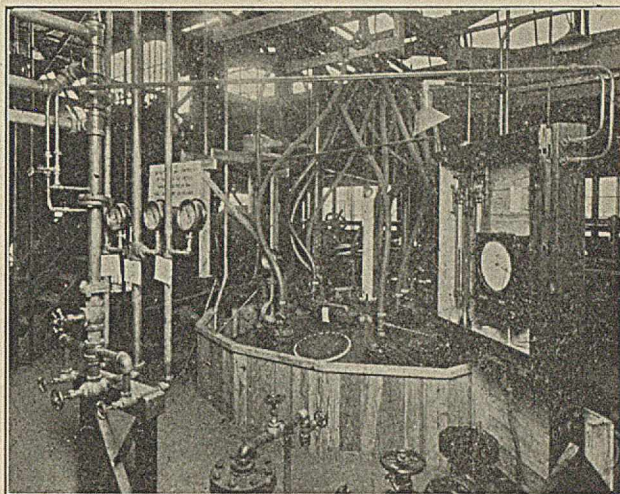


FIG. 13—DETAIL OVERHEAD VIEW OF LATEST MUSTARD GAS UNIT

with this exothermic reaction of oxygen and carbon, a standard U. G. I. gas producer can be employed and carbon monoxide made in very large quantities of high purity. The temperature of the reacting zone can be maintained as desired by regulating the relative amounts of oxygen and carbon dioxide used. The phosgene plant consists, therefore, of a carbon dioxide plant, having a daily capacity of 125,000 cu. ft. of pure carbon dioxide, an oxygen plant with a capacity of 200,000 cu. ft. of oxygen per day, which when used with four producers gives a daily production of 400,000 cu. ft. of carbon monoxide. When carbon monoxide and chlorine are passed over a carbon catalyzer, phosgene is produced with the generation of much heat. It is necessary, therefore, to maintain by cooling a definite temperature. The reaction is practically complete and the phosgene is liquefied by passing through condensing coils immersed in refrigerated brine. At present phosgene is employed in filling the standard caliber gas shell, Stokes mortar bombs, and Livens projector bombs. It is also shipped to the Allies in large quantities in wrought iron drums containing 1700 lbs. The demonstrated capacity of the plant as it exists at present is 40 tons per 24-hour day. Two additional units are almost complete which will bring the total capacity to 80 tons per day. Phosgene is manufactured also in the government plant operated by the Oldbury Electrochemical Company, where the carbon monoxide issuing from the phosphorus furnaces is utilized. The capacity of this plant is 10 tons per day and used partly in filling projectiles at the plant, and partly in containers for shipping abroad. The Bound Brook, N. J., plant of Frank Hemingway, Incorporated, has a capacity of 5 tons per day. This product goes almost exclusively to the Allies in bulk.

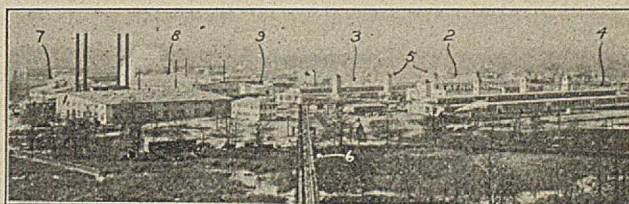


FIG. 14—GENERAL VIEW OF CHLORINE PLANT

- | | |
|-----------------------------|---|
| 1—Salt preparation building | 6—Chlorine gas pipe line to sulfur chloride, chlorine liquefaction, and chemical plants |
| 2—Sub-station | 7—Boiler and evaporator house |
| 3—Cell house No. 1 | 8—Caustic fusion |
| 4—Cell house No. 2 | 9—Drum-making shop |
| 5—Chlorine drying towers | |

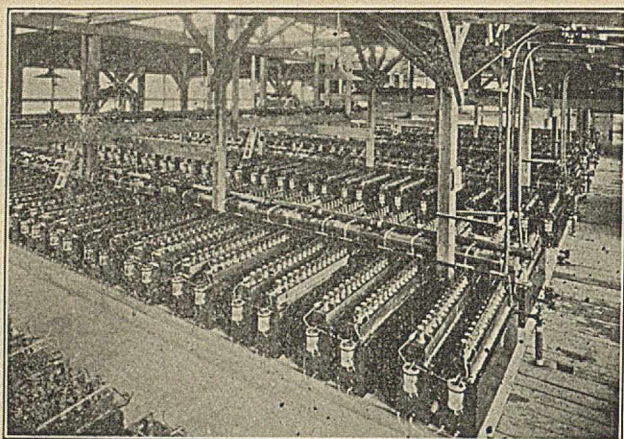


FIG. 15—ONE OF THE EIGHT CELL ROOMS. EACH OF THESE ROOMS IS EQUIPPED WITH GENERATOR, DRYING TOWER, AND NASH PUMP TO FORM A COMPLETE UNIT

CHLORPICRIN

Chlorpicrin is a strong lethal gas and is also a strong lachrymator. Being a liquid at normal temperature and pressure, a somewhat higher explosive charge is required in projectiles thus filled than when a real gas such as phosgene is employed. Chlorpicrin is produced by reacting upon calcium picrate with bleaching powder in wrought iron digesters furnished with condensers. The reaction proceeds evenly when the temperature is maintained within very definite limits in which the chlorine of the bleaching powder reacts with the calcium picrate. If, however, the proper conditions are not maintained, the bleaching powder reacts with a liberation of oxygen, instead of chlorine, and the entire mass foams into the condenser. The chlorpicrin distills from the reaction mass and is separated from the accompanying water by standing for two or three days in settling tanks. At the plant at Stamford, picric acid is produced from phenol and used directly in making chlorpicrin. At the Edgewood plant, the picric acid is provided from other government producing plants. A great portion of the picric acid thus employed has been that rejected by both the U. S. and the Allied Governments on account of excessive lead content. Chlorpicrin is employed for filling all types of projectiles either by itself, or mixed with stannic chloride or phosgene.

MUSTARD GAS

Mustard gas, dichlorodiethylsulfide, is an intense vesicant as well as being very toxic when inhaled. It has a marked action upon the eyes, causing temporary blindness, and quickly pro-

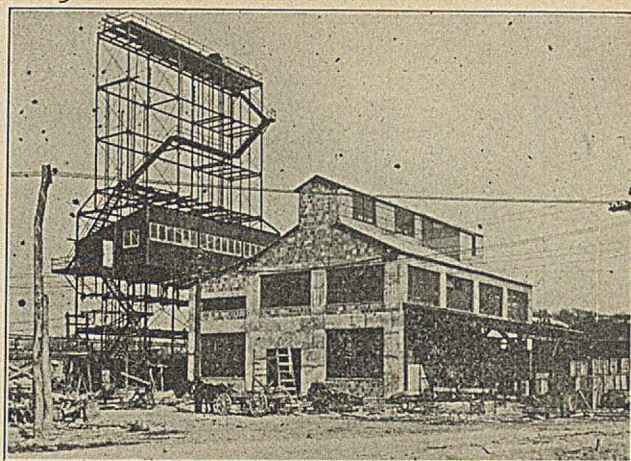


FIG. 16—CHLORINE LIQUEFACTION, 40 TONS PER DAY

duces intense hoarseness, followed by inflammation of the lungs. It penetrates clothing readily, producing a flesh wound of much the same character as the burn from phosphorus.

Mustard gas is produced by passing dry, pure ethylene into sulfur chloride at a temperature maintained within very narrow limits. The reaction vessel can be either cast iron or wrought iron lined with lead. The reaction is highly exothermic and a large cooling surface must be maintained. The reaction is a cranky one and is accompanied by destructive side-reactions which are difficult to control. When a batch "goes wild" great volumes of hydrochloric acid are given off, accompanied by highly toxic gases of an unknown composition. As the gas is strongly lachrymatory, such accidents produce great discomfort. Under certain conditions free sulfur is deposited which usually appears as a eutectic with mustard gas, giving a viscous mixture which is mechanically very difficult to handle.

Mustard gas is filled into shell of all calibers and has been sent to the Allies in bulk in large quantities. Starting with $1\frac{1}{2}$ tons per day in July, the production has constantly increased, until to-day the plant has a demonstrated capacity of somewhat over 30 tons per day. Other units to be completed within the month would bring the capacity of this plant to 80 tons per day. In order that other sources of mustard gas could be available in case of accident at Edgewood, or were a greater supply demanded, this Arsenal has constructed a plant with a capacity of 25 tons per day at the plant of Zinsser and Company, Hastings-on-Hudson. A second plant of 50 tons capacity is nearing completion at the works of the National Aniline and Chemical Co., Buffalo, N. Y.

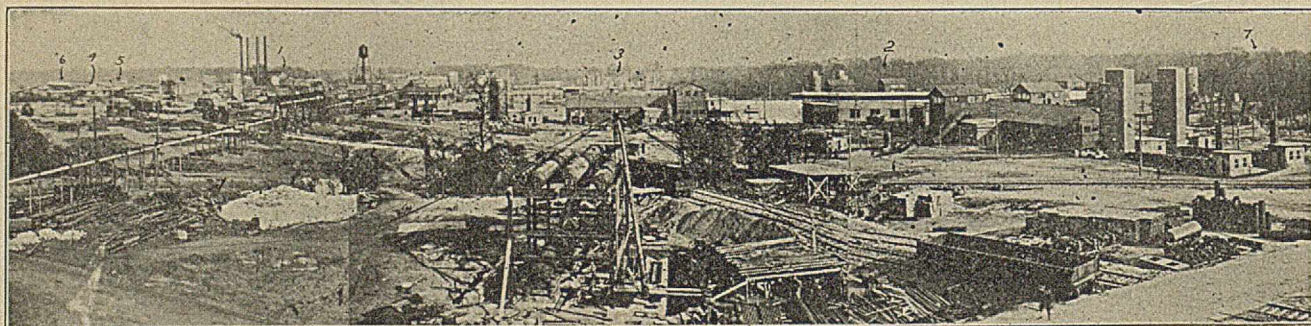


FIG. 17—GENERAL VIEW OF FILLING PLANTS

- 1—Shell-filling group No. 1 (filling shell and Livens drums) and Power Plant No. 1
 2—Shell-filling group No. 2 (filling 155 mm. shell and Stokes bombs)
 3—Shell-filling group No. 3 (filling 75 mm. shell)

- 4—Stannic chloride grenade-filling plant
 5—White phosphorus grenade-filling plant
 6—Incendiary drop bomb-filling plant
 7—Plant under construction for filling 9.2 in. and 240 mm. shell

CHLORINE PLANT

A chlorine plant with a capacity of 100 tons per day and an equivalent amount of caustic soda was designed by the Samuel M. Green Company, of Springfield, Mass., and built under the personal direction of Mr. Green. The electrolytic apparatus employed is that designed by Mr. H. R. Nelson. The cell is known as the "Nelson Cell." Ground was broken for this plant on May 11, 1918, and it was ready to begin operation in August. The entire plant was constructed from first to last without any material change in design and without occasion to tear down and rebuild any part or detail of it—an unusual experience in plant construction.

The chlorine is dried with sulfuric acid and conveyed in a steel-pipe line to the chemical plant where a portion is converted into phosgene, a portion to sulfur chloride, and a portion is liquefied. This liquefying plant has a capacity of 40 tons per 24 hours, compression being effected by a falling column of sulfuric acid. This liquid chlorine goes almost exclusively to the Allies as raw material for further manufacture, although a portion is mixed with phosgene to be filled into cylinders for gas-cloud attacks. The sulfur chloride plant has a capacity of 35 tons per day and furnishes a high grade of material without difficulty.

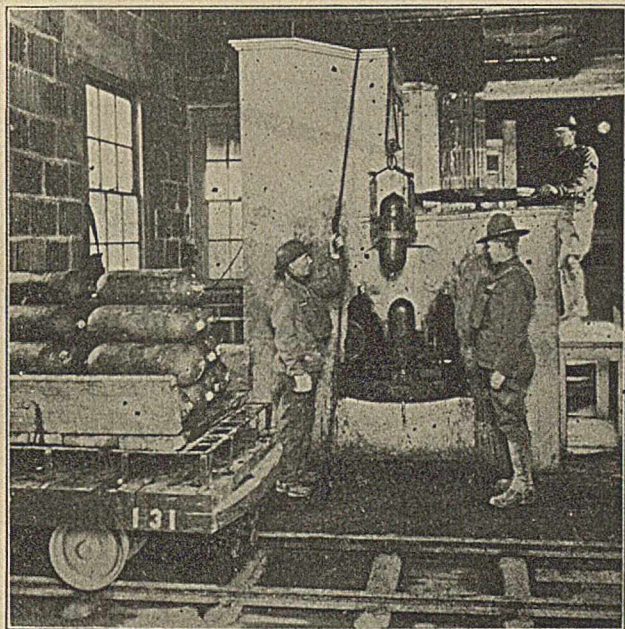


FIG. 18—FILLING LIVENS DRUMS WITH PHOSGENE

Lt. Col. C. F. Vaughn (formerly of the Mathieson Alkali Works, Niagara Falls, N. Y.) is in charge and is assisted by Captains R. A. Hungerford, C. J. Frankforter, and A. U. Wetherbee. The erection of the cells is in charge of Lt. R. G. Brown.

CHEMICAL LABORATORY

Major Wm. L. Evans was placed in charge of organizing a laboratory. He assembled a strong organization, and at the outset, in lieu of a laboratory, placed his force in borrowed laboratory space throughout the country, principally at Johns Hopkins University, Bureau of Standards, Washington, and at Ohio State University. A splendid chemical laboratory, equipped with all modern appliances, has now been provided at Edgewood Arsenal and has been productive of most far-reaching results. It has been under the able direction of Major Evans, assisted by Captains J. A. Wilkinson, R. E. Hall, and W. O. Robinson. Here all of the control processes necessary for the operation of the plants have been worked out, as well as the research incident to factory operation, and results of great value

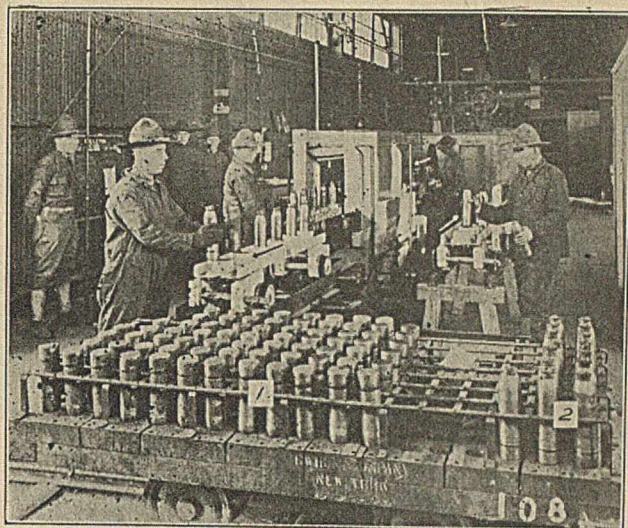


FIG. 19—FILLING SHELL WITH MUSTARD GAS
1—Empty shell 2—Filled shell

have been obtained. Major Evans has charge also of the Inspection Department, and upon him rests the responsibility of seeing that all shell-filling material is in accordance with specifications, that shells are filled to the proper weight and void, that they are properly painted, marked, and tested.

SHELL-FILLING PLANT

The shell-filling plant is constructed to care for the filling of all caliber of shell from the small 75 mm. to the large 240 mm. Inasmuch as phosgene must be maintained in liquid condition at atmospheric pressure, refrigeration is provided for reducing the temperature both of the phosgene itself and the projectile into which it is to be filled. Conveyors carry the empty shell through rooms held at a temperature of 0° F., discharging the same in front of the filling machines at a temperature far below the boiling point of the toxic gas. The shells are filled to a constant void by an automatic machine in which six shells are handled at one time. They are closed by motors actuated by compressed air and which, in the closing process, are driven until they stall. In this way a uniform closing torque is obtained. Industrial railroads bring the shell from the incoming dump where they are unpacked, inspected, and classified, and carry the filled shell to the outgoing dump where they are weighed, inspected for leaks,

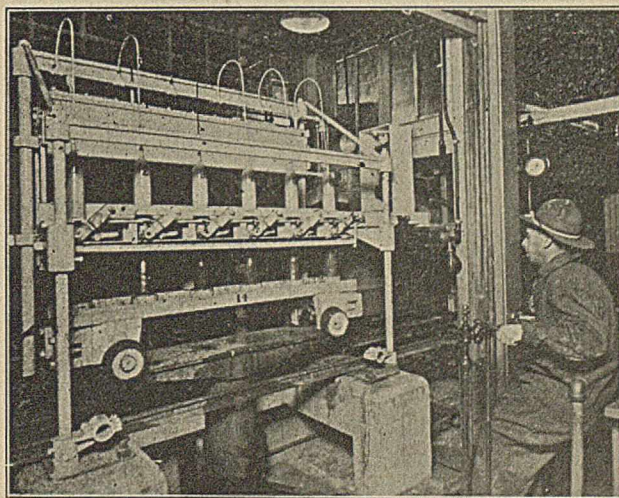


FIG. 20—SHELL-FILLING MACHINE FILLING 75 MM. SHELL WITH MUSTARD GAS

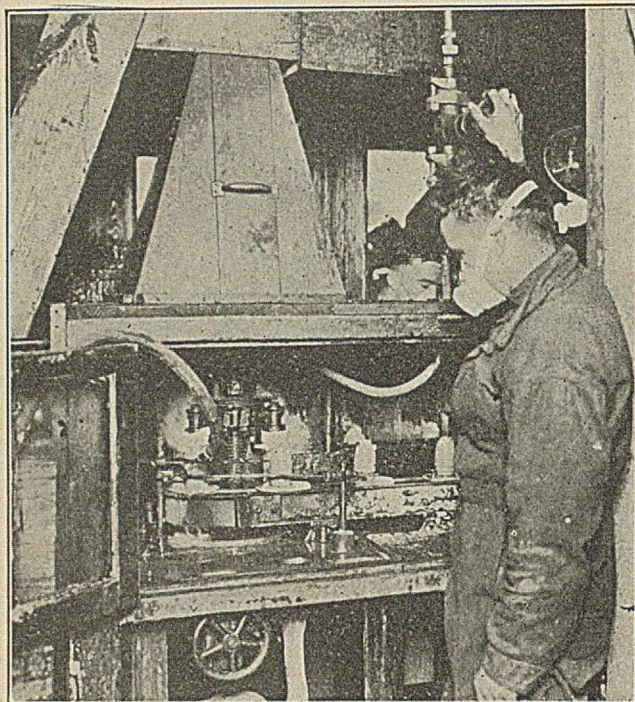


FIG. 21—FILLING HAND GRENADES ON ENDLESS CHAIN WITH STANNIC CHLORIDE

painted, marked, and boxed for shipment. Each unit is ventilated with great care, and the tail gas is washed in stoneware towers. In the construction of these towers a standard type of silo was employed. In the combined units there can be filled in one 24-hour day 80,000-75 mm. shell, 10,000-4.7 in., 50,000-155 mm., and 4,000-8 in. shell. The capacity for filling 6 in., 9.2 in., and 240 mm. shell has not yet been demonstrated. A separate plant is provided for filling smoke shell with phosphorus, and there are also separate plants for filling hand grenades with both gas- and smoke-producing material, and for manufacturing incendiary bombs and darts.

Lt. Col. E. M. Chance is in charge, assisted by Majors F. W. Mack, E. B. Van Keuren, A. M. Heritage, and T. M. Chance. Shell dumps are in charge of Capt. B. B. Gill, phosphorus shell and incendiary bombs, Capt. W. J. Taylor.

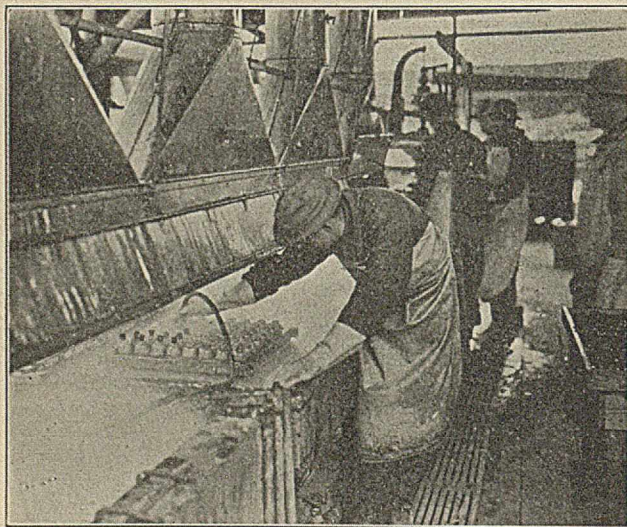


FIG. 22—FILLING HAND GRENADES WITH WHITE PHOSPHORUS

HEALTH AND RECREATION

Gunpowder Neck is devoid of substratum water, so, for domestic purposes, a sanitary water system was installed supplying two million gallons per day, the water being pumped from the Highlands back of Edgewood through a storage reservoir with ample capacity. This domestic supply is filtered and chlorinated.

The construction of the plant and other facilities was done by civilian labor, while the operation is exclusively in the hands of enlisted men, of whom there are now 6200. They are divided in complete military organization, are housed in standard type barracks, and are subjected to the discipline and drill which obtains in the best army camps. Both the commissioned and enlisted men working at Edgewood Arsenal and at the branch plants situated in other parts of the country deserve all of the honor and credit bestowed upon the enlisted men who have been sent to France to go "over the top." At Edgewood he carries hard manufacturing duties and is subjected to poison gas in all of its forms and conditions. While every precaution is taken to preserve the health of the men and to protect them, accidents do happen and casualties occur. A hospital of 250 beds is maintained and is provided with every facility for the most modern scientific treatment of accidents and disease. In each cantonment there are fine Y. M. C. A. and K. of C. buildings, baseball diamond with bleachers, and at the central cantonment a fine athletic field, with running tracks, etc. The Y. M. C. A. assembly halls are provided with moving picture machines, and in the summer time an open air moving picture theatre is largely attended. The camp is enlivened by a band of 42 pieces made up of enlisted men at the plant.

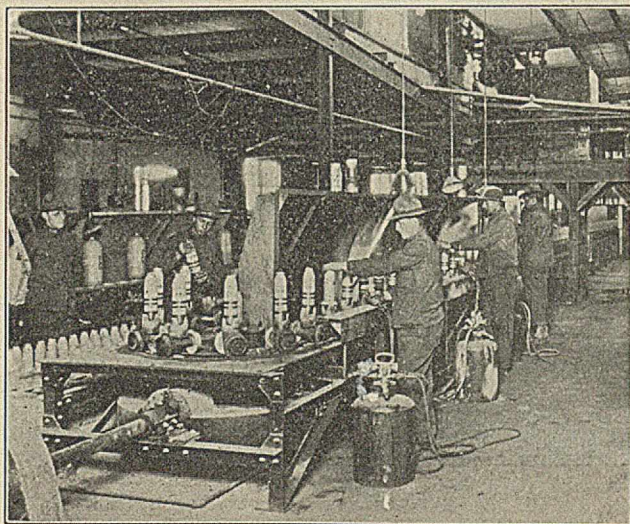


FIG. 23—PAINTING AND STRIPING FILLED GAS SHELL ON ENDLESS CONVEYOR. LIVENS DRUMS IN LEFT REAR

CONCLUSION

Here is a mammoth plant, constructed in record time, efficiently manned, capable of an enormous output of toxic material, and just reaching its full possibilities of death-dealing at the moment when news is hourly expected of the signing of the armistice. What a pity we did not possess this great engine of war from the day American troops first sailed for France, for had we been so prepared how many of our boys who "have gone West" could have returned for the welcome home! Shall we forget this lesson of preparedness? Is this great plant to be scrapped? Possibly wise heads may find a solution of the problem which will add this great resource to American chemical industry, at the same time preserving its value to the Nation as a greater asset, in case of future war, than a standing army.

C. H. H.

THE WORK OF THE TECHNICAL DIVISION CHEMICAL WARFARE SERVICE, A. E. F.

By Col. RAYMOND F. BACON, Chief of the Technical Division, C. W. S., A. E. F.

The importance of gases in the present war has been universally recognized as extremely great. In proportion to the amount of gas shell used the casualties produced thereby have been far in excess of those caused by any other form of ammunition. To enable protection against these casualties and to employ gases with desirable effect upon the enemy has required investigation and experiment of a most comprehensive nature, both in the laboratory and in the field. Then, too, initiative and ingenuity have had every opportunity for their display in the tactical use of gases to neutralize activity or to produce casualties. The military use of the term "gas" obscures the fact that the substances so designated have great differences in properties and effects, and it has required systematic military instruction to demonstrate the variety of results obtainable by their employment in warfare—that two gases may be as different in their tactical possibilities as H. E. differs from shrapnel, and that this variety of behavior affords a vast number of possible combinations with other means of modern warfare.

The experience of the past three years has shown that many unique effects can be obtained by the use of gases (chlorine, carbonyl chloride) readily dissipated by wind; liquids (chlorpicrin, diposgene, dichlorethylarsine) moderately persistent; liquids (brombenzyl cyanide, dichlorethyl sulfide) highly persistent; and solids (diphenylchlorarsine, diphenylcyanarsine). To illustrate, it was found early in the practice of chemical warfare that "gas" harassed to an unprecedented extent—far beyond any other known shell filling. Unlike H. E., shrapnel, etc., the effects of the "gases" were not completed immediately upon the explosion of the shell, but persisted for greater or less time, imposing upon the enemy the necessity of wearing a mask, a source of discomfort, impairment of vision, and extreme fatigue. The psychological effects on troops of the different gases with their various and alarming symptoms of poisoning were of even more serious consideration. "Gases" were, moreover, ascertained to be capable of penetrating certain means of defense, such as trenches and dugouts, frequently more effectively than other forms of ammunition, and were especially effective in silencing enemy batteries.

The Gas Service, American E. F., was organized at a time (September 1917) when broad study of the possibilities of both gas and anti-gas warfare had become exigent. Following the arrival of the first overseas contingent of the Chemical Service Section, in January 1918, a research laboratory was established at Puteaux, near Paris, and later, in March, arrangements were concluded for an experimental field for proving and field-investigation purposes. Until the organization of the Chemical Warfare Service (General Order, War Dept., No. 62),¹ the Chemical Service Section in France reported to the Chief of the Gas Service, A. E. F., but also had charge of relating chemistry to warfare in the entire expeditionary forces. Not only did the Section act in a research and consultative capacity in all the numerous technical phases of gas warfare, but it also conducted the investigation of emergency problems for all branches of the service in France. The results of these inquiries have been recorded in a series of reports.

The Chemical Warfare Service, A. E. F., has continued the functions of the Gas Service, A. E. F., with increased authority. As at present constituted, this Service, the European Division²

¹ THIS JOURNAL, 10 (1918), 675.

² This Division includes personnel assigned to all divisions, corps and army headquarters, in addition to those required for the supply of material in the field in France. For a list of its commissioned personnel, see THIS JOURNAL, 10 (1918), 681.

of the Chemical Warfare Service, U. S. A., has the following organization plan:

CHIEF

Brig. Gen. Amos A. Fries

STAFF

Medical Adviser: Col. H. L. Gilchrist, M. C.

Adjutant: Maj. C. E. Richardson, C. W. S., in direct charge of office administration.

Assistant Adjutants, Capt. J. D. Law, C. W. S.

1st Lieut. J. M. White, C. W. S.

HEADQUARTERS ORGANIZATION

ASSISTANT CHIEF

Col. E. N. Johnston, C. W. S.

To act for the Chief in his absence; in charge of Offense Division and new field projects.

PERSONNEL OFFICER

Lieut. Col. R. B. Clark, C. W. S.

In charge of procurement and assignment of commissioned and enlisted personnel of the Chemical Warfare Service, A. E. F.

DEFENSE DIVISION

Chief: Lieut. Col. G. N. Lewis, C. W. S.

In charge of material for use in the defensive, the training of anti-gas officers and all other instruction of a defensive nature, and the defensive operations in the field.

Assistants

Lieut. Col. R. N. Maddux, C. W. S. 1st Lieut. N. F. Hall, C. W. S.

Maj. J. G. Barry, C. W. S. 1st Lieut. J. J. Hast, C. W. S.

1st Lieut. R. W. Austin, C. W. S.

OFFENSE DIVISION

Chief: Col. E. N. Johnston, C. W. S.

In charge of material for use in offensive gas warfare, the training of officers for the field work of the Division and all other instruction of an offensive nature, and the offensive operations in the field.

Assistants

Artillery Officer: Lieut. Col. L. R. Dice, C. W. S.

Ordnance Officer: Maj. A. M. Prentiss, C. W. S.

Engineer Officer: Maj. Henry Adams, C. W. S.

TECHNICAL DIVISION

Chief: Col. R. F. Bacon, C. W. S.

In charge of all investigations in chemical warfare, the research laboratory at Puteaux, near Paris, and the study of defensive and offensive problems at the Experimental Field, near Chaumont; also acts in an advisory capacity on all technical matters pertaining to gas warfare, and collaborates with other Divisions in the development of material to the point of proving.

Assistants

Maj. W. A. Hamor, C. W. S. 1st Lieut. A. R. Norton, C. W. S.

1st Lieut. L. H. Greathouse, C. W. S.

PURCHASE AND SUPPLY DIVISION

Chief: Lieut. Col. R. Mayo-Smith, C. W. S.

In charge of estimates, programs, appropriations and allotments of material and property; the maintenance and operation of dumps and salvage plants; and the purchase and supply of all material required by the other Divisions.

INTELLIGENCE DIVISION

Chief: Maj. J. L. Clarkson, C. W. S.

In charge of the procurement and distribution of military intelligence, reports and other documents relating to chemical warfare, the preparation of bulletins of information, and the issuance of instruction brochures for use in the training of gas officers and for the confidential information of the Service.

Assistants

Capt. O. J. Noer, C. W. S. 2nd Lieut. L. E. Roberts, C. W. S.

2nd Lieut. W. J. Harper, C. W. S.

FIELD ORGANIZATION

The Defense, Offense, and Purchase and Supply Divisions maintain field organizations, including personnel assigned to army divisions and corps. That of the Defense Division is particularly elaborate, embracing the Gas Defense Schools and Gas Defense Officers on duty with the armies.

TECHNICAL DIVISION

Director, Research Laboratory: Maj. F. G. Keyes, C. W. S.

This Laboratory, also known as the "Paris Laboratory," has a staff of 20 officers and 45 soldiers, all of whom are chemists qualified to conduct original investigations; its accomplishments will be presented below.

Director of Experiments, Hanlon Field: Maj. J. H. Hildebrand, C. W. S.

Maj. Hildebrand's section has been charged with the duty of proving the efficiency of material under field conditions and with the conduct of research into all matters pertaining to gas warfare under conditions obtaining at the "front."

Liaison Officer with the French: Lieut. Col. J. E. Zanetti, C. W. S.

Liaison Officer with the British: Lieut. Col. J. F. Norris, C. W. S.

In direct charge of obtaining special information, reports and other documents relating to chemical warfare from the Allies; the material procured is distributed by the Intelligence Division.

WORK OF THE TECHNICAL DIVISION

A large variety of chemical and physical problems, mainly of an emergency character, has been studied, and, for the most part, solved, at the Paris Laboratory of the Technical Division. The results of these investigations are presented in the weekly progress and special reports of the Technical Division, of which about 90 have been issued (C. W. S., A. E. F., Serial B); copies of all these reports have been distributed by the Intelligence Division to the Chemical Warfare Service, U. S. A., to the Allies, and to certain officers of the C. W. S. on duty in the field. More recently, since July 1918, a number of important inquiries have been carried out by the technical staff at Hanlon Field; and, while serious handicaps have frequently been encountered because of the need of certain equipment, not a few results of decided military value have been obtained. The successful outcome of most of the work of the Technical Division is to be attributed to the splendid spirit of the specialists engaged in research at Paris and Hanlon Field.¹

The laboratory equipment was not received from this side until in May, although it had been purchased four months before, and accordingly work was begun with such necessary apparatus and chemicals as could be obtained abroad because of the pressing importance of the problems submitted to the Division. Enthusiasm, ingenuity, and team-work enacted prominent rôles in the essential productivity of the Laboratory during that semester of military life, when it became urgent to provide immediate protective measures for our fighters against Boche "blue cross" and "yellow cross," when it became all-important to develop a suitable fighting mask, and when it became clear that satisfactory procedures must be developed for recognizing and destroying persistent "gases" in the field. These and other problems were attacked and solved.

Following the receipt and installation of the American laboratory equipment, the Paris establishment rapidly assumed the fore-front of those laboratories engaged in chemical warfare research in Europe. Indeed, it will interest the American chemical profession to learn that the equipment of this laboratory excelled even that of any of the permanent laboratories in the Allied countries. Additional personnel then came and the growth enabled the formation of definite sub-sections, with a consequent general expansion in activity. Maj. J. H. Hildebrand served as Director until his transfer to Hanlon Field as Director of Experiments there, and Maj. W. A. Hamor, his successor, was enabled, during June and July, to place the Labora-

tory upon its present conspicuously high plane, both from a scientific as well as a military standpoint. When Major Hamor assumed the office of Acting Chief of the Technical Division during the writer's absence on a military mission to the United States, Maj. F. G. Keyes followed the standard which had been established, and he has continued the productivity with admirable energy and resourcefulness.

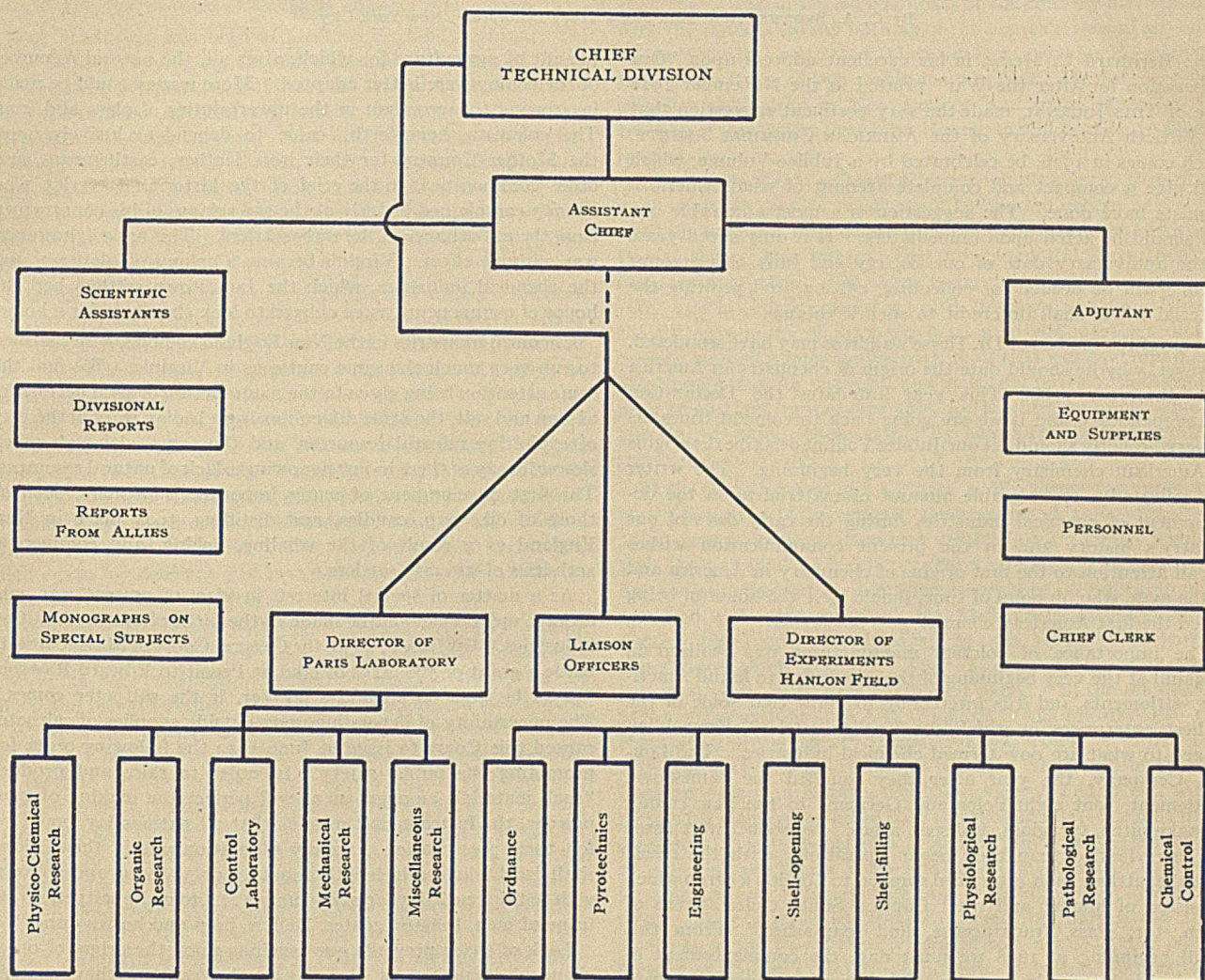
At the present time, this section of the Technical Division has the following departments, or sub-sections:

| SUB-SECTION | CHIEF |
|------------------------------|------------------------|
| Physico-Chemical Research... | Maj. F. G. Keyes |
| Organic Research..... | Capt. B. H. Nicolet |
| Control Laboratory..... | Sgt. Leo. Finkelstein |
| Mechanical Research..... | Maj. F. G. Keyes |
| Miscellaneous Research..... | 1st Lieut. A. R. Olsen |

The physico-chemical investigations have largely centered on the determination of the physical constants of the various "gases" in use—information much needed in connection with the formulation of gas-shell programs—and marked progress has been recorded by Major Keyes and his principal assistant, Sergeant Weisberg. This sub-section has recently completed a physico-chemical study of charcoals and their absorptive powers, and has also participated in the development of a practical detector for the recognition of "mustard gas" in the field. The organic researches have included the following: Development of systematic procedures for the examination of gas-shell contents, contaminated water supplies, and earth infected with "gases;" development of compounds suitable for use in "camouflage gases;" and the preparation of new "gases" for use in warfare. The gas-camouflage is of particular interest. It has been found that malodorous compounds (butyl mercaptan, dimethyl tri-thiocarbonate, etc.) are useful to mask the presence of other "gases" or to force the enemy to wear respirators when no other "gases" are present. As in the case of lachrymators, such "stink gases" must frequently be accompanied by other "gases," in order that the enemy may never know when toxic gases are actually absent. Camouflage gases are also useful in that they save "mustard gas" and the highly lethal gases. Their value has been demonstrated in trials at Hanlon Field and also at the front. The control laboratory has been charged with the examination of anti-gas appliances and equipment, new, defective, and used under varying conditions, and with the development of protective appliances and fabrics. Its canister testing facilities are excellent, and usually 150 canisters per month have been received from gas officers for examination; the necessity for knowing at all times the actual condition of the masks and canisters used by our fighting troops is, of course, obvious. The mechanical researches, conducted in the experimental engineering laboratory, have culminated in a field detector for "mustard gas," an automatic fire-extinguisher for airplanes, a gas-proof pigeon container, and certain improvements in shell-filling. The sub-section on miscellaneous research attends to the study of the various problems submitted by other arms of the service in France. It has been of special assistance to the Air Service and Signal Corps, A. E. F.

Hanlon Field, the experimental ground, has an area of approximately 20 square miles and is provided with the required laboratories (chemical, physiological, and pathological), shops, shell-opening, shell-filling and gaine-filling plants, meteorological station, ranges, trenches, etc. Here also are located the Gas Defense and Gas Offense Schools, at which the gas officers of the Service are trained for field duty. Hanlon Field compares very favorably in layout and equipment with the experimental field of the British at Porton, England, from which many suggestions were received at the inception of the Technical Division's work.

¹ For an earlier expression of appreciation of the work of the personnel of the Technical Division, see Hamor, *THIS JOURNAL*, 10 (1918), 495.

TECHNICAL DIVISION, CHEMICAL WARFARE SERVICE,
 A. E. F.


Among the investigations successfully concluded and reported upon by the staff at Hanlon Field, mention may be made of the following: A method of firing Livens projectors without "digging-in;" the development of a practical base-plate for Livens projectors; the effects of H. E. in Livens drums; the design of a practical airplane bomb for gases; the value of fumigens when employed in conjunction with gases; and the character of gas clouds and the persistence of gas clouds, especially of chlorpicrin and dichlorethyl sulfide, when formed by the bursting of shell under different explosive charges. Important findings have also emanated from the Field chemical laboratory (1st Lieuts. J. L. Crenshaw, C. W. S., and H. I. Cole, C. W. S.), where, in collaboration with the shell-opening plant (1st Lieut. H. E. Stump, C. W. S.), examination is made of enemy "duds" and their fillings, in order to maintain constant familiarity with the types of shell in use, their markings, and the "gases" employed therein. The needed protective measures are determined at the Paris Laboratory in the case of every filling possessing novel characteristics, and prompt dissemination of this information has invariably been arranged for through the Defense and Intelligence Divisions. The Field physiological laboratory (Maj. A. N. Richards, C. W. S., and 1st Lieuts. Samuel Goldschmidt and D. W. Wilson, C. W. S.) has been

largely concerned with the study of the effects of various gases on different animals and the degree of protection afforded by certain proposed preparations, while the pathological laboratory (Maj. H. C. Clark, C. W. S.) has established liaison with the Medical Department, studying considerable material obtained from the hospitals.

It has been impossible, in this résumé, to discuss at any informative length the varied and numerous investigations conducted for the American Expeditionary Forces by the Technical Division during the past year. The general character of its chemical warfare work has, however, been described as the maintenance of an intimate knowledge of conditions at the front, the planning and supervision of researches at the Paris Laboratory and Hanlon Field, the interpretation and application of the results of these investigations, as well as those conducted at American University and by the Allies, and recommendations regarding what gases and what types of masks, protective clothing, and other anti-gas equipment to issue. The research and advisory work of an offensive nature has required constant consideration of the tactical aspects of gas warfare, while the anti-gas activities have been the results of sojourns to a more familiar field—the chemistry of vocational hygiene.

THE TWO HUNDRED AND FIFTIETH ANNIVERSARY OF CHEMICAL INDUSTRY IN AMERICA

By C. A. BROWNE, New York Sugar Trade Laboratory, New York City

Dr. Bernhard C. Hesse, in his excellent address upon "Our Preparation for After the War" printed in the November 1918 issue of *THIS JOURNAL*, made the very pertinent suggestion that the Fiftieth Anniversary of the AMERICAN CHEMICAL SOCIETY, which comes in 1926, be celebrated by a Jubilee Volume, which shall give a compact and complete account of what American chemists have done. The suggestion is a most admirable one and should be acted upon immediately. It is only seven years to the anniversary date of our Society and fully this amount of time will be needed for collecting, editing, and printing the material which shall do credit to such a volume.

Some of the readers of Dr. Hesse's address may have wondered, however, why he should date the origin of chemistry in America from the year 1768. This year antedates the Declaration of Independence and if we are going back to colonial times, as we very properly should, let our Jubilee Volume describe the origins of American chemistry from the very beginning. The writer has collected a considerable amount of material upon the development of chemical industries during the early days of our country's history and in the present communication wishes to call attention to the first origins of chemistry in America and to the man, who, in point of time, should have the honor of being called the first American chemist.

The importance of colonial manufactures was realized in England at the very beginning of the movement to found American settlements, and it is interesting to know that some of the earliest enterprises in which the English settlers engaged belonged to what are now termed chemical industries. The London Company, the year after they founded the Jamestown Settlement, sent eight Poles and Germans to the new colony to make pitch, tar, glass, and soap-ashes. No sooner were these workmen landed than they began operations, with the result that the settlers soon afterward shipped to London a cargo which consisted of lumber and what Captain Smith called "trials of pitch, tar, glass, frankincense, and soap-ashes." From this small beginning in 1608 we must date the commencement of chemical industries in America. The glass-house used for these trials stood in some woods about a mile from Jamestown. In the words of Dr. J. L. Bishop, "though probably very unpretending in its dimensions and appointments, it was doubtless the first manufactory ever erected in this country."

The scope of industrial activities at Jamestown was rapidly widened. In 1620 Sir Edwin Sandys, treasurer of the London Company, reported that 150 workmen had been sent to set up three iron works, that the efforts to make pitch, tar, potashes, and soap-ashes were being developed, and that the salt works, which had been suffered to go to decay, were restored with hopes of such plenty as not only to serve the needs of the colony but also to supply the great fisheries on the Atlantic Coast. The iron works mentioned in this report were at Falling Creek on the Jamestown River and the salt works at Cape Charles on the Eastern Shore.

Attempts were being made to extend the activities of the colony to lead smelting and to other fields when all industrial efforts were paralyzed by the Indian massacre of 1622. The iron works, glass-house, and other establishments were not only entirely demolished, but the courage to begin new enterprises which were under contemplation, such as the development of mineral resources, the distillation of walnut oil, the preparation of gums, drugs, dyes, and other plant products, was completely crushed. The Virginia settlers, after the failure of these early enterprises, turned from manufacturing to the more congenial and lucrative

pursuit of agriculture for which, after all, the natural resources of the colony were better adapted. More money could be made in growing tobacco than in the uncertainties of glass and iron. The colonists, henceforth, came to depend exclusively upon the Mother Country for their iron, leather, earthenware, and other commodities, to the grief of the historian Beverley who in 1705 complained bitterly of the sad relapse of his countrymen from the self-reliance of the early settlers. This appeal, however, was without effect. Virginia became a colony of planters, and the chemical industries, which the Jamestown settlers had the honor of commencing, were obliged to look elsewhere for a home.

Chemical industries in the New England colonies were destined to run very much the same course as in Virginia. We find the same attention being given to the manufacture of such necessities as iron and salt, the same difficulties from Indian wars in the way of exploiting mineral resources, and the same, although much slower, decay of these industries owing to lack of natural resources. The first development of many important industries, such as those of oil, soap, candles, and distilling, took place in New England as a result of the whaling, fishing, and commercial activities of its early settlers.

As a matter of special interest, in view of present war conditions, mention should be made of the birth of our ammunition industries. On June 6, 1639, the General Court of Massachusetts made a grant of 500 acres of land at Pecoit to Edward Rawson, "so as he goes on with the powder, if the saltpeter comes." The uncertainty of depending upon outside supplies of saltpeter caused this Court to issue in June 1642 the following order for promoting the public safety. In order to raise and produce "such materials amongst us as will perfect the making of gunpowder, the instrumental means that all nations lay hold on for their preservation. . . . every plantation within this Colony shall erect a house in length about 20 or 30 foote, and 20 foote wide within one half year next coming. . . . to make saltpeter from urine of men, beastes, goates, hennes, hogs and horses dung."

Lack of space prevents our touching upon the origin of other chemical industries in New England except as they concern the life of the earliest American chemist.

In the beginning of 1669, just 250 years ago, Henry Oldenburg, secretary of the newly founded Royal Society, wrote the following words to John Winthrop, Jr., fellow member of the Society, and Governor of the Colony of Connecticut: "Give me leave, I pray, to inquire what chymists you have in your parts and whether they have written anything considerable."

This attempt to determine the names and status of American chemists may be regarded as the prototype of the questionnaire which our Chemical Warfare Service recently sent through the length and breadth of the land. It is not known what answer, if any, Governor Winthrop made to the request of Oldenburg. Probably modesty forbade his replying to the Honorable Secretary that excepting himself there was at that time probably no other man in the American colonies who could claim the title of chemist.

The name of John Winthrop, the younger, is so firmly associated with the political and military history of the English settlements that his services in the field of science and industry have been overlooked. Excepting a few curious-minded antiquarians, probably no chemists of the present generation ever have occasion to refer to the early records of the Royal Society, otherwise Winthrop's contributions to various chemical subjects would have been more frequently mentioned. All American chemists know of Sir Robert Boyle, discoverer of Boyle's law and author

of "The Skeptical Chymist," yet few of them, probably, are aware of his intimate friendship with Winthrop and of the association of these two men, not only in chemical matters, but in subjects which had a more immediate bearing upon the material and spiritual welfare of the early colonial settlements.

John Winthrop¹ was born at Groton, England, February 12, 1606. After studying at the Free Grammar School at Bury St. Edmunds, he spent several years at Trinity College, Dublin, and then finished by studying law in London, where he was admitted to the bar in 1625. The next five years were spent in adventure and travel, Padua, Venice, Constantinople, and many other European cities being visited. It was during this period, no doubt, that Winthrop formed an acquaintance with many of those scientists and scholars with whom in after years he corresponded in Latin.

In 1630 Winthrop's father sailed for the new colony at Massachusetts Bay and the succeeding year the son followed. Young Winthrop entered immediately into all the activities of his new life. In March 1633, he planted a settlement at Agawam, the present Ipswich, but the death of his wife and daughter caused a change in his plans and the following year he sailed for England on an errand in the interest of the colony. It was during this visit that young Winthrop was granted authority by Lords Say and Brook to begin a plantation in Connecticut for which they gave him men and means with an official commission as Governor. Winthrop, who had meantime remarried, sailed again for America and in November 1635 built a fort at Saybrook in his future colony.

Winthrop's connection with the Massachusetts Bay Colony did not, however, definitely cease until 1650, and during this interval he was constantly engaged in many activities of an official and private nature. In June 1638 he obtained permission to set up a salt factory at Ryall-Side, in what is now Beverly, and in 1641 he sailed for England to obtain funds and men for the erection of iron works. Among the papers of Winthrop is an interesting memorandum upon "Considerations concerning Ironworks" in which he tells how after making a search for ore in Maine and New Hampshire, he finally decided to locate his iron furnace at Braintree, Mass., at which place the General Court in 1644 gave him and his partners a grant of 3000 acres. He obtained the same year a grant to start similar works in the Pequot country, a section which in 1647 was transferred to Connecticut.

In 1646 Winthrop made his home in New London and in 1650 severed his official connection with the Massachusetts Bay Colony, in order to devote his time entirely to the welfare of Connecticut. His interests in the material resources of his colony is shown by an act of the General Assembly for 1651:

Whereas in this rocky country, among these mountains and rocky hills, there are probabilities of mines of metals, the discovery of which may be of great advantage to the country in raising a staple commodity; and whereas John Winthrop, Esquire, doth intend to be at charges and adventure for the search and discovery of such mines and minerals; for the encouragement thereof, and of any that shall adventure with the said John Winthrop, Esquire, in the said business, it is therefore ordered by the Court that if the said John Winthrop, Esquire, shall discover, set upon and maintain such mines of lead, copper, or tin, or any minerals, as antimony, vitriol, black lead, allum, stone-salt, salt springs, or any other the like, within this jurisdiction, and shall set up any work for the digging, washing, and melting, or any other operation about the said mines or minerals, as the nature thereof requireth, that then the said John Winthrop, Esquire, his heirs, associates, partners or assigns, shall enjoy forever said mines, with the lands, wood, timber, and water within two or three miles of said mines, for the

¹ For the main facts in this article pertaining to Winthrop's life use was made of T. F. Water's excellent biography, published by the Ipswich Historical Society. For Winthrop's relations with the Royal Society, Birch's History of the Royal Society, the Proceedings of this Society, and the letters of Winthrop, published in the Massachusetts Historical Society's Proceedings, Series I, Vol. XVI, Pp. 206-251, were consulted.

necessary carrying on of the works and maintaining of the workmen, and provision of coal for the same.

It is doubtful if a greater or more unlimited monopoly for the production of chemical products was ever granted to a man than this. The unsettled condition of the country and troubles with the Indians (to say nothing of the non-existence of any such mines of wealth) prevented Winthrop from enjoying the slightest part of the fruits of this ambitious program. He did, however, establish salt-works at New London and made plans for the erection of iron works near New Haven, to which place he moved in 1655.

In order to obtain a Royal Charter for his colony, Winthrop, in the autumn of 1661, went again to London, where he resided until the spring of 1663 before his diplomatic errand was finished. It was during this interval that he joined the Royal Society (organized in 1660), his name being proposed December 13, 1661, and his admission taking place January 1, 1662. During the fifteen months of his participation in the meetings of the Society he took a most active part in all that was said and done. Winthrop's love for chemical and scientific pursuits had always been strong and he was now able, for the first and only time in his life, to satisfy these tastes by associating with interested and congenial friends.

In the Society meeting for March 5, Winthrop was appointed to a committee to investigate the refining of gold. On April 23 he gave a demonstration of a self-feeding tin lamp "burning high like a candle" of which a diagram was made and registered. At this same meeting he exhibited a specimen of malleable mineral lead and other samples. On April 30 he exhibited other mineral specimens. On June 25 he was asked to prepare a paper upon pitch and tar. This subject was reported upon July 9, and on July 16 his completed paper, "Of the Manner of Making Tar and Pitch in New England," was registered in the *Proceedings* of the Society (Register Book, Vol. 1, p. 179). The title and date are important, for it marks the first contribution from an American before a scientific society, and it is a satisfaction for chemists to know that the subject relates to industrial chemistry. In this paper Winthrop describes in detail the method of collecting pitch-pine knots and subjecting them to heat, the tar being recovered by what he calls a *distillatio per descensum*. Other subjects reported upon by Winthrop during the 1662 meetings of the Royal Society related to black lead, the manufacture of potashes, and the exhibition of various mineral and vegetable products.

On January 7, 1663, Winthrop was asked by the Royal Society to undertake an experiment upon brewing beer from maize. The research was a rather elaborate one as we can see from references contained in the minutes of subsequent meetings. Finally on March 11 he made his report, presenting the members as a result of his experiments some bottles of beverage which was pronounced to be "a pale, well-tasted, middle beer." In this experiment eight gallons of beer were brewed from about half a bushel of maize.

Winthrop's report upon the brewing of maize was included in a paper upon the "Description, Culture and Use of Maize" which appeared in the *Philosophical Transactions* of the Society for 1678 (No. 142, pp. 1065-1069). In this paper Winthrop calls attention to the possibility of making syrup and sugar from cornstalks: "A syrup as sweet as sugar may be made of it, as hath been often try'd. And meats sweetened with it have not been distinguished from the like sweetened with sugar. Trial may easily be made, whether it will not be brought to crystallize, or shoot into a saccharine powder, as the juice of the sugar cane." It was over 150 years before this suggestion of Winthrop was carried out.

Winthrop was asked by the Society to keep some of the beer which he exhibited in order to see how it would stand ageing but this part of the experiment was interrupted by other duties.



On March 18 he notified the Society that he was about to return to New England. His final attendance at the meetings was on March 25 when he was given a commission to execute some experiments upon sea-sounding and was provided with apparatus to procure samples of water from the bottom of the ocean. This last commission, owing to defects in the apparatus and the roughness of Winthrop's homeward voyage, could not be carried out.

The chemists whom Winthrop met at the meetings of the Royal Society were among the celebrities of the day and comprised men of every shade of opinion. There were old-time alchemists, such as Elias Ashmole and Kenelm Digby, practical technologists, such as Robert Moray, and skilled experimenters, such as Robert Boyle. It was a transition period between the old order of things and the new, and remnants of old beliefs crept into the meetings on more than one occasion. A smile is provoked now upon reading that at one meeting, after Winthrop had exhibited the tail of a rattlesnake, a doctor who was present took the rattles home "to make some trial of the powder of it," yet the incident is recorded with all seriousness. No mention was afterwards made of the powder's medicinal value.

The short time spent by Winthrop among the members of the Royal Society has been called the happiest period of his life and his return to the wilds of Connecticut, in spite of the desire to see his family again, was no doubt attended with feelings of regret. The separation from the comradeship of the Royal Society was somewhat alleviated, however, by correspondence, although months and years, in some cases, elapsed before mail was delivered. All too frequently the letters, communications, and specimens which Winthrop sent to the Royal Society were lost at sea either from capture by Dutch privateers or from shipwreck. In the same way letters and books sent to Winthrop by his European friends often failed to reach their destination.

The modern chemist, in the comforts of his club or in the fellowship of his society meeting, does not always appreciate the benefits of his position. There is no better way of bringing this truth home than by contrasting these advantages with the desolation of Winthrop's surroundings. We can form some idea of his longing for scientific companionship from a letter which he wrote to Sir Robert Moray from Hartford, September 20, 1664.

I had sad and serious thoughts about the unhappiness of the condition of a Wilderness life so remote from the fountains of learning and noble sciences. . . . when I was greatly revived with the special favour of your honor's letter. . . .

After telling Sir Robert about his attending the surrender of New York by the Dutch to the English the previous August, Winthrop next answers some of his correspondent's questions regarding the industries and mineral resources of Connecticut.

Matters of public concernment have been so many and difficult since I came over and severall occasions preventing, that, though I have had men at work about some preparations for a salt worke, yet could never have tyme to goe to the Sea Side (which is about 60 miles from this place) to make triall of the businesse, but am waiting some good oportunitie for it, of which I may give your honor some account afterwards.

I had a piece of Marcasite, which seemed to containe copper, an Indian brought from up in the country, but there have bene such warres amonge the heathen in these parts that there could be no travelling that way upon such discoveries, but time I hope will give better oportunities. I heare there is peace like to be made amongst those Indians shortly, which before the Dutch suffered not whilst that land was in their power. I should be glad there could be found any minerall matters of reall worth.

I must be bold to crave the favor of my humble service to the President and the gentlemen of the Royall Society.

The difficulties and dangers of prospecting retarded the de-

velopment of chemical industries in the early colonies at least a hundred years. In a subsequent letter (August 18, 1668) to Sir Robert Moray, Winthrop alludes to this:

I shall not now repeat what was mentioned in former letters except some little about mineralls, though I may be assured that all which were sent came not to your hands. I have been very inquisitive after all sorts of mineralls, which this wilderness may probably afford; but indeed the constant warrs, which have continued amongst the Indians since I came last over, hath hindered all progresse in searching out such matters, for some of them which have formerly brought any specimens of that kind were kild in the warr, and others, who pretend to know places of likely appearance, dare not goe up into the country, without strong parties: those places which have bene for present of most hopes for D and Q^1 are best knowne to the Honble. Colonell Nicolls. . . Better tymes may promote better discoveries, for which we must waite. Those shewes of mineralls, which we have from the Indians, doe only demonstrate that such are in reality in the Country, but they usually bring but small pieces, which are found accidentally in their huntings, sticking in some rock or on the surface of the earth, or the side of some hill, or banke of a river: but they seldom speake of any great quantity where they finde it, nor can they in likelihood meet with a solid veine of good metall, which usually lyeth deepe in the earth, never opened by them, nor have they meanes to do it, therefore cannot know what is in those bowells, except where an earthquake hath shaken downe the side of an hill, or made some rent amonge the rocks. . . .

Concerning the Iron stone of these parts and the Iron works, I forbear to mention anything againe now about those matters, having written largely formerly, as also concerning lead and something about copper and some considerable expenses bestowed rashly upon trialls of a stone that holdeth (as is supposed) some small quantity of that metall: as also what trialls have bene made by digging into the earth and through some rocks, in hope of good metalls, of all which I may hope againe to recollect my thoughts about those particulars of which I have formerly written.

Winthrop's faculty for making and holding friends had probably as much to do with the correspondence between him and the members of the Royal Society as a mutual desire to gather knowledge. Wherever this faculty exists it seems always to be accompanied by a certain liberality and tolerance of opinion—traits which, as exemplified in such men as Franklin and Priestley, are usually found to go with a love for science. The harsh, intolerant spirit, which characterized so many New England Puritans, was entirely absent in Winthrop. "I rejoyce," wrote Roger Williams, "that youre name is not blurrd, but rather honor'd, for your prudent and moderate hand in the late Quaker trialls amongst us," and again in a letter written to Winthrop the year before his death, "You have bene noted for tendernes towards the bodies and infirmities of poor mortalls. You have bene tender too toward the estates of men in your civill stearge of government and toward the peace of the land, yea, of these wild savages."

The same attachment to Winthrop is shown in the letters of his English and Continental friends. One of the latter, when about to send some works of Glauber and other chemists to Winthrop, wrote to an English acquaintance in quaint German, "Hern Winthrop wolle der Herr meinet wegen hertzlichen grüssen. Ich bin seiner nit vergessen, dencke noch oft an Ihn und bisweilen wünsche Ich mich bey Ihn auff $\frac{1}{2}$ oder gantzen tag."

But of all these friends none was more faithful than Henry Oldenburg, who must always rank as the model for a scientific secretary. "You will please to remember," he writes Winthrop, "that we have taken to taske the whole Universe and that we were obliged to doe so by our Dessen, . . . We know your ingenuity, experience and veracity, the best qualities of a man and philosopher and we doubt not but you will let us share in the happy fruits and products thereof. And, since you have now been from us severall years, give us at least a visit by a Philosophicall letter. . . . The Royal Society, who retains still a particular

¹ The alchemistic symbols for silver and mercury.

respect and kindness for you, will receive what shall come from you... with no ordinary affection and thankfulness."

Oldenburg not only urges Winthrop to contribute papers upon the mineral resources of his colony and upon his new method for manufacturing salt, but he sends him at the same time copies of the Society's transactions with chemical books by Boyle and other authors. He also keeps him posted upon the latest researches which the Society had under way. "Since you went," he writes again, "the Society hath made, among others, the Torricellian Experiment in a glass-tube of 40 feet high which costed much trouble but gave contentment." He then describes with considerable detail another experiment which seemed to contradict Boyle's theory of "the spring and weight of the air."

In every letter Oldenburg pressed his friend to write a book upon the natural resources of New England but the cares of office allowed Winthrop no time for such a project. He longed for leisure and the opportunities for research and study and wished to resign the Governorship but the General Assembly refused to give their consent. In performance of his duties as Governor he attended a meeting of the Colonial Commissioners at Boston in the winter of 1675-1676, and it was while absent upon this mission that he contracted his final sickness. He died at Boston, April 6, 1676, and was buried in King's Chapel cemetery.

The objection may be raised against the claim that Winthrop was our first American chemist by saying that he was not a professional chemist but only an amateur. Without denying this, it may be said that the same objection would apply to all chemists for the next hundred years after Winthrop's death. They were not chemists by vocation, but by avocation. The great Priestley was not a chemist by profession, but a Unitarian minister.

In support of the claim for Winthrop we have not only his own letters and the records of the Royal Society but we have the testimony of his contemporaries. In a tribute by the colonial poet Benjamin Thompson the dedication is addressed "to the Honourable Dust of that most Charitable Christian, Unbiased Politician and Unimitable Pyrotechnist, John Winthrop, Esq.: A Member of the Royal Society and Governor of Connecticut Colony in New England, who expired in his Country's Service, April 6, 1676."

In this tribute Thompson mentions little about Winthrop's

political achievements but devotes nearly half the poem to his chemical pursuits.

Projections various by fire he made
Where nature had her common Treasure laid.
Some thought the tincture Philosophick lay
Hatcht by the Mineral Sun in Winthrop's way,
And clear it shines to me he had a Stone
Grav'd with his Name which he could read alone.

.....
Sometimes Earth's veins creeping from endless holes
Would stop his plodding eyes: anon the Coals
Must search his Treasure, conversant in use
Not of the Mettals only but the Juice.
Sometimes his wary steps, but wandring too,
Would carry him the Chrystal Mountains to,
Where Nature locks her Gems, each costly spark
Mocking the Stars, spher'd in their Cloisters dark.
Sometimes the Hough, anon the Gardner's Spade
He deigned to use, and tools of th' Chymick trade.

Winthrop's death may be said to mark the close of the first epoch in the history of industrial chemistry in America, the epoch which was mostly devoted to what were called "trials." The future of chemical industries in America was destined to remain neither in Virginia nor in New England. With the founding of another colony by William Penn, six years after Winthrop's death, a new era was to begin when undiscovered mineral resources, of an extent and character hitherto undreamed, were to make the Middle Atlantic Section the future center of chemical industry.

But the period when our ancestors made trials of pitch, tar, glass, salt, powder, and iron ought not to be forgotten and it should be commemorated at the fiftieth anniversary of the AMERICAN CHEMICAL SOCIETY. The occasion would be fitting, for it has the sanction of a commemoration in more ways than one.

Winthrop died on April 6, 1676, and on April 6, 1876, exactly two hundred years later to the day, the AMERICAN CHEMICAL SOCIETY had its birth.

As the origin of our Society dates back to a meeting of chemists about the grave of Priestley, we can celebrate its fiftieth anniversary in no better way than by meeting in Boston in 1926 about the grave of Winthrop, the man who first brought chemistry into the wilderness, who labored to apply his chemical knowledge to the service of his fellowmen, and who, in spite of his own failures, had unbounded faith and confidence in the future.

CHEMICAL MARKETS OF THE WEST INDIES

By O. P. HOPKINS, Washington, D. C.

It is a fact not generally appreciated that the West Indies are second only to Europe as a market for American goods. During the fiscal year 1916 these islands imported nearly as much from America as the continent of South America, two-thirds as much as was taken by all Asia and the East Indian Islands, or seven times the total sold to China. Cuba, of course, takes the bulk of the trade, but some of the other islands are worth-while customers and constantly becoming more attractive; in fact, the opportunities for future expansion throughout the Archipelago are quite as promising as in any other quarter. The extraordinary natural resources of the islands have not nearly been fully developed.

The wealth of the West Indies lies in agricultural, forest, and mineral products which are exported in the main as crude or partly manufactured materials. Imports, on the other hand, consist of manufactured

goods and foodstuffs, of which the United States is the chief source of supply because of favorable location and superior knowledge of the markets.

All of the islands are covered in this article except a few of the very smallest, which have no trade to speak of, and the American possessions, Porto Rico and the Virgin Islands, which are usually included in studies of the American possessions. The table showing the chemical trade as a whole is in each case compiled from the official statistics of the country, while the tables showing the trade with the United States are made up from published statistics of the United States Bureau of Foreign and Domestic Commerce.

CUBA

Sugar is the principal source of Cuban wealth, followed by tobacco. The elimination of the competition from European beet sugar during the war has

stimulated the Cuban industry and brought prosperity to the whole country, so that the market for imported articles is even more attractive than it was before the war. Other agricultural products of minor but growing importance are cacao, coffee, winter vegetables, pineapples, citrus fruits, bananas, and other tropical fruits. Henequen and malva blanca are two fibers that are grown in increasing quantities to meet the demand for sugar bags.

The mineral resources of the island have not been extensively exploited, but iron and copper ores have been taken out in quantity, especially under the stimulation of war prices.

The only important manufacturing industries are carried on in connection with the cane and tobacco crops. American capital is heavily invested in the sugar mills. The minor manufacturing industries are unable in any case to meet the domestic demands, and the great bulk of manufactured goods is imported.

The purchases of chemical products are rather heavy, as "Salts not elsewhere specified" were imported to the extent of more than three and a half millions during the fiscal year 1917, while "Pharmaceuticals not elsewhere specified" were imported to the value of more than two millions, and fertilizers to the extent of a million. It is unfortunate that more details as to the items included under these classes are not available, but there seems to be a dearth of information on the matter.

The merits of chemical fertilizers have only recently been recognized, but the results obtained with them by the more progressive cane and tobacco growers have had their effect upon the others, and the demand is rapidly growing. American packers, Chilean nitrate concerns, and German fertilizer agencies have been active in the market, and American capital has erected a plant for the manufacture of complete fertilizer from imported materials. This market will continue to expand.

The products imported are for the most part such as the United States can furnish to good advantage, and this country now has the lion's share of the trade in most lines. French manufacturers have always done a good business in proprietary medicines, pharmaceuticals, and perfumes, but the Germans have not been particularly successful.

The following Cuban statistics for the fiscal years 1914 and 1917 show the extent of the imports of chemicals and allied products and the manner in which the principal competing countries have participated:

| CUBAN IMPORTS OF CHEMICALS AND ALLIED PRODUCTS | | |
|--|------------|------------|
| ARTICLES | 1914 | 1917 |
| CHEMICALS, DRUGS, DYES, MEDICINES | | |
| Acids..... | \$ 213,832 | \$ 308,301 |
| Belgium..... | 15,304 | ..... |
| United States..... | 166,839 | 300,236 |
| Alcohol..... | 827 | 353 |
| Alkaloids..... | 16,807 | 12,186 |
| France..... | 3,863 | 5,772 |
| United States..... | 2,804 | 5,649 |
| Calcium carbide..... | 328,539 | 276,032 |
| United States..... | 328,492 | 276,032 |

| CUBAN IMPORTS OF CHEMICALS AND ALLIED PRODUCTS (Continued) | | |
|--|------------|------------|
| ARTICLES | 1914 | 1917 |
| CHEMICALS, DRUGS, ETC. (Continued) | | |
| Chemicals, n. e. s..... | \$ 212,192 | \$ 286,389 |
| Germany..... | 22,968 | ..... |
| United States..... | 143,311 | 263,476 |
| Dyes, natural and artificial..... | 5,572 | 6,714 |
| Germany..... | 2,476 | ..... |
| United States..... | 2,303 | 5,936 |
| Fertilizers, chemical..... | 504,713 | 1,014,833 |
| Germany..... | 140,202 | ..... |
| United States..... | 254,290 | 1,014,833 |
| Glycerin, olein..... | 115,650 | 353,767 |
| Belgium..... | 16,773 | ..... |
| United States..... | 80,769 | 353,767 |
| Medicines, patent or proprietary..... | 547,535 | 415,876 |
| France..... | 175,203 | 152,782 |
| United Kingdom..... | 28,417 | 9,657 |
| United States..... | 302,803 | 232,652 |
| Opium..... | 66,933 | 97,293 |
| China..... | ..... | 47,570 |
| United States..... | 2,226 | 19,061 |
| Oxides..... | 130,227 | 234,575 |
| United Kingdom..... | 34,824 | ..... |
| United States..... | 94,409 | 232,775 |
| Pharmaceutical products, n. e. s..... | 1,214,844 | 2,127,623 |
| France..... | 639,018 | 666,779 |
| Germany..... | 16,936 | ..... |
| Spain..... | 49,501 | 125,740 |
| United Kingdom..... | 16,948 | 40,259 |
| United States..... | 469,716 | 1,240,165 |
| Quinine..... | 3,506 | 6,936 |
| United States..... | 549 | 2,770 |
| Roots, herbs, etc..... | 76,649 | 245,091 |
| Spain..... | 10,675 | 112,570 |
| United States..... | 14,293 | 68,250 |
| Saccharine..... | 1,689 | 3,146 |
| Salts, n. e. s..... | 2,919,691 | 3,632,270 |
| Chile..... | 2,519 | 285,313 |
| United Kingdom..... | 527,696 | 256,825 |
| United States..... | 2,355,135 | 3,060,585 |
| Seeds..... | 6,858 | 21,463 |
| Mexico..... | 6,730 | 21,285 |
| Vanilla..... | 5,456 | 5,550 |
| EXPLOSIVES | | |
| Cartridges..... | 72,677 | 137,218 |
| United States..... | 63,199 | 137,218 |
| Dynamite (U. S.)..... | 128,966 | 340,402 |
| Fireworks..... | 4,938 | 3,867 |
| Gunpowder (U. S.)..... | 22,868 | 20,192 |
| Hunters' powder..... | 6,681 | 10,260 |
| United States..... | 6,681 | 9,653 |
| Miners' fuses (U. S.)..... | 8,787 | 19,433 |
| Other explosives (U. S.)..... | 45 | 6,840 |
| OILS: | | |
| Animal: | | |
| Cod-liver oil..... | 8,679 | 4,154 |
| Norway..... | 3,010 | 220 |
| United States..... | 4,289 | 2,655 |
| Other animal oils..... | 2,323 | 7,430 |
| United Kingdom..... | ..... | 5,891 |
| United States..... | 1,336 | 1,539 |
| Mineral: | | |
| Crude..... | 678,040 | 1,470,431 |
| United Kingdom..... | 812 | 3,186 |
| United States..... | 677,209 | 1,467,245 |
| Refined..... | 711,809 | 1,610,396 |
| United Kingdom..... | 6,768 | 528 |
| United States..... | 701,300 | 1,602,345 |
| Benzine..... | 690 | 198,455 |
| Gasoline..... | 26,357 | 310,509 |
| Naphtha..... | 24,993 | 101,879 |
| Oil for cordage works..... | 19,266 | 12,713 |
| Refined petroleum..... | 63,086 | 56,173 |
| Other refined oils..... | 577,420 | 930,667 |
| Vegetable: | | |
| Cottonseed oil..... | 346,013 | 1,046,113 |
| Spain..... | 40,348 | ..... |
| United States..... | 305,651 | 1,046,113 |
| Olive oil..... | 1,104,941 | 1,880,653 |
| Spain..... | 1,012,556 | 1,725,041 |
| United States..... | 63,369 | 137,359 |
| Oil for manufacture of soap..... | 21,801 | 195,608 |
| Spain..... | ..... | 386 |
| United States..... | 21,801 | 195,222 |
| Other vegetable oils..... | 176,025 | 313,576 |
| Portugal..... | ..... | 78,887 |
| United Kingdom..... | 98,353 | 29,283 |
| United States..... | 43,689 | 200,946 |
| PAINTS, PIGMENTS, COLORS, VARNISHES: | | |
| Colors, natural..... | 14,698 | 10,103 |
| Spain..... | 3,115 | 3,602 |
| United States..... | 5,893 | 5,892 |
| Colors, metallic base..... | 622,172 | 1,041,861 |
| Belgium..... | 37,361 | ..... |
| United Kingdom..... | 177,496 | 112,566 |
| United States..... | 378,165 | 904,603 |
| Other colors and paints..... | 94,375 | 94,344 |
| Germany..... | 13,457 | ..... |
| United Kingdom..... | 6,049 | 6,279 |
| United States..... | 64,947 | 83,440 |
| Varnishes..... | 76,769 | 75,250 |
| United Kingdom..... | ..... | 2,957 |
| United States..... | 67,214 | 70,706 |

| CUBAN IMPORTS OF CHEMICALS AND ALLIED PRODUCTS (Concluded) | | |
|--|------------|------------|
| ARTICLES | 1914 | 1917 |
| PERFUMERY AND ESSENCES..... | 606,450 | 805,654 |
| France..... | 454,045 | 598,308 |
| United States..... | 82,459 | 145,665 |
| SOAP AND CANDLES | | |
| Candles..... | \$ 173,965 | \$ 222,825 |
| Spain..... | 85,802 | 44,654 |
| United States..... | 71,995 | 169,569 |
| Soap, common, in cakes..... | 376,191 | 596,730 |
| Spain..... | 203,508 | 140,681 |
| United States..... | 149,739 | 414,265 |
| Soap, fine..... | 89,956 | 142,912 |
| France..... | 43,918 | 35,743 |
| Spain..... | 1,523 | 60,896 |
| United States..... | 38,087 | 41,361 |
| Soap, other..... | 72,559 | 82,994 |
| United States..... | 51,385 | 61,507 |
| Soap greases..... | 217,849 | 475,547 |
| United States..... | 217,055 | 467,358 |
| GLASS AND GLASSWARE..... | 1,577,972 | 2,064,183 |
| Germany..... | 466,581 | 265 |
| United States..... | 361,558 | 1,518,919 |
| Belgium..... | 217,112 | |
| Spain..... | 139,964 | 230,566 |
| PAPER AND CARDBOARD..... | 1,942,422 | 3,827,533 |
| United States..... | 1,021,099 | 3,249,388 |
| Germany..... | 300,782 | |
| Spain..... | 289,786 | 362,060 |

That the American share in the trade has increased substantially for nearly every item since the war started is clearly shown in the next table. This increase is to be attributed in part to the elimination of European competition, but an even more important factor has been the increased purchasing power of the country. The immediate problem before the American exporter is not how to further expand this trade, but how to maintain his present share in it.

There seems to be a discrepancy between the Cuban figures for imports of fertilizer from the United States and the American figures for exports of fertilizer to Cuba, the probable explanation being that the Cuban returns for "Salts not elsewhere specified" include some items that might have been classified under "Fertilizers." The statistics in this table are for the fiscal years 1914 and 1917:

| AMERICAN PRODUCTS SOLD IN CUBA | | |
|--|-----------|-----------|
| ARTICLES | 1914 | 1917 |
| Aluminum..... | \$ 3,748 | \$ 33,497 |
| Asphaltum: | | |
| Unmanufactured..... | 119,008 | 455 |
| Manufactured..... | 1,997 | 21,745 |
| Babbitt metal..... | 16,280 | 68,828 |
| Blacking, shoe paste, etc..... | 35,055 | 57,258 |
| Candles..... | 70,723 | 185,910 |
| Celluloid and manufactures..... | 3,582 | 38,646 |
| Cement, hydraulic..... | 1,011,720 | 1,282,818 |
| Chemicals, drugs, dyes, medicines: | | |
| Acids: | | |
| Sulfuric..... | 6,956 | 40,439 |
| All other..... | 90,490 | 244,037 |
| Baking powder..... | 12,714 | 16,232 |
| Bark extract for tanning..... | 3,697 | 17,122 |
| Calcium carbide..... | 367,578 | 280,982 |
| Copper sulfate..... | 4,014 | 7,549 |
| Dyes and dyestuffs..... | 670 | 24,412 |
| Medicines, patent or proprietary..... | 524,438 | 1,019,505 |
| Petroleum jelly, etc..... | 3,664 | 13,032 |
| Soda salts and preparations..... | (a) | 588,578 |
| Sulfur (brimstone)..... | 5,452 | 60,101 |
| Washing powder and fluid..... | 23,945 | 29,356 |
| All other..... | 771,394 | 1,748,468 |
| Chewing gum..... | 3,441 | 23,488 |
| Clays..... | 4,750 | 28,565 |
| Explosives: | | |
| Cartridges, loaded..... | 173,169 | 240,959 |
| Dynamite..... | 134,936 | 262,827 |
| Gunpowder..... | 5,337 | 17,255 |
| All other..... | 41,967 | 129,541 |
| Fertilizers: | | |
| Phosphate rock: | | |
| Land pebble..... | | 21,329 |
| All other..... | | 18,698 |
| All other..... | 389,622 | 3,738,222 |
| Flavoring extracts and fruit juices..... | 6,808 | 51,158 |
| Glass and glassware..... | 267,644 | 1,317,286 |
| Glucose..... | 25,896 | 58,066 |
| Glue..... | 14,839 | 50,216 |
| Grease: | | |
| Lubricating..... | 109,769 | 205,603 |
| Soap stock and other..... | 443,071 | 1,314,503 |
| India-rubber manufactures..... | 414,733 | 1,920,572 |
| Ink: | | |
| Printers'..... | 30,962 | 90,222 |
| All other..... | 16,608 | 36,315 |
| Leather, patent..... | 17,774 | 77,738 |
| Matches..... | 509 | 924 |
| Metal polish..... | 10,214 | 30,280 |

| AMERICAN PRODUCTS SOLD IN CUBA (Concluded) | | |
|--|------------|------------|
| ARTICLES | 1914 | 1917 |
| Naval stores: | | |
| Rosin..... | \$ 127,886 | \$ 207,747 |
| Tar, turpentine, and pitch..... | 18,940 | 14,470 |
| Turpentine, spirits of..... | 31,748 | 41,612 |
| Nickel, nickel oxide, and matte..... | | 16,704 |
| Oilecloth and linoleum..... | 65,930 | 78,583 |
| Oils: | | |
| Animal..... | 1,924 | 21,832 |
| Crude mineral..... | 429,810 | 1,303,774 |
| Refined mineral: | | |
| Gas and fuel..... | 43,989 | 84,084 |
| Illuminating..... | 84,411 | 163,766 |
| Lubricating and heavy paraffin..... | 543,148 | 925,987 |
| Gasoline..... | 61,587 | 466,440 |
| Other light oils..... | 2,502 | 223,252 |
| Vegetable: | | |
| Corn..... | 8,388 | 24,286 |
| Cottonseed..... | 382,590 | 1,158,123 |
| Linseed..... | 17,968 | 68,587 |
| All other fixed..... | 10,173 | 163,187 |
| All other oils..... | 17,070 | 42,278 |
| Paints, pigments, etc.: | | |
| Dry colors..... | 8,951 | 98,029 |
| Ready-mixed paints..... | 223,459 | 411,456 |
| Varnish..... | 48,748 | 77,407 |
| White lead..... | 8,083 | 24,805 |
| Zinc oxide..... | 5 | 9,058 |
| All other (including crayon)..... | 147,776 | 537,307 |
| Paper: | | |
| Carbon..... | 12,851 | 20,312 |
| Board..... | (a) | 301,346 |
| Printing: | | |
| News..... | 266,257 | 478,601 |
| All other..... | 263,157 | 1,117,523 |
| Wrapping..... | 44,391 | 645,672 |
| Writing and envelopes..... | 114,775 | 340,166 |
| All other..... | 223,416 | 315,538 |
| Paraffin and paraffin wax..... | 9,403 | 41,478 |
| Paste..... | 10,758 | 24,697 |
| Perfumeries, cosmetics, etc..... | 41,983 | 172,902 |
| Photographic goods: | | |
| Motion-picture films..... | 14,699 | 46,432 |
| Other sensitized goods..... | 62,476 | 80,186 |
| Plaster of Paris..... | | 12,161 |
| Plumbago and manufactures..... | 8,743 | 29,106 |
| Salt..... | 165,029 | 187,211 |
| Soap: | | |
| Toilet..... | 60,772 | 148,881 |
| All other..... | 137,073 | 372,752 |
| Starch..... | 3,683 | 73,652 |
| Stearin: | | |
| Animal..... | 39,190 | 241,110 |
| Vegetable..... | (a) | 15,262 |
| Sugar, refined..... | 103,675 | 229,035 |
| Wax, manufactures of..... | 1,886 | 8,509 |
| Yeast..... | 15,386 | 22,103 |

(a) Not stated separately in 1914.

The principal Cuban product sold in the United States is cane sugar; in fact, this is now the most valuable item imported from any country. There are very few countries whose total exports to the United States equal in value our purchases of Cuban sugar.

| CUBAN PRODUCTS SOLD IN THE UNITED STATES | | |
|--|------------|-------------|
| ARTICLES | 1914 | 1917 |
| Asphaltum and bitumen, crude..... | \$ 4,600 | \$ 32,846 |
| Bones, hoofs, horns, and manufactures..... | 48,605 | 50,982 |
| Cacao, crude..... | 326,642 | 149,447 |
| Chemicals, drugs, dyes, medicines: | | |
| Glycerin, crude..... | 27,431 | 106,776 |
| Potash salts..... | | 9,868 |
| Vanilla beans..... | 30 | |
| All other..... | 7,210 | 9,753 |
| Copper: | | |
| Ore..... | 1,270,182 | 5,824,698 |
| Concentrates..... | | 469,168 |
| Matte, regulus, etc..... | | 101,004 |
| Old and clippings..... | 162,709 | 242,725 |
| Dyewoods, in crude state: | | |
| Logwood..... | | 19,253 |
| All other..... | | 3,381 |
| Fertilizers: | | |
| Guano..... | 1,250 | 8,846 |
| Potash, sulfate..... | | |
| All other..... | 2,675 | 735 |
| Glass and glassware..... | 1,133 | 5,291 |
| Hide cuttings and other glue stock..... | 21,689 | 26,945 |
| India rubber: | | |
| India rubber..... | | 74,444 |
| Scrap..... | 12,426 | 37,507 |
| Iron ore..... | 3,717,975 | 1,913,804 |
| Manganese oxide and ore..... | | 461,835 |
| Oils: | | |
| Mineral..... | | 15,647 |
| Coconut..... | | 3,184 |
| All other..... | 2,014 | 8,634 |
| Starch..... | 129 | 3,987 |
| Sugar and molasses: | | |
| Molasses..... | 1,474,200 | 10,381,816 |
| Sugar, cane..... | 98,394,782 | 204,521,160 |
| Wax, beeswax..... | 168,691 | 217,563 |
| Zinc, block and old..... | 7,293 | 19,865 |

The only other important imports suitable for inclusion in this list are molasses, copper ore, and iron ore, the first two of which have been greatly increased since the war started. The preceding table contains details of our imports from Cuba for the fiscal years 1914 and 1917.

DOMINICAN REPUBLIC

The Dominican Republic's output of sugar was valued at \$5,000,000 in 1914, cacao at \$4,000,000, tobacco at \$400,000, and coffee at \$350,000, and these are the principal products of the country. The war has greatly stimulated the output of sugar and has also led to some exploitation of the immense dyewood resources, which had previously been neglected. The forests contain an abundance of tropical woods, and agriculture could be much extended. There is very little manufacturing, and the mineral resources have not been surveyed. The population is estimated at about 800,000.

To date there has not been much of a demand for chemicals, although the market for patent medicines and pharmaceuticals is not altogether unattractive. Before the war Germany had a good share of the business in paper and glass, and France sold most of the perfumes, but in all other lines the United States has practically no competition.

The following table will give some idea of the extent to which chemicals and allied products are imported:

| IMPORTS OF CHEMICALS AND ALLIED PRODUCTS INTO THE DOMINICAN REPUBLIC | | | |
|--|---------|---------|--|
| ARTICLES | 1913 | 1917 | |
| CHEMICALS, DRUGS, GUMS, RESINS, FATS, AND WAXES. | | | |
| France..... | 38,361 | 38,187 | |
| Germany..... | 22,881 | ..... |  |
| United States..... | 228,737 | 411,468 | |
| Calcium carbide..... | (a) | 35,662 | |
| Caustic soda..... | (a) | 8,755 | |
| Tallow and greases..... | (a) | 36,211 | |
| Other oils, fats, waxes..... | (a) | 367,012 | |
| Vegetable juices and extracts..... | (a) | 6,463 | |
| Gums, resins, and caustic soda for the manufacture of soap..... | 103,989 | (b) | |
| Resins..... | 3,371 | 12,407 | |
| All other chemicals..... | 212,834 | 9,727 | |
| PERFUMERY AND COSMETICS. | | | |
| France..... | 43,776 | 77,350 | |
| United States..... | 28,963 | 39,085 | |
| United States..... | 6,827 | 31,273 | |
| OILS, ALL SORTS. | | | |
| Spain..... | 448,384 | 786,956 | |
| United States..... | 30,078 | 14,809 | |
| United States..... | 384,082 | 743,045 | |
| Oils for table use..... | (a) | 268,458 | |
| Spain..... | (a) | 14,809 | |
| United States..... | (a) | 230,708 | |
| Oils, mineral: | | | |
| Crude, and fuel oil..... | (a) | 45,324 | |
| Gasoline..... | (a) | 117,450 | |
| Illuminating oil..... | (a) | 217,811 | |
| Lubricating oil..... | (a) | 69,339 | |
| All other..... | (a) | 68,574 | |
| SOAP. | | | |
| United States..... | 86,884 | 248,902 | |
| United States..... | 82,583 | 240,915 | |
| EXPLOSIVES. | | | |
| United States..... | (a) | 10,872 | |
| United States..... | (a) | 10,436 | |
| PAINTS, PIGMENTS, VARNISHES. | | | |
| Germany..... | 56,073 | 140,852 | |
| Germany..... | 6,467 | ..... |  |
| United Kingdom..... | 7,855 | 4,967 | |
| United States..... | 41,415 | 133,982 | |
| PAPER AND MANUFACTURES OF. | | | |
| United States..... | 125,683 | 248,381 | |
| Germany..... | 52,898 | ..... |  |
| United States..... | 54,764 | 202,448 | |
| GLASS AND GLASSWARE. | | | |
| Germany..... | 55,330 | 72,360 | |
| Germany..... | 22,189 | ..... |  |
| United States..... | 29,144 | 63,867 | |

(a) Not shown in 1914. (b) Not shown in 1917.

it will be seen that demands for practically all lines have expanded since the war started.

AMERICAN PRODUCTS SOLD IN THE DOMINICAN REPUBLIC

| ARTICLES | 1914 | 1917 |
|---|----------|-----------|
| Blacking, shoe paste, etc..... | \$ 6,270 | \$ 10,726 |
| Candles..... | 6,449 | 66,465 |
| Celluloid and manufactures..... | 5,665 | 5,803 |
| Cement, hydraulic..... | 77,733 | 146,129 |
| Chemicals, drugs, dyes, medicines: | | |
| Acids..... | 1,970 | 15,292 |
| Calcium carbide..... | 22,597 | 30,996 |
| Medicines, patent and proprietary..... | 80,523 | 153,134 |
| Soda salts and preparations of..... | (a) | 18,293 |
| All other..... | 51,121 | 175,506 |
| Chewing gum..... | 9 | 7,725 |
| Explosives: | | |
| Cartridges, loaded..... | 59,932 | 508 |
| Dynamite..... | 12 | 3,045 |
| Gunpowder..... | ..... | 216 |
| All other..... | 4,169 | 4,450 |
| Flavoring extracts and fruit juices..... | 710 | 9,287 |
| Glass and glassware..... | 14,852 | 52,019 |
| Glue..... | 310 | 4,127 |
| Grease: | | |
| Lubricating..... | 7,012 | 13,788 |
| Soap stock and other..... | 20,669 | 6,110 |
| India-rubber manufactures..... | 27,131 | 80,026 |
| Ink..... | 3,275 | 10,616 |
| Leather, patent..... | 15,027 | 14,286 |
| Lime..... | 6,088 | 6,656 |
| Matches..... | ..... | 5,606 |
| Naval stores: | | |
| Rosin..... | 14,688 | 18,339 |
| All other..... | 1,974 | 2,565 |
| Oilcloth and linoleum..... | 4,854 | 8,178 |
| Oils: | | |
| Mineral: | | |
| Crude..... | ..... | 10,705 |
| Gas and fuel..... | 8,442 | 17,885 |
| Illuminating..... | 105,101 | 134,646 |
| Lubricating and heavy paraffin..... | 24,865 | 54,632 |
| Gasoline..... | 25,442 | 107,256 |
| All other (including residuum)..... | ..... | 72,858 |
| Vegetable: | | |
| Corn..... | 28,307 | 113,994 |
| Cottonseed..... | 134,595 | 154,178 |
| Linseed..... | 3,266 | 16,911 |
| All other fixed..... | 2,445 | 7,383 |
| Essential..... | 460 | 2,196 |
| Paints, pigments, etc.: | | |
| Dry colors..... | 3,184 | 7,128 |
| Ready-mixed paints..... | 14,613 | 27,833 |
| White lead..... | 1,218 | 3,609 |
| All other (including crayon)..... | 16,937 | 46,079 |
| Paper and manufactures..... | 54,130 | 204,262 |
| Paraffin and wax..... | 51 | 11,391 |
| Perfumery, cosmetics, etc..... | 4,510 | 22,636 |
| Photographic goods, sensitized..... | 2,197 | 6,336 |
| Soap: | | |
| Toilet..... | 8,040 | 30,692 |
| All other..... | 72,735 | 194,868 |
| Starch..... | 855 | 3,301 |
| Sugar, refined..... | 56,932 | 135,607 |

(a) Not stated separately in 1914.

The Republic's chief contributions to the United States are now cacao and sugar, as the next table shows. As a source of cacao it is second only to Ecuador. The sudden development of the logwood industry is shown by the jump in exports to the United States from four thousand to two hundred thousand dollars in three years.

DOMINICAN REPUBLIC PRODUCTS SOLD IN THE UNITED STATES

| ARTICLES | 1914 | 1917 |
|---|-------------|-------------|
| Cacao, crude..... | \$3,187,006 | \$7,202,747 |
| Chemicals, drugs, dyes, medicines: | | |
| Glycerin, crude..... | ..... | 1,883 |
| All other..... | 3,308 | 42,328 |
| Copper: | | |
| Ore..... | ..... | 32,690 |
| Matte, regulus, etc..... | ..... | 17,225 |
| Old and clippings..... | 1,813 | 27,799 |
| Dyewoods, in crude state: | | |
| Logwood..... | 4,410 | 221,718 |
| All other..... | 8,221 | 4,669 |
| Coconut meat (copra)..... | ..... | 13,723 |
| Sugar and molasses: | | |
| Molasses..... | 8,590 | 161,029 |
| Sugar, cane..... | 86,761 | 5,242,515 |
| Tanning materials: Mangrove bark..... | ..... | 13,834 |
| Wax: Beeswax..... | 19,894 | 142,354 |

HAITI

Imports of American goods, according to the American classification, are shown in the next table, by which

Agricultural and forest products comprise Haiti's contribution to international trade. There are said

to be mineral resources, but little is known of them, and there is practically no manufacturing. Coffee is the principal product and was exported to the extent of seventy-nine million pounds in 1914. Other exports are cacao, cotton, logwood, fustic, and other woods, gum guaiacum, honey, orange peels, and hides and skins. Sugar and indigo were once exported in large quantities, but these products are now unimportant. The United States is the principal purchaser of the island's goods and easily the chief source of supply for manufactured goods. The coffee trade suffered by the cutting off of the markets in Germany, Belgium, and Holland, but the increased demand for logwood and other dyewoods has brought prosperity to many of the inhabitants. There are very few white persons in the country.

Haitian statistics are notoriously incomplete and unreliable; in fact, there have been no detailed official trade figures in recent years, and it has consequently been impossible to compile a table that would present the trade in chemicals and allied products as a whole. The table that follows shows the imports from the United States as given in the statistical publications of our own Government, and as the trade is very largely American it gives a fairly definite idea of the importance of the market.

The chief imports are soap and mineral oil, both of which are purchased almost exclusively from the United States. The bulk of the soap is a cheap grade of yellow laundry soap that comes in bars. The importance of this item, as compared with totals for other countries of similar standing, is probably to be accounted for by the fact that even this simple industry is not well developed in the country.

AMERICAN PRODUCTS SOLD IN HAITI

| ARTICLES | 1914 | 1917 |
|------------------------------------|----------|-----------|
| Blacking, shoe paste, etc. | \$ 7,484 | \$ 12,097 |
| Candles | 4,861 | 4,914 |
| Celluloid and manufactures | 35 | 3,170 |
| Cement, hydraulic | 25,574 | 63,185 |
| Chemicals, drugs, dyes, medicines: | | |
| Medicines, patent or proprietary | 7,563 | 16,534 |
| All other | 22,823 | 53,252 |
| Glass and glassware | 9,019 | 17,805 |
| India-rubber manufactures | 5,525 | 10,654 |
| Leather, patent | 7,492 | 18,446 |
| Matches | 2,702 | 13,078 |
| Naval stores | 5,277 | 5,627 |
| Nickel, nickel oxide, and matte | | 3,038 |
| Oilcloth and linoleum | 6,544 | 6,156 |
| Oils: | | |
| Mineral: | | |
| Gasoline | 1,358 | 3,415 |
| Illuminating | 112,307 | 82,338 |
| Lubricating, etc. | 6,305 | 6,799 |
| All other | 6 | 2,010 |
| Vegetable: | | |
| Corn | | 5,623 |
| Cottonseed | 13,298 | 28,895 |
| Linseed | 5,445 | 11,675 |
| All other fixed | 218 | 3,672 |
| Essential | 95 | 558 |
| Paints, pigments, etc.: | | |
| Dry colors | 1,715 | 3,860 |
| Ready-mixed paints | 5,245 | 13,799 |
| All others (including crayons) | 5,860 | 19,624 |
| Paper and manufactures | 17,547 | 44,011 |
| Perfumery, cosmetics, etc. | 1,271 | 10,658 |
| Soap: | | |
| Toilet | 1,549 | 27,901 |
| All other | 455,524 | 420,732 |
| Sugar, refined | 40,342 | 38,609 |

Logwood is the only material of interest to the chemical industry that is imported into this country from Haiti in large quantities, as the following table shows.

HAITIAN PRODUCTS SOLD IN THE UNITED STATES

| ARTICLES | 1914 | 1917 |
|------------------------------------|-----------|------------|
| Cacao, crude | \$218,947 | \$ 384,739 |
| Chemicals, drugs, dyes, medicines: | | |
| Gums | 416 | 2,200 |
| All other | | 90,363 |
| Copper, old, and clippings | 491 | 8,085 |
| Dyewoods, in crude state: | | |
| Logwood | 95,609 | 1,800,397 |
| All other | 687 | 1,476 |
| Fertilizers: | | |
| Guano | | |
| All other | | 2,166 |
| India rubber: | | |
| Balata | | 1,546 |
| All other | | 37 |
| Oils, vegetable: | | |
| Cottonseed | | 15,261 |
| All other | | 1,244 |
| Seeds, castor | | 2,993 |
| Sugar, cane | | 144,600 |
| Wax: | | |
| Beeswax | 17,287 | 16,365 |
| Vegetable | | 167 |

BRITISH WEST INDIES—BARBADOS

Cane is practically the only source of wealth in Barbados, and from this crop are obtained the sugar, molasses, rum, and alcohol that make up the rather important trade with Canada. There are deposits of manjack, an almost pure bitumen that is shipped to some extent to the United States for use in manufacturing a good grade of black insulating varnish. The total population is less than two hundred thousand, the great majority of whom are colored. The only imports of chemicals and allied products totaling more than one hundred thousand dollars are fertilizers and soap, Canada and England furnishing most of the former and England the bulk of the latter, as the following table shows:

IMPORTS OF CHEMICALS AND ALLIED PRODUCTS INTO BARBADOS

| ARTICLES | 1912 |
|---------------------------|-----------|
| CHEMICALS AND DRUGS | \$ 61,104 |
| United Kingdom | 30,824 |
| United States | 27,218 |
| SULFATE OF AMMONIA | 252,591 |
| Canada | 199,653 |
| OTHER FERTILIZERS | 244,590 |
| Chile | 31,632 |
| United Kingdom | 108,421 |
| United States | 3,528 |
| SOAP | 92,590 |
| United Kingdom | 89,247 |
| United States | 14,419 |
| PERFUMERY | 4,346 |
| United States | 27,661 |
| PAINTS AND VARNISHES | 23,904 |
| United Kingdom | 2,326 |
| United States | 17,631 |
| OILS, EDIBLE | 11,008 |
| United States | 51,926 |
| United States | 51,877 |
| OILS, OTHER | 46,577 |
| United States | 21,456 |
| PAPER AND STATIONERY | 52,398 |
| Germany | 6,341 |
| United Kingdom | 20,795 |
| United States | 12,862 |
| EARTHENWARE AND GLASSWARE | 32,469 |
| Germany | 2,686 |
| United Kingdom | 26,118 |

Details of the imports from the United States are shown in the next table, for the fiscal years 1914 and 1917:

AMERICAN PRODUCTS SOLD IN BARBADOS

| ARTICLES | 1914 | 1917 |
|------------------------------------|--------|----------|
| Cement, hydraulic | \$ 940 | \$ 1,973 |
| Chemicals, drugs, dyes, medicines: | | |
| Medicines, patent or proprietary | 10,770 | 14,359 |
| Soda salts and preparations | (a) | 5,718 |
| All other | 12,985 | 24,051 |
| Glass and glassware | 2,246 | 5,750 |
| India-rubber manufactures | 6,524 | 22,323 |
| Oils: | | |
| Mineral: | | |
| Gasoline | 13,089 | 12,741 |
| Illuminating | 41,838 | 60,847 |
| Lubricating | 5,632 | 10,595 |
| All other | | 1,421 |
| Vegetable: | | |
| Corn | 1,267 | 30,409 |
| Cottonseed | 6,376 | 10,506 |
| Linseed | 79 | 2,532 |
| All other | 115 | 523 |
| Paints, pigments, etc. | 3,049 | 10,072 |
| Paper and manufactures | 9,526 | 40,224 |
| Perfumery, cosmetics, etc. | 6,575 | 8,632 |
| Soap (except toilet) | 78 | 5,460 |
| Sugar, refined | 8,948 | 15,565 |

(a) Not shown in 1914.

Imports of sugar from Barbados have increased as a result of the war, but the total is not impressive. The "Asphaltum and bitumen," as given in the official statistics, is probably all manjack. The following table is for fiscal years:

| PRODUCTS OF BARBADOS SOLD IN THE UNITED STATES | | |
|--|----------|----------|
| ARTICLES | 1914 | 1917 |
| Asphaltum and bitumen..... | \$ 3,241 | \$ 3,385 |
| Copper, old, and clippings..... | ..... | 7,115 |
| Oils: | | |
| Fish and other animal..... | ..... | 269 |
| Sugar and molasses: | | |
| Molasses..... | 178,553 | 254,903 |
| Sugar, cane..... | 15 | 290,750 |

BRITISH WEST INDIES—JAMAICA

Bananas overshadow all other products as a source of wealth in Jamaica in normal times. The disastrous hurricane in 1915 gave the industry a severe setback. Normal exports of bananas approximate seven million dollars. No other article was exported in excess of a million dollars in 1914, but the following were shipped in excess of half a million: sugar, logwood extract, coffee, cacao, coconuts, and logwood. Other and characteristic products are rum, ginger, and annatto. The mineral and forest resources have not been much developed and there is no manufacturing to speak of. The United States takes about half the exports and furnishes about half the imports, England, the mother country, being second in importance in both respects. Of the total population of more than 800,000, only about 16,000 are white.

There is naturally only a very limited market for chemicals and allied products. The next table shows that the principal import, soap, comes almost exclusively from England. The United States has an equal or better share in the other lines.

JAMAICAN IMPORTS OF CHEMICALS AND ALLIED PRODUCTS

| ARTICLES | 1912 | 1914(a) |
|---|-----------|-----------|
| CHEMICALS | \$ 41,511 | ..... |
| United Kingdom..... | 22,882 | ..... |
| United States..... | 17,339 | ..... |
| DRUGS AND MEDICINES | 183,983 | \$153,961 |
| United Kingdom..... | 81,324 | ..... |
| United States..... | 90,468 | ..... |
| OILS, MINERAL | | |
| Naphtha and gasoline..... | 38,518 | ..... |
| United States..... | 38,294 | ..... |
| Petroleum..... | 179,087 | 232,891 |
| United States..... | 175,836 | ..... |
| OILS, VEGETABLE | | |
| Cottonseed oil (U. S.)..... | 108,611 | 74,920 |
| PAINTERS' COLORS AND MATERIALS | 70,744 | ..... |
| United Kingdom..... | 47,507 | ..... |
| United States..... | 20,994 | ..... |
| PERFUMERY | 62,048 | ..... |
| Germany..... | 6,555 | ..... |
| United Kingdom..... | 22,318 | ..... |
| United States..... | 30,873 | ..... |
| PERFUMED SPIRITS | 19,957 | ..... |
| SOAP, COMMON | 205,142 | 168,673 |
| United Kingdom..... | 203,780 | ..... |
| SOAP, FANCY | 20,084 | ..... |
| PAPER, PRINTING | 39,604 | ..... |
| United Kingdom..... | 4,745 | ..... |
| United States..... | 34,859 | ..... |
| PAPER, WRITING, STATIONERY | 82,575 | ..... |
| United States..... | 19,597 | ..... |
| PAPER, OTHER; MANUFACTURES OF | 124,159 | ..... |
| United States..... | 37,662 | ..... |
| GLASS AND GLASSWARE | 65,737 | ..... |
| Germany..... | 12,809 | ..... |
| United Kingdom..... | 27,754 | ..... |
| United States..... | 24,196 | ..... |

(a) Statistics available for only a few classes.

More details of the trade in American goods are shown in the table that follows, which is a compilation from our own statistics for the fiscal years 1914 and 1917.

| AMERICAN PRODUCTS SOLD IN JAMAICA | | |
|---|----------|----------|
| ARTICLES | 1914 | 1917 |
| Blacking, shoe paste, etc..... | \$ 3,788 | \$ 7,071 |
| Celluloid and manufactures..... | 26 | 2,124 |
| Cement, hydraulic..... | 25,400 | 60,766 |
| Chemicals, drugs, dyes, medicines: | | |
| Acids..... | 3,022 | 4,698 |
| Calcium carbide..... | 2,448 | 3,545 |
| Medicines, patent or proprietary..... | 48,485 | 52,191 |
| Petroleum jelly..... | 7,761 | 9,240 |
| Soda salts and preparations..... | (a) | 24,390 |
| All other..... | 36,709 | 90,635 |
| Explosives: | | |
| Cartridges, loaded..... | 2,726 | 3,265 |
| Dynamite..... | 1,046 | 3,855 |
| All other..... | 1,369 | 5,168 |
| Fertilizers..... | 1,281 | 13,894 |
| Flavoring extracts and fruit juices..... | 1,392 | 5,105 |
| Glass and glassware..... | 15,922 | 40,810 |
| Grease: | | |
| Lubricating..... | 4,920 | 10,894 |
| All other..... | 375 | 951 |
| India-rubber manufactures..... | 71,882 | 135,076 |
| Ink..... | 2,032 | 3,628 |
| Naval stores..... | 3,761 | 5,409 |
| Oilcloth and linoleum..... | 3,731 | 5,365 |
| Oils: | | |
| Mineral: | | |
| Gasoline..... | 45,222 | 105,768 |
| Illuminating..... | 196,765 | 139,011 |
| Lubricating..... | 13,409 | 43,362 |
| Vegetable: | | |
| Corn..... | ..... | 120,137 |
| Cottonseed..... | 162,252 | 73,625 |
| Linseed..... | 333 | 5,986 |
| All other..... | 696 | 27,348 |
| Paints, pigments, etc.: | | |
| Ready-mixed..... | 6,728 | 8,763 |
| White lead..... | 19 | 3,093 |
| All other (including crayons)..... | 10,046 | 30,615 |
| Paper and manufactures..... | 89,162 | 185,713 |
| Perfumery and cosmetics..... | 16,807 | 26,851 |
| Photographic goods: | | |
| Motion-picture films..... | 7,223 | 22,210 |
| Other sensitized goods..... | 3,326 | 7,291 |
| Salt..... | ..... | 3,157 |
| Soap: | | |
| Toilet..... | 14,784 | 17,387 |
| All other..... | 1,454 | 13,092 |
| Sugar and molasses: | | |
| Molasses..... | 51 | 4,793 |
| Sugar, refined..... | 25,970 | 46,305 |

(a) Not shown in 1914.

Logwood is now an important import from Jamaica, but it is the only one. The imports of essential oil are interesting, but the official statistics do not throw any light on the kind or kinds included in this total. There is a small plant or two for making oil from orange peels.

JAMAICA PRODUCTS SOLD IN THE UNITED STATES

| ARTICLES | 1914 | 1917 |
|---------------------------------------|-----------|------------|
| Cacao, crude..... | \$102,660 | \$ 322,997 |
| Chemicals..... | 54,879 | 116,982 |
| Coconut meat (copra)..... | 12 | 65,423 |
| Dyewoods, in a crude state: | | |
| Logwood..... | 269,272 | 1,118,334 |
| All other..... | 29,920 | 18,210 |
| India-rubber scrap..... | 703 | 2,044 |
| Oils: Essential..... | 54,501 | 147,690 |
| Sugar, cane..... | 17 | 197,373 |
| Tanning materials: Mangrove bark..... | 15 | 26,339 |
| Wax: Beeswax..... | ..... | 763 |

BRITISH WEST INDIES—TRINIDAD AND TOBAGO

Statistics of trade and production always lump the returns from Trinidad and Tobago, the latter island being of comparatively little importance. The population of Tobago is only about twenty thousand as compared with the three hundred and fifty thousand of Trinidad. Negroes and East Indians predominate.

The principal products are sugar, cacao, petroleum, asphalt, coconuts, and mangrove bark. Manjack is mined to some extent. The sugar production in 1915 amounted to more than five million dollars, all of which went to England. Cacao is a very important product, more than six million dollars worth being sold to the United States, the principal customer, in 1917. The product of the famous asphalt lake is well known

in the United States, as most of the output comes to this country. The petroleum fields are also a prime source of wealth.

In spite of the comparative wealth of the islands, however, there is not much of a market for chemicals or allied products, as the first table following shows, although later figures, if available, would probably show an increase in this respect. Soap, the most important item, is imported chiefly from England.

| IMPORTS OF CHEMICALS AND ALLIED PRODUCTS INTO TRINIDAD AND TOBAGO | | 1912 |
|---|--|-----------|
| ARTICLES | | |
| MEDICINES (NON-ALCOHOLIC) | | \$ 72,925 |
| United Kingdom | | 33,155 |
| United States | | 26,279 |
| British West Indies | | 25,861 |
| OPIMUM AND GANJA | | 12,677 |
| FERTILIZERS | | 92,313 |
| United Kingdom | | 67,070 |
| United States | | 9,855 |
| SOAP | | 194,251 |
| United Kingdom | | 172,985 |
| United States | | 8,258 |
| CANDLES | | 39,360 |
| United Kingdom | | 26,581 |
| United States | | 3,494 |
| PAINTS AND PAINTERS' COLORS | | 41,998 |
| United Kingdom | | 29,895 |
| United States | | 4,550 |
| PETROLEUM | | 119,249 |
| United States | | 119,220 |
| OLIVE AND OTHER EDIBLE OILS | | 74,229 |
| France | | 43,185 |
| United States | | 13,203 |
| PAPER AND STATIONERY | | 125,809 |
| Germany | | 6,502 |
| United Kingdom | | 73,187 |
| United States | | 17,553 |
| GLASSWARE | | 49,453 |
| Germany | | 13,183 |
| United Kingdom | | 22,381 |
| United States | | 12,629 |

In the next table, which shows imports from the United States, it will be seen that there has been an increased demand for chemicals from this country since the war started, but the total is relatively insignificant.

| AMERICAN PRODUCTS SOLD IN TRINIDAD AND TOBAGO | | |
|---|----------|----------|
| ARTICLES | 1914 | 1917 |
| Blacking, shoe paste, etc. | \$ 2,173 | \$ 3,841 |
| Candles | 7,254 | 14,530 |
| Cement, hydraulic | 19,543 | 80,373 |
| Chemicals, drugs, dyes, medicines: | | |
| Acids: | | |
| Sulfuric | 23 | 8,432 |
| All other | 403 | 5,185 |
| Calcium carbide | 480 | 5,378 |
| Medicines, patent or proprietary | 30,841 | 34,755 |
| Petroleum jelly | 1,338 | 3,008 |
| Soda salts, and preparations of | (a) | 23,923 |
| All other | 23,131 | 107,184 |
| Explosives: | | |
| Cartridges, loaded | 2,961 | 6,571 |
| All other | 2,038 | 2,664 |
| Glass and glassware | 6,396 | 44,043 |
| Grease | 2,964 | 8,710 |
| India-rubber manufactures | 32,455 | 82,039 |
| Naval stores | 4,654 | 7,352 |
| Oilcloth and linoleum | 5,111 | 6,548 |
| Oils: | | |
| Mineral: | | |
| Illuminating | 116,816 | 132,759 |
| Lubricating, etc. | 17,759 | 46,125 |
| Naphthas: | | |
| Gasoline | 21,673 | 4,420 |
| All other | 66 | ..... |
| Vegetable: | | |
| Corn | ..... | 18,236 |
| Cottonseed | 9,702 | 25,475 |
| Linseed | 331 | 5,688 |
| All other | 1,187 | 2,743 |
| Paints, pigments, etc.: | | |
| Ready-mixed paints | 2,789 | 5,560 |
| Varnish | 1,900 | 4,398 |
| All other (including crayons) | 4,572 | 10,067 |
| Paper and manufactures | 28,405 | 112,060 |
| Perfumeries and cosmetics | 9,629 | 19,438 |
| Photographic goods: Motion-picture films | 223 | 6,225 |
| Soap: | | |
| Toilet | 4,847 | 9,246 |
| All other | 544 | 23,175 |
| Sugar, refined | 7,942 | 37,664 |

(a) Not stated separately in 1914.

The next table shows that our purchases of asphalt from Trinidad, although looming large in the popular

imagination, are a very poor second to our takings of cacao, which are really of prime importance. The item "Chemicals, etc." is large enough to be interesting, but it is not to be accounted for by a study of the products of the islands, and probably gets its importance from the fact that some products of the mainland are shipped by way of Port of Spain, Trinidad. Tonka beans, which are included under chemicals in American statistics, have been imported from Venezuela for many years, cured, and then reshipped.

| TRINIDAD AND TOBAGO PRODUCTS SOLD IN THE UNITED STATES | | |
|--|------------|------------|
| ARTICLES | 1914 | 1917 |
| Asphaltum and bitumen | \$ 433,208 | \$ 565,960 |
| Cacao, crude | 4,891,574 | 6,311,496 |
| Chemicals, etc. | 635,290 | 188,722 |
| Copper ore | ..... | 5,955 |
| Coconut meat (copra) | 493 | 165,051 |
| Glass and glassware | 4,225 | 950 |
| India rubber: | | |
| Balata | 24,555 | 2,318 |
| India rubber | ..... | 1,258 |
| Scrap | 65 | 307 |
| Oil: Crude mineral | 297,603 | 146,429 |
| Sugar, cane | 36 | 210,653 |
| Tanning materials: Mangrove bark | ..... | 226 |

DUTCH WEST INDIES

The Dutch West Indies consist of the island of Curacao and five smaller islands, the total population of which is not more than sixty thousand, mostly colored. There are no products of great importance, although the exports of straw hats to the United States have reached as high as one hundred and fifty thousand dollars. There is small exportation of aloes for chemical use, divi-divi, and gold.

The very limited importation of chemicals and allied products is shown in the following table for 1913, the latest year for which statistics are available:

| IMPORTS OF CHEMICALS AND ALLIED PRODUCTS INTO THE DUTCH WEST INDIES | | |
|---|-----------------|-----------------|
| ARTICLES | IMPORTS FROM | |
| | THE NETHERLANDS | OTHER COUNTRIES |
| CHEMICALS AND DRUGS | \$1,214 | \$13,162 |
| COLORS AND DYES | 3,312 | 7,815 |
| PERFUMERY | 787 | 17,741 |
| SOAP | 380 | 13,855 |
| STEARIN CANDLES | 4,030 | 4,204 |
| OTHER CANDLES | ..... | 790 |
| OILS: | | |
| Gasoline | ..... | 8,938 |
| Petroleum | ..... | 19,968 |
| Linseed | 2,842 | 3,963 |
| Other sorts | 1,118 | 11,206 |
| MATCHES | ..... | 2,171 |
| GLASS AND GLASSWARE | ..... | 4,260 |

The next table shows that there has been an increase in the imports from the United States since the war started:

| AMERICAN PRODUCTS SOLD IN THE DUTCH WEST INDIES | | |
|---|----------|----------|
| ARTICLES | 1914 | 1917 |
| Cement, hydraulic | \$ 4,704 | \$46,337 |
| Chemicals, drugs, dyes, medicines: | | |
| Medicines, patent or proprietary | 4,562 | 4,561 |
| All other | 6,074 | 15,389 |
| Explosives | 1,128 | 7,205 |
| Glass and glassware | 2,366 | 14,062 |
| India-rubber manufactures | 2,070 | 13,283 |
| Naval stores | 958 | 2,563 |
| Oils: | | |
| Mineral: | | |
| Illuminating | 20,650 | 28,946 |
| Lubricating | 1,649 | 4,122 |
| Gasoline | 12,094 | 57,525 |
| Vegetable: | | |
| Corn | 2,140 | 7,139 |
| Cottonseed | 3,228 | 6,815 |
| Linseed | 273 | 5,557 |
| All other | 637 | 1,827 |
| Paints, pigments, etc. | 2,723 | 7,829 |
| Paper and manufactures | 3,057 | 14,120 |
| Perfumeries, cosmetics, etc. | 1,557 | 4,872 |
| Soap: | | |
| Toilet | 3,252 | 4,858 |
| All other | 905 | 10,937 |
| Sugar, refined | 3,377 | 16,841 |

The table that follows shows the character of materials imported into this country from the colony. It is an interesting fact that the liqueur called "Curacao" is really manufactured in Holland, although the orange peel that gives it its peculiar flavor is supplied only from Curacao.

| DUTCH WEST INDIES PRODUCTS SOLD IN THE UNITED STATES | | |
|--|----------|-----------|
| ARTICLES | 1914 | 1917 |
| Cacao, crude..... | | \$ 15,449 |
| Chemicals, drugs, dyes, medicines: | | |
| Gums..... | \$56,051 | 87,498 |
| All other..... | | 102,897 |
| Copper, old, and clippings..... | 246 | 2,904 |
| Dyewoods in a crude state: | | |
| Logwood..... | | |
| All other..... | 12,515 | 5,002 |
| Fertilizers..... | 6,683 | 9,414 |
| Salt..... | 12,287 | 8,854 |
| Sugar, cane..... | | 4,300 |
| Tanning materials: Mangrove bark..... | | 6,256 |

FRENCH WEST INDIES

These French possessions consist of Guadeloupe, with a number of much smaller islands, and Martinique.

The total population of Guadeloupe is not more than thirty-five thousand, and sugar and rum are the only products normally exported to the value of more than a million dollars. Imports of chemicals are not important. In the following table the items "chemicals" and "cottonseed oil" are the only ones exceeding a hundred thousand dollars in value, the former probably including fertilizers, which are used to some extent in the cane fields. These are the latest official figures from the authorities of the islands:

| IMPORTS OF CHEMICALS AND ALLIED PRODUCTS INTO GUADELOUPE AND DEPENDENCIES | | |
|---|-----------|-----------|
| ARTICLES | 1913 | 1914 |
| CHEMICALS..... | \$142,714 | \$203,605 |
| United States..... | 688 | 549 |
| DYES, PREPARED..... | 988 | 130 |
| EXPLOSIVES..... | 1,661 | 1,404 |
| MEDICINES, PREPARED..... | 10,607 | 30,448 |
| United States..... | 623 | 20 |
| ROOTS, HERBS, SEEDS..... | 1,107 | 224 |
| PAINTS, COLORS, VARNISHES..... | 12,344 | 9,232 |
| United States..... | 615 | 429 |
| PERFUMERY..... | 5,635 | 22,681 |
| SOAP, COMMON..... | 35,891 | 36,163 |
| CANDLES..... | 27,353 | 30,602 |
| OILS, MINERAL..... | 42,437 | 52,218 |
| United States..... | 38,679 | 51,455 |
| OILS, VEGETABLE: | | |
| Cottonseed oil..... | 140,132 | 132,821 |
| United States..... | 140,132 | 132,821 |
| Other oils..... | 35,364 | 58,023 |
| PAPER, CARDBOARD, AND MANUFACTURES OF..... | 23,300 | 26,327 |
| United States..... | 296 | 483 |
| GLASS AND GLASSWARE..... | 20,892 | 15,555 |
| United States..... | 893 | 318 |

The population of Martinique is nearly two hundred thousand, of which comparatively few, however, are whites. The cane products, sugar and rum, are of considerable importance, the exports of the former amounting to four and a half million in 1915 and of the latter, three million. Cacao is exported to the extent of about a quarter of a million annually. War prices have brought prosperity to the island.

"Chemicals" and cottonseed oil are the principal exports that can be considered in this article. "Chemicals" undoubtedly include the important imports of fertilizers, which comprise ammonium sulfate, potash, superphosphate, and guano. Ordinarily France

furnishes somewhat more than half the total imports, with the United States second, but this condition has been reversed since the war started. The following table contains such details as are available for 1913 and 1914:

| IMPORTS OF CHEMICALS AND ALLIED PRODUCTS INTO MARTINIQUE | | |
|--|-----------|-----------|
| ARTICLES | 1913 | 1914 |
| CHEMICALS..... | \$424,377 | \$467,639 |
| United States..... | 83,897 | 30,126 |
| DYES, PREPARED..... | 162 | 183 |
| EXPLOSIVES..... | 1,520 | 2,027 |
| MEDICINES, PREPARED..... | 18,790 | 12,906 |
| United States..... | 60 | 93 |
| ROOTS, HERBS, SEEDS..... | 1,311 | 1,082 |
| PAINTS, COLORS, VARNISHES..... | 14,798 | 12,123 |
| United States..... | 319 | 452 |
| PERFUMERY..... | 8,069 | 7,204 |
| SOAP, COMMON..... | 30,187 | 32,508 |
| CANDLES..... | 21,424 | 13,279 |
| OILS, MINERAL..... | 50,373 | 45,489 |
| United States..... | 45,371 | 40,055 |
| OILS, VEGETABLE: | | |
| Cottonseed oil..... | 132,449 | 163,926 |
| United States..... | 131,486 | 163,926 |
| Other oils..... | 24,630 | 29,284 |
| PAPER, CARDBOARD, AND MANUFACTURES OF..... | 26,492 | 29,685 |
| United States..... | 517 | 574 |
| GLASS AND GLASSWARE..... | 19,830 | 16,137 |
| United States..... | 506 | 869 |

In the American statistics the French possessions in the West Indies are grouped together, and the next table shows the imports of American chemicals and allied products into Guadeloupe and dependent islands, and Martinique. The most important items are cottonseed and corn oil, "All other chemicals," and fertilizers. It will be seen that the American share of the fertilizer trade is increasing.

AMERICAN PRODUCTS SOLD IN THE FRENCH WEST INDIES

| ARTICLES | 1914 | 1917 |
|--|---------|----------|
| Candles..... | \$ 173 | \$ 8,520 |
| Cement, hydraulic..... | 7,167 | 31,140 |
| Chemicals: | | |
| Acids: | | |
| Sulfuric..... | 6,400 | 2,000 |
| Other..... | | 378 |
| Medicines, patent or proprietary..... | 731 | 1,215 |
| Soda salts, and preparations of..... | (a) | 8,168 |
| All other..... | 4,169 | 111,678 |
| Explosives..... | 828 | 104 |
| Fertilizers (except phosphate rock)..... | 26,683 | 92,376 |
| Glass and glassware..... | 1,091 | 11,304 |
| Glucose..... | 8 | 4,876 |
| Grease..... | 785 | 4,409 |
| India-rubber manufactures..... | 2,334 | 27,976 |
| Matches..... | | 12,095 |
| Naval stores..... | 389 | 2,595 |
| Oilcloth and linoleum..... | 382 | 4,260 |
| Oils: | | |
| Mineral: | | |
| Gas and fuel..... | 436 | 5,048 |
| Gasoline..... | 7,435 | 61,695 |
| Illuminating..... | 51,827 | 71,903 |
| Lubricating..... | 5,865 | 20,652 |
| Vegetable: | | |
| Corn..... | 5,526 | 121,875 |
| Cottonseed..... | 266,887 | 374,382 |
| Linseed..... | 52 | 11,332 |
| Other fixed..... | 126 | 3,031 |
| Paints, pigments, etc.: | | |
| White lead..... | | 4,485 |
| All other (including crayons)..... | 1,464 | 13,088 |
| Paper..... | 773 | 14,674 |
| Soap (except toilet)..... | 263 | 49,333 |
| Sugar and molasses..... | 505 | 28,870 |

(a) Not shown in 1914.

Of the imports from the islands, vanilla beans alone are of sufficient importance to merit attention, as the following table, for fiscal years, shows:

| FRENCH WEST INDIAN PRODUCTS SOLD IN THE UNITED STATES | | |
|---|----------|----------|
| ARTICLES | 1914 | 1917 |
| Chemicals, drugs, dyes, medicines: | | |
| Vanilla beans..... | \$42,346 | \$76,338 |
| All other..... | 2,332 | 1,294 |
| Oils, essential..... | 2,823 | 6,090 |

ORIGINAL PAPERS

EFFECT OF PHOSPHINE AND HYDROGEN SULFIDE ON THE OXIDATION OF AMMONIA TO NITRIC ACID¹

By GUY B. TAYLOR AND JULIAN H. CAPPS

Received July 31, 1918

In a recently published paper² it has been shown that acetylene gas derived from commercial carbide has a marked deleterious effect on the oxidation of ammonia to nitric acid by catalytic platinum. Further experiments have shown that this effect is to be ascribed to impurities in the acetylene rather than to acetylene gas itself. Lunge and Keané³ state that the common impurities present in acetylene are hydrogen sulfide, phosphine, ammonia, carbon monoxide, hydrogen, methane, nitrogen, and oxygen. Silicon hydride may also be present in minute quantity. Captain G. A. Perley and Mr. J. D. Davis, of this Bureau, from experiment and observation on commercial ammonia converters oxidizing cyanamide ammonia, strongly suspected phosphine as the active poisoning agent. As a result, the present investigation was undertaken to secure data on the effects of phosphine and of hydrogen sulfide.

The apparatus and experimental methods have been previously described.⁴ Thoroughly activated, pure platinum gauzes were used, 0.0026 in. diameter wire, 80 wires to linear inch.

PURIFIED ACETYLENE

To free acetylene from impurities the gas was passed through a train of wash bottles containing solutions as follows: Copper sulfate, acid cuprous chloride, 50 per cent nitric acid, alkaline sodium hypochlorite, and sodium hydroxide. The purified gas was collected in a large bottle and allowed to stand over night in contact with sodium hypochlorite solution. Thiosulfate was added to take care of any free chlorine that might have been evolved, and copper sulfate to precipitate hydrogen sulfide derived therefrom. This purified acetylene was used in a short run of about 2 hrs., during which the concentration in the ammonia-air mixture was gradually raised to about 0.4 per cent. There was no noticeable effect on the gauze except a rise in the temperature, and the yields were quite satisfactory. Examination of the gauze after the run showed it had suffered no change and had the characteristic gray appearance of an active gauze.

PHOSPHINE

Phosphine was prepared by heating yellow phosphorus with sodium hydroxide solution. The gas was collected in bottles in which it was treated with hydrochloric acid to free it from the self-inflammable variety. The acid was then neutralized with strong alkali.

In the preliminary experiments a gas was used containing 23 per cent PH_3 as determined by absorption

in a solution of copper sulfate. The rest was presumably hydrogen. This was fed into the ammonia-air mixture at a rate of about 10 cc. a minute for 2 min., corresponding to about 25 parts PH_3 per million. The electrically heated gauze blackened immediately. After shutting off the phosphine the gauze cleared in 5 min. The rate was then varied and it was found that 10 parts per million was sufficient to cause black areas to appear on the gauze. A total of 590 cc. of the phosphine-hydrogen mixture was fed into the system, reaching a final concentration of 0.07 per cent in the gases passing to the oxidizer. The gauze was black nearly all over most of the time. Examination of the gauze after the run showed in a pronounced way the same appearance as the gauze that had been run with impure acetylene. It was brittle and pulled apart even though carefully handled.

Quantitative experiments were then undertaken, using another gauze from the same sheet, in order to determine the limit concentration of phosphine allowable.

Phosphine, PH_3 , prepared as above, was diluted with air in a small metal gas holder which was water-sealed. This gas mixture was led into the ammonia-air feed line through 6 ft. of brass tubing, which formed the delivery pipe of the gas holder, at rates which should have added phosphine in amounts between 0.4 and 4 parts per million of the gas entering the oxidizer. The efficiency of oxidation was not modified by this to the extent that the preliminary tests had indicated.

On examination, however, it was found that the phosphine in the gas holder decreased rapidly on standing over water. Furthermore at the conclusion of the tests, the brass delivery tube of the gas holder was corroded and it seemed certain that a further portion of the phosphine was destroyed in passing through it. On account of these known sources of error, the rather inconsistent results of these tests were discarded.

The phosphine mixtures always contained hydrogen. While it did not appear probable that hydrogen could have any deleterious effect, preliminary of the above tests, electrolytic gas from electrolysis to sodium hydroxide solution was introduced and found to be without effect up to one-tenth per cent hydrogen in the ammonia-air feed.

At about this time actual trials with added phosphine made by Lieut. Brush at Captain Perley's direction, showed that even two or three parts of phosphine per hundred million of mixed gases were serious in plant operation.

Therefore, a second series of tests was made using special precautions to insure the phosphine added actually reaching the gauze. The metal gas holder was varnished inside, a glass delivery tube arranged, and the phosphine-air mixture confined with an oil seal. The gas came in contact with no metal or water and did not vary in phosphine concentration from day to day. About 200 cc. of 20 per cent PH_3 was diluted in the gas holder to about

¹ Published by permission of Director, U. S. Bureau of Mines.

² THIS JOURNAL, 10 (1918), 547.

³ "Technical Methods of Chemical Analysis," [I], 2, 587.

⁴ Taylor and Capps, *Loc. cit.*

60 liters. This was diluted twice during the tests with an equal volume of air.

TABLE I—EFFECT OF PHOSPHINE

| TEST No. | Date | Time | Cu. ft. PH ₃ -air mixture | | | Composition of NH ₃ -air mixture | | Yield HNO ₃ per cent |
|----------|---------|-------|--------------------------------------|--------------|--------------------------|---|--------------------------|---------------------------------|
| | | | per hr. | Cc. per min. | per cent PH ₃ | per cent NH ₃ | P. p. m. PH ₃ | |
| ... | July 16 | 10:55 | 170 | 0 | .. | .. | 0 | .. |
| 458 | July 16 | 11:25 | 170 | 0 | .. | 9.74 | 0 | 91.5 |
| ... | July 16 | 11:30 | 170 | 55 | 0.05 | .. | 0.3 | .. |
| 459 | July 16 | 11:45 | 180 | 60 | 0.05 | 9.80 | 0.3 | 9.5 |
| ... | July 16 | 11:47 | 180 | 0 | .. | .. | 0 | .. |
| 460 | July 16 | 12:45 | 180 | 0 | .. | 9.22 | 0 | 92.4 |
| ... | July 16 | 1:47 | 180 | 25 | 0.05 | .. | 0.14 | .. |
| 461 | July 16 | 1:05 | 170 | 25 | 0.05 | 9.22 | 0.14 | 53.0 |
| ... | July 17 | 12:50 | 170 | 0 | .. | .. | .. | .. |
| ... | July 17 | 1:00 | 170 | 25 | 0.024 | .. | .. | .. |
| 462 | July 17 | 1:30 | 170 | 25 | 0.024 | 10.5 | 0.07 | 71.0 |
| ... | July 17 | 1:35 | 170 | 12 | 0.024 | .. | 0.03 | .. |
| 463 | July 17 | 2:10 | 180 | 12 | 0.024 | 10.15 | 0.03 | 87.5 |
| 464 | July 17 | 3:00 | 185 | 12 | 0.024 | 9.73 | 0.03 | 85.8 |
| 465 | July 17 | 3:35 | 165 | 12 | 0.024 | 9.80 | 0.03 | 85.2 |
| ... | July 18 | 2:00 | 185 | .. | 0.024 | .. | .. | .. |
| ... | July 18 | 2:08 | 185 | 25 | 0.024 | .. | 0.06 | .. |
| 466 | July 18 | 2:35 | 185 | 25 | 0.024 | 10.25 | 0.06 | 74.5 |
| ... | July 18 | 2:40 | 180 | 12 | 0.024 | .. | 0.03 | .. |
| 467 | July 18 | 3:15 | 200 | 12 | 0.024 | 9.85 | 0.03 | 86.5 |
| 468 | July 18 | 3:35 | 165 | 12 | 0.024 | 9.95 | 0.03 | 86.2 |
| ... | July 19 | 9:45 | 165 | 0 | .. | .. | .. | .. |
| 469 | July 19 | 10:20 | 165 | 0 | .. | 10.3 | .. | 89.5 |
| ... | July 19 | 10:25 | 165 | 25 | 0.013 | .. | 0.035 | .. |
| 470 | July 19 | 11:08 | 165 | 29 | 0.013 | 9.80 | 0.04 | 80.3 |
| ... | July 19 | 11:10 | 165 | 50 | 0.013 | .. | 0.07 | .. |
| 471 | July 19 | 11:45 | 170 | 50 | 0.013 | 9.30 | 0.07 | 76.5 |

The gas in the holder was analyzed every day in duplicate by oxidation of 2 liter samples with sodium hypochlorite. The hypochlorite solution was strongly acidified with nitric acid and boiled down to a small volume to eliminate chlorine. The phosphate was then precipitated with ammonium molybdate and determined volumetrically with *N/20* NaOH, taking all the usual precautions in this well-known procedure. The alkali was standardized against a known phosphate solution. We feel confident that the calculated phosphine concentrations given in parts per million in Table I were actually present in the ammonia-air mixture to ± 10 per cent.

The rate of flow of the ammonia-air mixture was about 90 liters a minute. The phosphine-air mixture, less than 0.1 per cent PH₃, was fed in at rates from 0 to 60 cc. a minute.

During these tests the electric current of 115 to 140 amperes was never cut off, even momentarily, while phosphine was being admitted.

In connection with these tests, an attempt was made to determine the phosphine concentration in the ammonia-air mixture directly by application of the nephelometric reagent of Kober and Egerer,¹ molybdate strychnine solution, for phosphates. By oxidation of a 2-liter sample with hypochlorite we were able to detect 1 part in a million where silver nitrate test paper showed nothing. Quantitative results could hardly be expected.

Fair results were obtained nephelometrically² in the analysis of acetylene and gas containing above 0.02 per cent PH₃.

The results presented in Table I show that 2 or 3 parts phosphine in a hundred million undoubtedly reduce the yield. The results are consistent throughout. The gauze, which had been used in previous

¹ *J. Am. Chem. Soc.*, 37 (1915), 2373.

² The nephelometer was on the Richards principle adapted to a Duboscq colorimeter. This instrument was kindly placed at our disposal by Dr. W. M. Clark of the Department of Agriculture.

tests, was undoubtedly not in the best of condition, as shown by efficiencies taken when no phosphine was present. This points to cumulative poisoning of the platinum.

Several nephelometric analyses of the acetylene gas generated from the same lot of carbide used in our experiments with this gas, showed 0.02–0.03 per cent PH₃. These analyses were confirmed by passing 23 liters of acetylene through sodium hypochlorite solution in a Friedrich spiral wash bottle in 16 hrs. The phosphate was determined gravimetrically and calculated 0.0226 per cent PH₃. Assuming a value of 0.02 per cent PH₃ in the acetylene used in the earlier experiments where 0.02 per cent acetylene in the ammonia-air mixture caused a drop of 2 or 3 per cent in the yield and 0.1 per cent a drop of 25 or 30 per cent, corresponding to 4 and 20 parts PH₃ per hundred million, respectively, the results with acetylene are accounted for on the basis of phosphine alone.

HYDROGEN SULFIDE

Hydrogen sulfide generated in a Kipp from ferrous sulfide and dilute sulfuric acid was measured into the feed line through a water wash bottle and the flowmeter. The results are given in Table II and show that H₂S has no deleterious effect in concentrations approaching 0.1 per cent. Tests were made on the same gauze used with phosphine.

TABLE II—EFFECT OF HYDROGEN SULFIDE ON AMMONIA OXIDATION

| TEST No. | Time | Date | Cu. ft. air | | Intake NH ₃ per cent | Gas H ₂ S per cent | Yield HNO ₃ per cent |
|----------|------|---------|-------------|---------|---------------------------------|-------------------------------|---------------------------------|
| | | | per hr. | Amperes | | | |
| ... | 1:30 | June 20 | 165 | 130 | .. | 0 | .. |
| 447 | 1:46 | June 20 | 165 | 130 | 10.12 | 0 | 91.5 |
| ... | 1:48 | June 20 | 160 | 130 | .. | 0.02 | .. |
| 448 | 2:00 | June 20 | 160 | 130 | 10.07 | 0.02 | 93.0(a) |
| ... | 2:02 | June 20 | 160 | 130 | .. | 0.04 | .. |
| 449 | 2:33 | June 20 | 155 | 130 | 9.66 | 0.04 | 94.3(a) |
| ... | 2:35 | June 20 | 160 | 130 | .. | 0.07 | .. |
| 450 | 2:47 | June 20 | 160 | 130 | 9.62 | 0.07 | 95.0(a) |

(a) Not corrected for H₂SO₄ formed.

SUMMARY

I—Pure acetylene has no effect on the catalytic action of platinum in oxidizing ammonia to nitric acid.

II—Hydrogen sulfide in small concentrations has no immediate toxic effect.

III—Phosphine to the extent of 2 or 3 parts per hundred million in the ammonia-air mixture affects the yield several per cent; 20 to 30 parts are ruinous.

IV—It has been shown that phosphine is a sufficiently active poison to account for previous results obtained with crude acetylene. It seems certain that the difficulty of oxidizing cyanamide ammonia with high efficiency is due to its phosphine content.

V—It seems probable that phosphine has to some extent a cumulative action, since the platinum appears to become less efficient with use.

ACKNOWLEDGMENT

The work described in this report was done under the general direction of the chief chemist of the Bureau of Mines, Dr. Chas. L. Parsons.

BUREAU OF MINES
WASHINGTON, D. C.

SOME NOTES ON ACETYSALICYLIC ACID

By HENRY L. DAHM

Received May 27, 1918

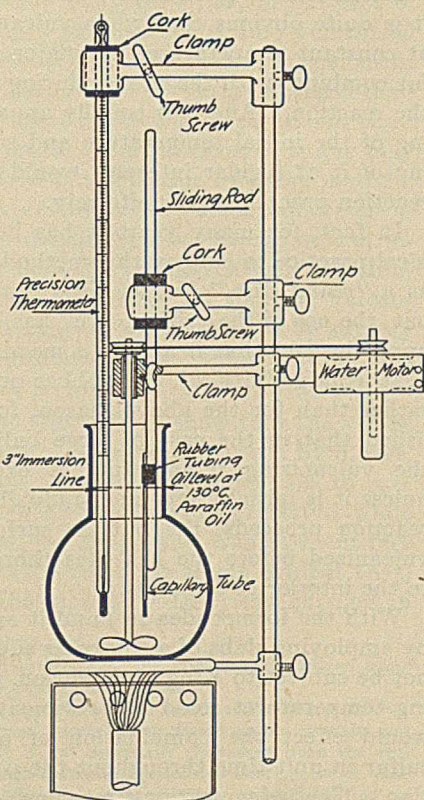
Recent publications¹ have brought to light the difficulty of obtaining true accurate melting points of bodies which decompose during the progress of the test, particularly in the case of acetylsalicylic acid.

The following modification of the method described in the *U. S. P.* has been used for the past year in this laboratory and gives consistent checking results by different operators.

A sketch illustrates the apparatus used. It consists of a 250 cc. CO₂ flask filled with paraffin oil, stirred by a small propeller, connected to a Rabe water turbine or a small electric motor. A standardized thermometer provided with an air jacket for protection against air current, graduated in 0.2° C. and calibrated for a 3-in. immersion, is adjusted permanently in the oil bath with a 3-in. immersion when the temperature is 130° C. The melting-point tube is carried on a separate movable rod which easily slides into position at the proper time. The melting-

point tube only is immersed in the oil, being drawn rather long for this purpose, the rod serving only as support, with 2 small rubber bands to hold the tube. The temperature is increased at the uniform rate of 1° per min. with constant stirring until the temperature has reached 130° C. when the melting-point tube is immersed in the oil.² With this method, samples of American- and foreign-manufactured aspirin were found to melt within the range of 133° to 135° C. (corrected).

Due to the rapid decomposition of acetylsalicylic acid on heating and lack of consistent results when lower temperatures were used, 130° C. was fixed as the proper point of immersion. Emery and Wright found a depression in the melting point of the pure substance of about³ 1° for every 5 min. heating just



MELTING-POINT APPARATUS

below its melting temperature, so that heating at the rate of 1° per min. and starting, for instance, from 120° C. would mean a depression of about 2° in the true melting point.

An increase in the rate of heating is also not advisable, due to difficulty of control and possibility of overheating, especially with a thermometer having a considerable time lag. It is advisable to use a thermometer fixed permanently in the bath, as the introduction of a cold thermometer carrying the sample would tend to give low results, due to cooling effects. The thermometer used for this work is graduated from 74° to 150° C. in 0.2° intervals, is 15 in. long (Taylor Instrument Company, No. 1457 Precision Grade), and has a small expansion bulb which makes it impractical to immerse it with the sample and obtain rapid readings. But they are more accurate and sensitive than a longer thermometer with a wider range, large mercury bulb and no expansion bulb, as the stem correction will be less and barely noticeable. It is important that the propeller used have sufficient surface to thoroughly agitate the oil.

A set of color standards for determining the approximate amounts of free salicylic acid in aspirin were found quite useful in comparing the quality of various samples. The standards are very stable and when once adjusted can be relied upon for a long time. They were prepared as follows:

A 10 per cent solution of hydrated cobalt chloride was prepared by dissolving 10.000 g. CoCl₂ + 2H₂O in 50 cc. water + 5 cc. 10 per cent HCl and diluting carefully to 100 cc. in a calibrated flask. By using various dilutions, as outlined below, standards were prepared. The standards are preserved in small, square or round, glass-stoppered bottles of uniform size and holding about 25 cc. of liquid.

| STANDARD SOLUTION Cc. | WATER Cc. | CoCl ₂ + 2H ₂ O Per cent | COLOR No. | SALICYLIC ACID IN EQUAL VOLS. Gram |
|-----------------------|-----------|--|-----------|------------------------------------|
| 5.0 | 395 | 0.125 | 0 | 0.00005 |
| 10.0 | 390 | 0.25 | 1 | 0.0001 |
| 10.0 | 190 | 0.50 | 2 | 0.0002 |
| 10.0 | 90 | 1.00 | 3 | 0.00025 |
| 10.0 | 75 | 1.50 | 4 | 0.0003 |
| 10.0 | 65 | 2.00 | 5 | 0.00035 |
| 10.0 | 40 | 2.50 | 6 | 0.0004 |

They were standardized by using a 0.1 per cent solution of sublimed salicylic acid, taking aliquots, adding 5 cc. of alcohol and diluting to a final volume of 25 cc. to which one drop of dilute ferric chloride solution (10 per cent soln., as per *U. S. P.*) was added. After standing for 5 min. in a flask similar to the standards, the color was matched to one of the standards and the per cent salicylic acid for that standard calculated. It is important to note that these results hold true only for similar quantities (25 to 30 cc.), after 5 min. time, and using the same amount of ferric chloride.

If 5 cc. of a 2 per cent solution of acetylsalicylic acid in alcohol, diluted with 20 cc. H₂O and placed in a similar bottle, are treated with 1 drop FeCl₃ solution and the color matched, the grams in the standard × 10 gives the per cent free salicylic acid in the acetylsalicylic acid.¹ If a colorimeter is available the same solution may be used, the volume ratios used giving the percentage ratio between sample and unknown.

The following results were obtained on three well-known American brands and one foreign brand of acetylsalicylic acid:

¹ Color Standard No. 2 is the maximum limit allowable in a good sample of acetylsalicylic acid.

¹ *Proc. Assoc. of Agr. Chem.*, 1912.

² The initial temperature of the bath, before immersing the melting point tube, should be 3° lower than the melting point of the sample. In my experience it is very rare that the initial temperature need be below 130° C.

³ Bureau of Chemistry, Dept. of Agr., *Bulletin 162*.

| | 1 | 2(a) | 3 | 4 |
|---------------------------|---------------------|---------------------|---------------------|----------------------|
| Melting Point | 133.5- 134.5° C. | 133.5- 134.5° C. | 133.4- 134.4° C. | 133.8- 134.8° C.. |
| Color: | White crystals | White powder | White crystals | White powder |
| Odor..... | None | None | None | Acid |
| Sulfates..... | Very faint trace | Very faint trace | Very faint trace | Very faint trace |
| Chlorides..... | Very faint trace | Very faint trace | Very faint trace | Very faint trace |
| Heavy metals..... | None | None | Very faint trace | None |
| Reaction of aqueous soln. | Acid | Acid | Acid | Acid |
| Free salicylic..... | None | None | None | None |
| Ash, per cent..... | 0.02 | 0.02 | 0.015 | 0.03 |
| Assay..... | 99.95 | 99.95 | 98.86 | 99.59 |

(a) Foreign product.

In carrying out these tests as well as others for the purity of various samples and brands of acetylsalicylic it can be stated that the same results and conclusions were obtained as those noted by Leech, with an exception in higher melting points, though comparative results were the same. There is no difference in quality and purity between various samples of American products now on the market and the much vaunted patented foreign brand formerly on the American market.¹

SUMMARY

A modification of the usual *U. S. P.* method of taking melting points, applicable to acetylsalicylic acid, is given.

A set of permanent color standards for use in determining the approximate amounts of salicylic acid in acetylsalicylic acid, with directions for preparation, is described.

Results of previous investigators as to quality and purity of American and foreign aspirin were confirmed, by tests made over a period of one year.

ANALYTICAL LABORATORIES
MONSANTO CHEMICAL WORKS
ST. LOUIS, MISSOURI.

THE VULCANIZATION OF RUBBER AT CONSTANT TEMPERATURE AND BY A SERIES OF INCREASING TEMPERATURES²

By G. D. KRATZ AND ARTHUR H. FLOWER

It has long been known that when the vulcanization of rubber is effected by heating for a period of time at a definite and constant temperature, the rate of combination of the sulfur with the rubber decreases with the time. In this particular instance, however, as is recorded in the experimental part of this paper, we have endeavored to maintain a constant rate of combination of the sulfur and rubber by a variation in the temperature. Our efforts have been confined primarily to devising a method for calculating a series of temperatures by the use of which the rate of vulcanization might be accurately controlled. With this possible, we desired to make a comparison of the physical characteristics of a rubber mixture vulcanized to the same point by both methods.

Although it is not within the scope of this article to review in its entirety the literature upon the subject or to draw conclusions from the results previously obtained by others, certain of these should be briefly recalled.

¹ *J. pharm. chim.*, [7] 5 (1917), 213; P. N. Leech, *THIS JOURNAL*, 10 (1918), 288.

² Presented before the Rubber Section at the 56th Meeting of the American Chemical Society, Cleveland, September 10 to 13, 1918.

The vulcanization of rubber at constant temperature was regarded by Weber¹ as consisting in a chemical reaction between the rubber and sulfur. Later, Skellon² also recorded results which tend to show that the combination of sulfur with rubber is strictly a chemical reaction, which is first preceded by the melting of sulfur and its solution in the rubber. Likewise he maintains that the rate of combination for unit time and constant temperature decreases with the decrease in the active mass of the sulfur present. Ostwald,³ on the contrary, has regarded the vulcanization phenomenon as due to an adsorption of the sulfur by the rubber, the rate of which, when expressed graphically, follows the typical adsorption isotherm. Spence⁴ and his co-workers, however, have demonstrated that Weber's vulcanization curves, on which Ostwald based his calculations, are subject to correction. They⁵ have also shown almost conclusively that the vulcanization phenomenon is the resultant both of an adsorption and a chemical interaction of the sulfur with the rubber, so that the views of others are probably not entirely free from need of modification.

Furthermore, from the results obtained by Spence it is quite obvious that when vulcanization is effected at constant temperature, the major portion of the sulfur combines with the rubber during the early stages of the reaction. And it is equally apparent that a lowering of the initial temperature and subsequent increasing of it at regular intervals would tend to make the reaction proceed more uniformly.

In fact, for many years it has been common technical practice to employ this method, popularly known as a "rising cure," but as King⁶ has recently pointed out, the use of the "rising cure" has been based mainly upon the fact that it affords a means whereby the low heat conductivity of the rubber may be minimized rather than for the above reason, for it is well established that in the case of large bulky articles, unless the vulcanizing temperature is exceedingly low, or unless it is initially low and gradually increased as the reaction proceeds, the outside surface may be over-vulcanized before the heat has thoroughly penetrated to the interior of the mass.

With the former idea in mind it appeared to us that by employing slabs of a thickness such that they would not be subject to King's contention, a series of increasing temperatures could be previously calculated which would effect the combination of a unit amount of sulfur in unit time throughout the period of vulcanization. The vulcanization-time curve thus would appear as a straight line. A mixture vulcanized in this manner might have widely different physical properties from those of the same mixture vulcanized at a constant temperature.

One of us⁷ has already shown that there is a distinct and readily measurable relationship between the time

¹ "Chemistry of India Rubber," 1906 edition, pp. 85-88.

² *India Rubber J.*, 46 (1913), 723; *Rubber Ind.*, 1914.

³ *Kolloid-Z.*, 6 (1910), 136.

⁴ *Ibid.*, 11 (1912), 28; *Chem.-Ztg.*, 36 (1912), 1162; *Kolloid-Z.*, 11 (1912), 274.

⁵ *Ibid.*, 8 (1911), 304; 11 (1912), 28; 13 (1913), 265.

⁶ *Met. and Chem. Eng.*, 18 (1918), 5.

⁷ G. D. Kratz, *India Rubber Review*, 16 (1916), 225.

required for vulcanization and the temperature at which it is effected, although there is hardly sufficient evidence to warrant its expression as a law as previously formulated by Bourne.¹ Based on our previous observations we have been able to calculate with accuracy the relative rates of vulcanization for various temperatures and to apply these different temperatures so that the vulcanization-time curve did actually take the form of a straight line. The satisfactory results obtained were remarkable in that the degree of vulcanization was measured not by chemical but by physical means, which is shown later to be a dangerous procedure.²

In the application of the above, however, although the accuracy of our calculations and the control obtained over the rate of combination of the sulfur with the rubber exceeded our expectations, the differences noted in the physical characteristics of a mixture vulcanized by the two methods were not widely different until a sulfur coefficient of 3.9 was obtained. At this point, vulcanization at constant temperature resulted in a product which was noticeably inferior to the same mixture when vulcanized by a series of increasing temperatures.

This was not entirely unexpected, as, in the case of a mixture containing 5 per cent of sulfur, vulcanized to the point of "technical cure"³ with a sulfur coefficient of 1.69, the vulcanization-time curve at constant temperature so closely approximated a straight line that, for all practical purposes, a unit amount of sulfur may be said to have combined in unit time by either method. In fact, the same statement may be made with reservation even up to a vulcanization coefficient of 2.9, although at this point both the tensile strength and elongation, particularly the latter, of the mixture vulcanized at constant temperature were found to be slightly inferior to those obtained when vulcanization was effected by a series of increasing temperatures.

Thus our results would tend to show that the values for the sulfur coefficient, as previously given by others, are in all cases high. Even the figures 2.8 to 3.0, recommended by Spence,⁴ appear to be excessive, while the values established by Eaton and Day⁵ are entirely out of question. Furthermore, it seems evident that, as has previously been stated by DeVries,⁶ changes in

¹ *India Rubber J.*, 45 (1913), 120.

² This work is now being repeated, the rate of vulcanization being measured by both chemical and physical means.

³ The term "technical cure" is used to indicate that degree of vulcanization at which are found coincident maximum tensile strength and maximum elongation. This is not necessarily dependent upon the vulcanization coefficient, although a certain relationship does appear to exist between them. "Technical cure" is thus used in contradistinction to "optimum cure," as it has been our experience that what is generally known as "optimum cure" is, in most instances, for practical purposes an overcure and that the previously established values for the correct vulcanization coefficient are for the most part high. Certainly it should not be in excess of 2.8 per cent for Hevea rubber. In connection with other work we have also determined the vulcanization coefficient of certain rubbers other than Hevea. These results show that although the coefficients for these rubbers are not necessarily constants, as suggested by Spence and Eaton, they should not be in excess of the following figures: Plantation Hevea, 2.8; Fine Hard Para, 3.2; Red Kassai, 3.4; and Ceara (Manihot), 4.4. Samples of these rubbers with higher coefficients were found to age quickly with rapid deterioration.

⁴ *India Rubber J.*, 52 (1916), 861.

⁵ *J. Soc. Chem. Ind.*, 36 (1917), 1116.

⁶ *India Rubber J.*, 53 (1917), 101.

the rubber-sulfur mixture which determine the physical properties of the mixture proceed independently of those which determine the vulcanization coefficient. Or in other words, the past history of the sample must be known if it is to be judged solely on the basis of its sulfur content. With such the case, certain qualifying statements should be made if it is to be assumed that a stoichiometric relationship exists between the rubber and sulfur at what is generally known as "optimum cure."

Likewise, it is obvious that whatever figure may be decided upon as the correct vulcanization coefficient for Hevea rubber, it is essential that, in order to obtain maximum physical results by vulcanization at constant temperature, restrictions be placed upon the minimum amount of sulfur and catalyst allowable in the original mixture. For best results at constant temperature there should be present in the mixture such quantities of both sulfur and catalyst that the active mass of the sulfur is not decreased to an extent that will slow up the rate of reaction before the desired sulfur content is attained. We have shown that if this is not taken into consideration the continued heating necessary to effect the combination of the latter fractions of the sulfur undoubtedly impairs the quality of the final product.

Summarizing briefly, under certain conditions we have found it possible to obtain a uniform rate of vulcanization for a rubber-sulfur mixture by employing a previously calculated series of increasing temperatures such that the vulcanization-time curve is reduced to a straight line.

By so doing we have shown that at comparatively high sulfur coefficients a better product is obtained by vulcanization with a series of increasing temperatures than with a constant temperature. We have also found the vulcanization coefficients previously recommended by others to be excessive, and that, unless the history of the vulcanization phenomenon is fully known, it is unsafe to judge samples solely on the basis of their sulfur content.

EXPERIMENTAL PART

In order that our calculations should be comparable with other work, our experiments were carried on with the same rubber mixture as previously employed,¹ not, however, using the same lot of rubber. This mixture consisted of the following proportions by weight:

| | |
|-----------------------------------|------|
| First latex plantation crêpe..... | 100 |
| Zinc oxide..... | 100 |
| Sulfur..... | 5 |
| Basic amine..... | 0.33 |

The rubber used was of the best quality typical of its variety and, as before, it was subjected to the minimum amount of milling necessary to work in all of the ingredients. The basic amine (catalyst) was ground to 200 mesh and worked into the rubber before the pigment and sulfur were added.

After mixing, the compound was allowed to stand for 48 hrs. before any portion of it was vulcanized. This interval having been allowed for recovery, portions were vulcanized in a hydraulic platten press of

¹ *Kratz, India Rubber Review*, 16 (1916), 225.

the usual type. The molds used produced slabs or buttons $\frac{1}{8}$ inch thick. A recovery period of seven days was allowed before physical tests were made. Physical tests were made with a Scott testing machine (vertical type).

A button mold was used where sulfur estimations only were desired. By employing a ten-cavity mold it was possible to obtain a sample for analysis at any point during the vulcanization. It was previously determined that the momentary releasing of pressure on the plattens, in order to partially withdraw the mold and remove a button, was without noticeable effect upon the final sulfur content of the other buttons in the mold.

All temperatures were maintained within 0.5° F. on either side of the figures given. In cases where a series of increasing temperatures was employed, each temperature change was made and established within one minute. This was accomplished by the use of a double system of steam regulators on the steam line to the press.

Throughout the following work, combined sulfur estimations were made by the method of Rosenstein-Davies,¹ each figure given being the average of at least two determinations checking within 0.1 per cent. In every instance the samples for analysis were previously subjected to 24 hrs. continuous extraction with acetone in a Soxhlet apparatus, dried in air, and then *in vacuo* at 100° C. to constant weight.

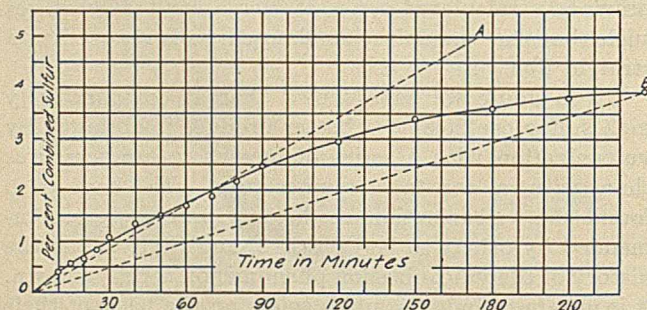


FIG. 1—VULCANIZATION-TIME CURVE AT CONSTANT TEMPERATURES

EXPERIMENT 1—Under this head, an investigation was made of the rate of vulcanization of the mixture at a constant temperature of 298° F. Our results, which confirm those previously obtained by others, are tabulated in Table I and are expressed graphically in Fig. 1. By this table and figure it is also shown that although 60 per cent of the sulfur present in the mixture combined with the rubber during the first two hours, less than 80 per cent had entered into combination at the end of 4 hrs.

In addition to this, it is seen in Table I that the "technical cure" for this mixture is obtained in about 60 min. at 298° F. with a vulcanization coefficient of 1.69. Further, while the general shape of the curve in Fig. 1 was found to be convex to the x -axis, that portion up to and including this 60 min. point very closely approximates the straight line OA drawn through this point. Thus in the case of this particular mixture "technical vulcanization" is attained before the active mass of the sulfur present is decreased to an extent

which would produce a marked decrease in the rate of vulcanization.

TABLE I—VULCANIZATION AT A CONSTANT TEMPERATURE OF 298° F.

| Time of Vulcanization Min. | Combined Sulfur Per cent | Tensile Strength Lbs. per Sq. In. | Elongation Per cent | Permanent Set Per cent |
|----------------------------|--------------------------|-----------------------------------|---------------------|------------------------|
| 10 | 0.404 | .. | ... | ... |
| 15 | 0.578 | .. | ... | ... |
| 20 | 0.663 | .. | ... | ... |
| 25 | 0.840 | .. | ... | ... |
| 30 | 1.080 | 1527 | 725 | 14.32 |
| 40 | 1.330 | 1533 | 710 | 14.06 |
| 50 | 1.490 | 1930 | 707 | 15.23 |
| 60 | 1.690 | 2277 | 697 | 15.62 |
| 70 | 1.875 | 2015 | 685 | 17.97 |
| 80 | 2.170 | 2102 | 690 | 20.30 |
| 90 | 2.485 | 2055 | 680 | 21.09 |
| 120 | 2.945 | 2156 | 678 | 24.22 |
| 150 | 3.410 | 2060 | 685 | 25.78 |
| 180 | 3.600 | 1725 | 677 | 23.44 |
| 210 | 3.780 | 1558 | 680 | 23.44 |
| 240 | 3.920 | 1435 | 652 | 18.75 |

EXPERIMENT 2—It has been shown in Experiment 1 that at a coefficient of 1.69 our method was not applicable for the differentiation of the small variations in the quality of the mixture due to the method of vulcanization employed. For this reason it was decided to effect a comparison of the physical characteristics of the mixture when vulcanized to a coefficient of 3.9 at constant temperature and by a series of increasing temperatures.

The temperatures and times to be employed to effect vulcanization by the latter method may be readily obtained by applying the data given in Table I and Figs. 1 and 1a. First, the number of different temperatures to be used should be previously decided upon. Second, the number of minutes required to effect a "technical cure" at each of these temperatures may be obtained from Fig. 1a. Then, treating each temperature in the series individually, let

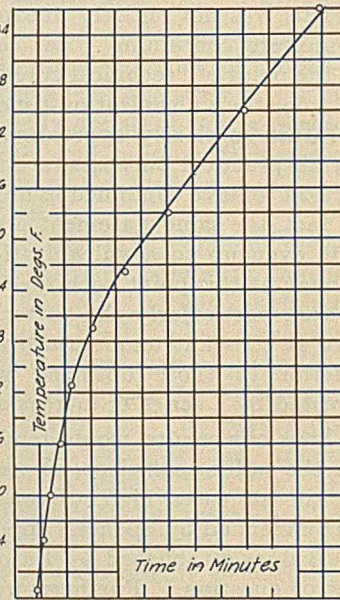


FIG. 1a—TEMPERATURE-TIME CURVE FOR VULCANIZATION TO TECHNICAL CURE

t = time in minutes required to effect a "technical cure" at that temperature. (Fig. 1a.)

t' = time in minutes required to effect a "technical cure" at 298° F. (Table I.)

c = time in minutes required to attain the desired vulcanization coefficient at 298° F. (Table I.)

n = number of temperatures in the series.

$$t \times \frac{c}{t'}$$

Then, $\frac{t \times \frac{c}{t'}}{n} = T$, where T equals the number of minutes required for vulcanization at a given temperature when employed in the previously established series.

It is quite obvious that, if temperatures are chosen at random from the figure, the sum of the times for the complete series of temperatures may not be the same

¹ *Chemist Analyst*, 15 (1915), 4.

as the time required to effect the desired degree of vulcanization at a constant temperature of 298° F. On the other hand, it is easily possible to make a selection such that the total time of vulcanization is the same by either method. In order that our results might be strictly comparable, we chose the following series of four temperatures, the sum of the times of which was exactly equal to 240 min., the time required to obtain a coefficient of 3.9 at 298° F.

| | |
|---------------|----------|
| 285.5° F..... | 107 min. |
| 298.0° F..... | 60 min. |
| 302.5° F..... | 43 min. |
| 307.0° F..... | 30 min. |
| TOTAL..... | 240 min. |

Employing the foregoing series of temperatures and times, the mixture was vulcanized in a button mold for a total time of 240 min., samples being removed for combined sulfur estimation at hourly intervals and at each change in the vulcanizing temperature. These results are shown in the first four columns of Table II and expressed graphically by the solid line in Fig. 2.

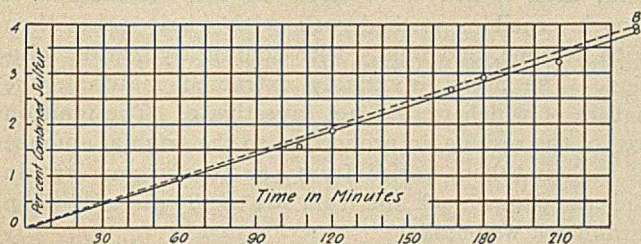


FIG. 2—VULCANIZATION-TIME CURVE FOR INCREASING TEMPERATURES

It is readily observed that the results obtained coincide almost exactly with the hypothetical straight vulcanization-time curve represented by the dotted line OB in Figs. 1 and 2.

Separate slab cures were then made for physical tests, at the temperatures and times required to produce vulcanization coefficients of 1.56, 2.96, and 3.86. The results of these tests are shown in the last three columns of Table II.

TABLE II—VULCANIZATION BY A SERIES OF INCREASING TEMPERATURES

| Total Time of Vulcanization Min. | Time at the Different Temps. Min. | Temperature Deg. F. | Combined Sulfur Per cent | Tensile Strength Lbs. per Sq. In. | Elongation Per cent | Permanent Set Per cent |
|----------------------------------|-----------------------------------|---------------------|--------------------------|-----------------------------------|---------------------|------------------------|
| 60 | 60 | 285.5 | 0.937 | 2168 | 715 | 17.97 |
| 107 | 107 | 285.5 | 1.567 | 2168 | 715 | 17.97 |
| 120 | 107 | 285.5 | 1.879 | ... | ... | ... |
| 167 | 13 | 298.0 | ... | ... | ... | ... |
| 167 | 107 | 285.5 | 2.702 | ... | ... | ... |
| 180 | 60 | 298.0 | 2.963 | 2234 | 714 | 25.52 |
| 180 | 13 | 302.5 | ... | ... | ... | ... |
| 210 | 107 | 285.5 | 3.252 | ... | ... | ... |
| 210 | 60 | 298.0 | ... | ... | ... | ... |
| 210 | 43 | 302.5 | ... | ... | ... | ... |
| 240 | 107 | 285.5 | 3.862 | 1944 | 705 | 25.00 |
| 240 | 60 | 298.0 | ... | ... | ... | ... |
| 240 | 43 | 302.5 | ... | ... | ... | ... |
| 240 | 30 | 307.0 | ... | ... | ... | ... |

To facilitate comparison, the results of these physical tests, together with those obtained at the same sulfur coefficient when vulcanization was effected at a constant temperature of 298° F., have been grouped together in Table III. From this table it is seen that there is very little difference in the tensile strength of the mixture at coefficients of 1.69 or 2.94 when vulcanized by either method. But in both instances a series

of increasing temperatures appears to produce a product of superior elongation. When the coefficient is increased to 3.9, however, it is seen that the product obtained by employing a series of increasing temperatures is markedly superior to that obtained at constant temperature, both as to tensile strength and percentage of elongation.

| Combined Sulfur Constant Temp. | Increasing Temp. | Tensile Strength Ibs. per Sq. In. | | Elongation Per cent | |
|--------------------------------|------------------|-----------------------------------|-------------------|---------------------|-------------------|
| | | Constant Temp. | Increasing Temps. | Constant Temp. | Increasing Temps. |
| 1.690 | 1.567 | 2277 | 2168 | 69 | 715 |
| 2.945 | 2.963 | 2156 | 2234 | 678 | 714 |
| 3.920 | 3.860 | 1435 | 1944 | 652 | 705 |

It is recognized that the results which have been recorded herein are not subject to indiscriminate or general application. This work has been confined to the investigation of one rubber-sulfur mixture only, and our calculations have been based on the correct or "technical cure" of the mixture as being obtained after vulcanization for 60 min. at 298° F. However, as the comparisons made are relative, and as the principle involved will apply to other mixtures and other vulcanization coefficients, we are warranted in drawing the following conclusions:

1—That it is possible to calculate and apply a series of increasing temperatures such that the vulcanization-time curve for any rubber-sulfur mixture may be made a straight line, the slope of which is dependent on the temperatures employed and the amount of catalyst present.

2—That in vulcanization at a constant temperature, in order to procure maximum physical properties, sulfur must be present in the mixture in such an amount that its active mass is not decreased to an extent which will appreciably slow up the rate of reaction before the desired vulcanization coefficient is attained.

3—That for rubber-sulfur mixtures containing 5 per cent or less of total sulfur, the physical properties of the mixture, when vulcanized by a series of increasing temperatures, are superior to those obtained by vulcanization at constant temperature; this is particularly true at vulcanization coefficients of 2.8 or above.

4—That the vulcanization coefficient for Hevea rubber is probably between 1.7 and 2.8.

5—That it is dangerous to evaluate samples of vulcanized rubber solely on the basis of their vulcanization coefficients.

THE FALLS RUBBER COMPANY
CUYAHOGA FALLS, OHIO

THE DETERMINATION OF FREE CARBON IN RUBBER GOODS¹

By A. H. SMITH AND S. W. EPSTEIN

INTRODUCTION

The main object, perhaps, in the determination of free carbon in rubber goods is not the information gained directly, but the opportunity thus permitted of the determination of the rubber content by difference. For some time past the most widely used method for the determination of rubber has been to cal-

¹ Read before the Rubber Section at the 56th Meeting of the American Chemical Society, Cleveland, September 10 to 13, 1918.

culate it as the difference between 100 per cent and the total of the percentages of ash, total sulfur, and the various extracts. Recently refinements on this general method for the determination of rubber have been proposed and quite generally accepted, and it stands to-day the accepted standard of analysis. Obviously, this method is subject to wide error when free carbon is present and no correction is made for it.

This Bureau first became interested in this problem some months ago. At that time we were receiving relatively large numbers of rubber articles containing free carbon in which we were to determine the rubber content. In such cases we previously had determined the rubber directly by the nitrosite combustion method.¹ Admittedly, this method is a long one for routine work and we desired, if possible, to return to the method of determination by difference by correcting the ash figure for the amount of free carbon present. This of course necessitated a determination of the free carbon content of the goods and we finally arrived at the procedure which is here presented.

DISCUSSION OF PROPOSED METHOD

Our search of the literature on the subject revealed two general methods for such a determination: first, that in which nitric acid is used to decompose and remove the rubber and the carbon then determined in the residue; and second, that in which the rubber is dissolved in high-boiling solvents such as petroleum oils, nitrobenzene, aniline, etc., and the carbon then similarly determined in the residue.

Henry William Jones² proposes the use of nitric acid as a means of separating free carbon from vulcanized rubber and describes his process as follows: "A one-to two-gram sample is heated with concentrated nitric acid and then filtered cold on a Gooch crucible, washed with nitric acid to remove the mother liquors, and then with water to remove the acid and soluble metallic salts. The insoluble residue is then air-dried at ordinary temperatures, weighed, ignited, and weighed again."

W. A. Caspari³ also utilizes nitric acid to decompose the rubber but uses ammonia to remove the nitrous products formed.

We found the method of Caspari to give high results since there is no attempt to remove any organic compounds which may not be dissolved by nitric acid or ammonia. The method of Jones seemed, in general, to be satisfactory. In the report referred to, however, the details are somewhat lacking and the latter part is more or less confusing.

Our method as we first tried it was, first, primarily to remove organic matter with a nitric acid treatment and then filter on a Gooch crucible, leaving only fillers which were not attacked by nitric acid; and second, to remove by suitable treatment any possible remaining mineral fillers which might be reduced during ignition of the carbon. The carbon could then be determined by the difference in weight before and after ignition.

Our first experiments indicated the following:

- 1—The carbon itself was liable to attack by nitric acid.
- 2—The organic matter was not all removed by nitric acid.
- 3—Lead sulfate seemed to be the chief mineral ingredient which needed to be removed after the nitric acid treatment.

We treated samples of lampblack and gas black for various periods with concentrated nitric acid. In each case the mixture was heated on the steam bath for a definite length of time and then evaporated to dryness. The residue was always heavier than the original sample and the increase in weight varies with the time of heating. This increase was from 3 to 5 per cent for the minimum time taken to evaporate off the acid and from 5 to 8 per cent for 15 hrs. heating.

We then treated samples of lampblack and gas black for definite lengths of time with concentrated nitric acid, after which we filtered off the solution on a Gooch crucible, washed well with nitric acid, then with acetone, and finally with sodium hydroxide solution. The alkali invariably extracted material, the nature of which we did not investigate. The ignition loss of the residue, in proportion to the original amount of carbon taken, varied from 100 to 102 per cent in the case of gas black and from 101 to 105 per cent when lampblack was used.

As yet we have not made any effort to identify the products formed by the action of nitric acid on the variously made forms of amorphous carbon, but are inclined to believe that the action is an oxidizing one similar to the formation of graphitic acid by the prolonged heating of a mixture of graphite, potassium chlorate, and nitric acid. Therefore, one would expect to find here complex carboxylic compounds formed by the addition of hydrogen and oxygen to the carbon atoms.

There seem to be at least three classes of compounds formed, namely, the first soluble in nitric acid, the second insoluble in nitric acid but soluble in alkali, and the third insoluble in both. Our experiments indicated that the last named was the major product of the reaction.

Our first trials at completely removing the nitrated rubber with nitric acid showed that this was practically impossible. After filtration from the nitric acid solution, washing with acetone would invariably give an extract, in some cases the characteristic yellow of the nitrosite of rubber, in others a deep brown extract which persisted for several washings. With samples giving these deep brown extracts with acetone, a further washing with sodium hydroxide would result in a second brown extract. This showed that the nitric acid did not remove all of the nitrosite of rubber, nor some other organic matter which may or may not have been nitrated but which seemed to be soluble in acetone or sodium hydroxide solution. It was noted that the brown acetone and sodium hydroxide extracts were invariably obtained when mineral rubber was known to be present. All of the samples nitrated had previously been extracted with acetone and chloroform,

¹ Bureau of Standards method for the direct determination of rubber.

² Paper presented before the Fourth International Rubber Congress.

³ India Rubber Laboratory Practice.

so we were led to conclude that we were encountering that part of mineral rubber which after vulcanization, according to Caspari, becomes insoluble in the usual solvents.

B. D. Porritt¹ confirms Caspari's work, showing that during vulcanization some of the bitumen passes into an insoluble form much as rubber does. In the case of vulcanite, he says nearly half of the bitumen is rendered insoluble. He presented no information, however, as to whether or not any combination with sulfur takes place. He also found that nitric acid had no apparent action on bitumen. He treated a rubber mixture containing bitumen with nitric acid, and tried to determine, by extracting with carbon bisulfide, the bitumen left in the residue. He obtained results extremely low. From this he concluded that the preliminary treatment with nitric acid had rendered a portion of the bitumen insoluble in the solvents. If this were the case, carbon determined as we have proposed would give high results.

An experiment which we hoped might disclose the effect of mineral rubber on the determination was made as follows: Some mineral rubber was melted and stirred up with sulfur at 200° C. A vigorous reaction took place with considerable evolution of hydrogen sulfide. The brittle solid product obtained was extracted with acetone and chloroform, and gave a very large insoluble residue. This residue was found to be insoluble in all of the common organic solvents and unattacked by strong sodium hydroxide. When treated with hot concentrated nitric acid for a few minutes the acid became colored a deep brown, but the larger part of the material persisted as a black floating mass. It remained so even after a 24-hr. treatment. This residue, however, we found to be readily soluble in either acetone or strong sodium hydroxide solution. The effect of mineral rubber on the determination would then be as follows: The preliminary extractions with acetone and chloroform would remove the soluble portions; after nitration, acetone and sodium hydroxide solution would remove that part which had become insoluble through vulcanization.

We carried out a large number of determinations on compounds by treating directly with nitric acid. We compared these results with results obtained on the same samples which had been extracted with acetone and chloroform before nitration. The carbon content usually appeared a few hundredths of a per cent higher in the former. This we attributed to the difficulty in washing the filter pad free from the large quantities of extractable matter often present. Practical experience showed us that, after filtering off the nitric acid solution, filtration proceeded much more rapidly if we used solvents alternately.

Assuming that the organic matter has all been removed by the nitric acid, organic solvents, and sodium hydroxide solution, there remain with the carbon all of the mineral constituents which were not removed by the nitric acid. Among the latter lead is very often present, since part of it is usually converted into

lead sulfide during vulcanization and subsequently into lead sulfate during the nitric acid treatment. Any mineral matter remaining which is not attacked by carbon during ignition or which itself suffers no ignition loss, obviously need not be removed. If lead sulfate, however, is allowed to remain in contact with the carbon during ignition, it becomes at least partially reduced and perhaps volatilized with a subsequent loss in weight. Lead sulfate is therefore removed by washing with concentrated ammonium acetate solution until the filtrate shows the absence of lead.

Our attention was called by Mr. I. V. Stone, of the United States Rubber Company, to the fact that calcium sulfate would show an ignition loss. This was confirmed and so the presence of calcium sulfate at this point would lead to erroneous results. It must be considered, however, that calcium sulfate is practically only added along with sulfides of antimony, and that a combination of antimony sulfides and gas black and lampblack is very unusual.

In order to remove the last traces of sodium hydroxide previously used as a wash, the pad was washed well with a very dilute solution of hydrochloric acid. This cannot well be followed by a wash with water since the carbon is apt to go into colloidal solution. On attempting to dry the residue at 200° C., it was found that it gradually decreased in weight, probably owing to the very slow oxidation of the carbon at this temperature. Drying for 1½ hrs. at 150° C., however, removed all of the hydrochloric acid and gave a constant weight.

DETAILS OF METHOD AS FINALLY ADOPTED

As a result of these preliminary considerations and experiments, we devised the following procedure:

Extract a 1 g. sample for 6 hrs. with acetone and then for 3 hrs. with chloroform or carbon bisulfide. Transfer the sample to a 250 cc. beaker and heat on the steam bath until it no longer smells of chloroform. Add a few cc. of hot concentrated nitric acid and allow to stand in the cold for about 10 min. Add 50 cc. more of hot concentrated nitric acid, taking care to wash down the sides of the beaker. Heat on the steam bath for about one hour or until the disappearance of all bubbles or foam from the surface. Pour the liquid, while hot, into a Gooch crucible containing a fairly thick pad of ignited asbestos. Filter by applying gentle suction and wash well with hot concentrated nitric acid. *Empty the filter flask*, wash the filter alternately with acetone and benzol until the filtrate is colorless. Next wash it well with a hot 15 per cent solution of sodium hydroxide. Test for the presence of lead by running some warm ammonium acetate solution, containing an excess of ammonium hydroxide, through the pad into a solution of sodium chromate. If a yellow precipitate forms, the pad must be washed with the ammonium acetate solution until the washings no longer precipitate the sodium chromate solution. Next wash the residue well with warm 5 per cent hydrochloric acid solution. Remove the crucible from the funnel, taking care that the outside is clean, and dry it in an air bath for 1½ hrs. at 150° C. Weigh, burn off the carbon at a dull red heat, and re-weigh. The difference in weight represents approximately 105 per cent of the carbon originally present in the form of lampblack or gas black.

NOTE—It is recommended that 0.5 g. samples be taken for compounds containing over 10 per cent of free carbon and 1 g. samples be taken for compounds containing less than this amount.

¹ "Estimation of Bitumen in Rubber Mixings," Proceedings of Fourth International Rubber Congress.

It will be noted that we have taken the factor of 105 per cent as a ratio between the ignition loss and the amount of carbon present. This factor is arrived at from the results of a large number of determinations made at the Bureau of Standards. The results of gas black determinations ran from 101 to 106 per cent and lampblack determinations from 102 to 108 per cent. Results were obtained on different samples containing large amounts of mineral rubber, lead (both in the form of oxide and sulfate), reclaimed rubber of various kinds, glue, substitute, sulfides of antimony, talc, and others. In all cases the results came between 101 and 108 per cent of the carbon originally present, so by using a factor of 105 per cent, the maximum divergence would be 4 per cent and the usual divergence very small.

In our analysis of the gas black and lampblack used in our experiments, we determined the volatile loss at 100° C., the actone extractable matter, and the ash, and assumed the remainder of our samples to be carbon. Our results have been calculated to this basis.

SUMMARY

I—It is necessary to correct the result as obtained by ignition loss to compensate for the error caused by the formation of compounds from the free carbon.

II—The attack of amorphous carbon by nitric acid renders an accurate determination by this method impossible; nevertheless the error caused thereby is sufficiently uniform and small in magnitude to allow of a practical determination.

III—Assuming the ignition loss to be 105 per cent of the weight of carbon, we feel that the results by this method justify its use at present as a routine method in the rubber laboratory.

BUREAU OF STANDARDS
WASHINGTON, D. C.

A RAPID AND ACCURATE METHOD FOR BUTTER ANALYSIS, SUITABLE FOR FACTORY CONTROL WORK

By EDWARD F. KOHMAN
Received July 11, 1918

Inasmuch as a fat standard for butter is advocated by many, it would be desirable to have some simple and rapid method for the determination of fat in butter to be used in creamery control work. We have found that with very little added time the fat can be determined in connection with the moisture test in the following manner:

The moisture is determined as usual over a small flame in a tall, rather narrow, lipped aluminum beaker with a capacity of about 100 cc., using a 10 g. sample. After the beaker is weighed to determine the loss of moisture, it is filled with petroleum ether and the contents stirred with a glass rod to secure a thorough mixture. It is then covered with a watch crystal and allowed to stand 2 or 3 min. for the mixture of curd and salt to settle, when the solvent is gently decanted off without disturbing the sediment. The beaker is then filled with fresh solvent. The curd and salt mixture settles rapidly in the fresh solvent and the liquid can be decanted off after a very short time. By gently heating the beaker now, either on a water bath, a hot plate, or directly over a small flame, but not so rapidly as to cause sputtering, the sediment can be completely freed of petroleum ether

by evaporation in a very short time. The per cent of fat is then determined by difference upon reweighing the beaker with its contents. The salt is now in ideal condition to be determined by titration, using a solution of such strength that the number of cc. used represents the per cent of salt.

No special practice is necessary in order to enable one to carry out this analysis successfully the first time. The writer has had no difficulty in assigning it to his students in dairy chemistry. In heating the butter to drive off the moisture, the slightest noticeable browning of the sample should be taken as the endpoint. But it is surprising how little the results are affected if the sample is heated until it assumes a coffee-brown. Before trying to evaporate the petroleum ether from the mixture of curd and salt, it is well to loosen it from the bottom of the beaker by gently tapping it on the desk in order to lessen the tendency to sputter. When making duplicate determinations the two beakers can readily be held by one pair of tongs while being heated. We have thus been able to make duplicate analyses of butter in 20 min. or single determinations in 15 min., and the results are as accurate as those obtained by the A. O. A. C. methods, as the table given below will show. It is well to keep the petroleum ether from the second decantation in a separate container and use it for the first extraction in future analyses.

In the following table are a few typical results in which the moisture and fat content of butter as determined by the A. O. A. C. method and the method outlined above are compared.

| ANALYSIS No. | A. O. A. C METHOD | | DECANTATION METHOD | |
|--------------|-------------------|--------------|--------------------|--------------|
| | Moisture Per cent | Fat Per cent | Moisture Per cent | Fat Per cent |
| 1 | 14.22 | 81.97 | 14.27 | 82.13 |
| | 14.20 | 82.06 | 14.24 | 82.09 |
| 2 | 18.00 | 78.27 | 18.06 | 78.36 |
| | 17.93 | 78.38 | 18.08 | 78.35 |
| 3 | 19.72 | 77.46 | 19.72 | 77.50 |
| | 19.69 | 77.54 | 19.74 | 77.48 |
| | | | 19.78 | 77.50 |
| | | | 19.77 | 77.47 |
| | | | 19.74 | 77.47 |
| 4 | 14.95 | 82.20 | 15.07 | 82.11 |
| | 15.00 | 82.06 | 15.11 | 82.08 |
| | | | 15.02 | 82.05 |
| | | | 15.08 | 81.99 |
| | | | 15.08 | 81.99 |
| 5 | 20.98 | 76.29 | 21.07 | 76.26 |
| | 20.97 | 76.27 | 21.10 | 76.20 |
| | | | 21.05 | 76.22 |
| 6 | 14.92 | 80.81 | 14.98 | 80.92 |
| | 14.98 | 80.82 | 15.00 | 80.83 |
| | | | 14.91 | 80.84 |
| | | | 15.90 | 80.52 |
| | | | 15.90 | 80.46 |
| 7 | 15.85 | 80.46 | 15.89 | 80.59 |
| | 15.82 | 80.49 | 15.91 | 80.57 |
| | | | 15.91 | 80.57 |
| 8 | 15.36 | 81.08 | 15.40 | 81.14 |
| | 15.39 | 81.08 | 15.40 | 81.04 |
| | | | 15.37 | 81.10 |
| 9 | 15.83 | 80.62 | 15.92 | 80.65 |
| | 15.85 | 80.60 | 15.90 | 80.60 |
| | | | 15.93 | 80.73 |
| | | | 15.94 | 80.69 |
| 10 | 14.57 | 82.08 | 14.59 | 82.23 |
| | 14.59 | 82.05 | 14.62 | 82.09 |
| | | 14.61 | 82.01 | |
| | | 14.63 | 82.01 | |

The work embodied in the above table was done by the writer in 1916 while in the Department of Dairy Husbandry of the University of Illinois.

BUREAU OF CHEMISTRY
INDIANAPOLIS, IND.

UTILITY OF BLANCHING IN FOOD CANNING
EFFECT OF COLD SHOCK UPON BACTERIAL
DEATH RATES

By EVA M. BRUETT

Received July 29, 1918

The so-called process of blanching is used both by commercial packers and by the housewife in preparing many vegetables and fruits for preservation by canning. The physical advantages of dipping such food first into boiling water, then into cold, are probably sufficient to justify its use. However, there is a distinct impression prevalent among canners that the blanching is to some degree an essential part of the process of sterilization, and that products so treated are more readily processed. This report presents the results of a series of studies on the effect of cold shock upon bacterial death rates when organisms are subjected to subsequent high temperatures. It has been thought that the cold shock following a preliminary heating might so injure the vitality of the bacteria as to make them more susceptible to subsequent heating.

In a preliminary note presented in December 1917, at the meeting of the Society of American Bacteriologists,¹ the conclusion was announced that there is no evidence that heat and cold shock increase the susceptibility of bacterial spores to heat, for death rates of such bacteria are not increased during a second heating beyond the death rates of "unshocked" bacteria subjected to the same temperature.

In a recent paper, Bushnell² comes to a similar conclusion as a result of studies on the canned products themselves.

This paper presents data in support of the conclusion announced in our preliminary note, with certain inferences which may be drawn as to the utility of the blanching process in cold pack canning.

It is obvious that the times and temperatures used in both commercial and home canning processes are such that organisms other than those in the spore condition will be very quickly destroyed. It is necessary, then, to study the effect of cold shock upon the vitality or viability of bacterial spores.

The organism used in this study was *Bacillus pseudotetanicus* (Kruse) Migula, a member of the group of spore-producing soil aerobes possessing considerable resistance to high temperatures. The parent culture was one secured from Dr. Ford, of Johns Hopkins. The bacteria were grown on 0.5 per cent dextrose agar slants, incubated at 30° C. for four days to insure adequate sporulation. The growth from a single culture was suspended in 10 cc. physiological salt solution. This suspension was centrifugated to remove clumps and passed through a sterile filter to secure a uniform suspension. In all cases the effect of temperature was studied by adding 1 cc. of this suspension to 9 cc. of 1 per cent peptone solution already heated to the desired temperature. A de Khotinsky portable water bath was used for maintaining a constant temperature, with corn oil substituted for water, as ex-

perience showed a much more constant temperature could be maintained at 80° C. and above by this means. The peptone solution was held at the temperature of the bath for the desired length of time, counts of the numbers of viable bacteria present being made at short intervals by plating. At higher temperatures the time intervals used were necessarily shorter than at lower temperatures. After the heating had been continued for the desired length of time, 1 cc. was transferred to a second tube of peptone containing 9 cc. of solution and at a temperature of about 1° C. maintained by the use of an ice bath. The length of exposure to the cold was arbitrarily fixed in each case at 5 min. A sample was then taken for a plate count, and the tube placed in the thermostat where it was heated together with the tube containing the "unshocked" bacteria.

Counting was carried out in general in conformity with standard methods. Salt solution was used for dilutions. The plating medium used was a 1 per cent dextrose, 2 per cent agar. This gave a relatively stiff medium and prevented the development of spreading colonies, a serious difficulty with softer media. The plates were incubated at 30° C. for 48 hrs., then counted.

It has been shown by several investigations that the deaths of microorganisms when subjected to any fixed unfavorable conditions will occur in conformity with the well-known equation of monomolecular reactions. This may be expressed:

$$k = \frac{1}{t} \log \frac{B}{b}$$

in which k = velocity coefficient of the rate of death of bacteria, a constant

t = interval of time between observations

B = number of bacteria at beginning of any time interval

b = number of bacteria at end of time t

Preliminary tests with the spores of *Bacillus pseudotetanicus* showed satisfactory agreement with the law; under a given set of conditions the value of k was found to be nearly constant, that is, the number of bacteria dying off in any unit of time is nearly proportional to the number present at the beginning of that time interval. It is evident that the effect of the cold shock upon bacterial spores may be determined by a comparison of the values of k found before and after "shocking" the bacteria, *i. e.*, if the value of k increases, the spores have lost their resistance to some degree and die off more quickly than do the "unshocked" bacteria.

It is apparent that considerable experimental error is inevitable. The results, however, are on the whole satisfactory.

Several methods may be used for calculating the value of k in any experiment. It is evident that the initial inoculum probably may contain some viable vegetative cells which will have a very different death rate from spores. The value of k may be approximated by (1) substituting for B the number of bacteria at beginning, for b the number of bacteria after

¹ *Abstracts of Bact.*, 2 (1918), 5.

² "The Influence of Cold Shock in the Sterilization of Canned Foods," *THIS JOURNAL*, 10 (1918), 432.

the varying time intervals, and averaging, or (2) substituting for B the number of bacteria at beginning of each time interval, and for b the number at the end of each time interval, and averaging, or (3) substituting for B the number of bacteria at the end of the first time interval, and for b the number of bacteria after each of the following time intervals, and averaging. The values of k were determined by each method as illustrated by the following example:

TABLE I—ILLUSTRATING METHODS OF DETERMINING VELOCITY COEFFICIENT ON DEATH RATE AT 80° C.

| Time after Inoculation Min. | Viable Bacteria per cc. | k Calculated by Method 1 | k Calculated by Method 2 | k Calculated by Method 3 |
|-----------------------------|-------------------------|----------------------------|----------------------------|----------------------------|
| 0 | 890,000 | 0.0021 | 0.0021 | ..... |
| 15 | 827,000 | 0.0024 | 0.0027 | 0.0027 |
| 30 | 752,000 | 0.0025 | 0.0028 | 0.0028 |
| 45 | 681,000 | 0.0029 | 0.0039 | 0.0031 |
| 60 | 594,000 | 0.0028 | 0.0026 | 0.0031 |
| 75 | 537,000 | 0.0027 | 0.0021 | 0.0028 |
| 90 | 504,000 | 0.0032 | 0.0062 | 0.0029 |
| 105 | 406,000 | ..... | ..... | ..... |
| | | Ave., 0.0026 | Ave., 0.0032 | Ave., 0.0029 |

It is apparent that in this instance there is little to choose in the method of determining k . It is thought, however, that either the third, or an average of the averages, should represent the facts fairly well. In general, the latter index has been used.

EXPERIMENTAL RESULTS

Three sets of experiments were run at 80°, one at 85°, two at 90°, and one at 100° C. The data and determined values for k are given in the following tables:

TABLE II—DETERMINATION OF VELOCITY COEFFICIENT OF DEATH RATE AT 80° C. FIRST TRIAL

| Time after Inoculation Min. | Viable Bacteria per cc. | | |
|-----------------------------|-------------------------|-------------------------------|-------------------------------|
| | Unshocked Bacteria | Shocked after Heating 15 min. | Shocked after Heating 30 min. |
| 0 | 890,000 | ..... | ..... |
| 15 | 827,000 | 81,000 | 70,300 |
| 30 | 752,000 | 72,000 | 67,100 |
| 45 | 681,000 | 60,350 | 64,000 |
| 60 | 594,000 | 59,650 | ..... |
| 75 | 537,000 | 57,700 | 55,200 |
| 90 | 504,000 | 54,200 | 48,100 |
| 105 | 406,000 | 53,200 | 43,300 |
| Value of k | 0.0029 | 0.0025 | 0.0021 |

It will be noted that the values for the velocity coefficients of the death rates of the shocked bacteria are not higher than those of the unshocked. The differences are probably not significant. The general tendency in this and other experiments is for the value for the shocked bacteria to be slightly lower. This may possibly be due to unavoidable experimental error in that the chilled tube does not instantly assume the desired temperature when replaced in the water bath.

TABLE III—DETERMINATION OF VELOCITY COEFFICIENT OF DEATH RATE AT 80° C. FIRST TEST

| Time after Inoculation Min. | Viable Bacteria per cc. | | |
|-----------------------------|-------------------------|-------------------------------|-------------------------------|
| | Unshocked Bacteria | Shocked after Heating 15 min. | Shocked after Heating 30 min. |
| 0 | 130,000 | 20,000 | 6,800 |
| 15 | 110,000 | ..... | ..... |
| 30 | 60,000 | 6,900 | 4,650 |
| 60 | 30,000 | 2,800 | 3,000 |
| 90 | 13,500 | 1,150 | ..... |
| Value of k | 0.0115 | 0.0136 | 0.0059 |
| | SECOND TEST | | |
| 0 | 189,000 | 10,000 | 6,200 |
| 15 | 125,000 | 7,500 | ..... |
| 30 | 82,000 | 4,700 | 4,700 |
| 60 | 34,000 | 2,300 | 2,800 |
| 90 | 32,000 | 1,000 | 1,880 |
| 120 | 15,200 | 800 | 960 |
| 135 | ..... | ..... | 360 |
| 150 | 6,300 | 360 | ..... |
| 165 | ..... | 320 | ..... |
| Value of k | 0.0106 | 0.0104 | 0.0065 |

The results in Table III are not comparable strictly and directly with those of Table II as these tests were performed with different lots of material.

Here again the differences in rates of death are probably not significant. In each of the following experiments it should be noted that the studies were made with different lots of material. The values of k determined in the various tables cannot be used therefore for a determination of the temperature coefficient of the reaction. Conditions were uniform in each experiment, but suspensions of bacteria prepared at different times did not give comparable results.

TABLE IV—DETERMINATION OF VELOCITY COEFFICIENT OF DEATH RATE AT 85° C.

| Unshocked Bacteria | | Shocked after Heating 10 min. | |
|-----------------------------|-----------------|-------------------------------|-----------------|
| Time after Inoculation Min. | Viable Bacteria | Time after Inoculation Min. | Viable Bacteria |
| 0 | 2,180,000 | 0 | 183,000 |
| 10 | 1,850,000 | 5 | 173,000 |
| 20 | 1,089,000 | 25 | 116,000 |
| 40 | 621,000 | 50 | 88,000 |
| 65 | 45,600 | 60 | 27,000 |
| Value of k | 0.0127 | .. | 0.0107 |

TABLE V—DETERMINATION OF VELOCITY COEFFICIENT OF DEATH RATE AT 90° C.

| Unshocked Bacteria | | Shocked after Heating 10 min. | |
|-----------------------------|-----------------|-------------------------------|-----------------|
| Time after Inoculation Min. | Viable Bacteria | Time after Inoculation Min. | Viable Bacteria |
| 0 | 481,000 | 0 | 22,600 |
| 10 | 296,000 | 15 | 10,700 |
| 20 | 67,000 | 30 | 5,000 |
| 35 | 26,000 | 45 | 570 |
| 50 | 2,900 | 65 | 340 |
| 65 | 2,200 | 75 | 135 |
| .. | ..... | 90 | 85 |
| Value of k | 0.0384 | .. | 0.0285 |

| Time after Inoculation Min. | Viable Bacteria per cc. | | |
|-----------------------------|-------------------------|------------------------------|-------------------------------|
| | Unshocked Bacteria | Shocked after Heating 5 min. | Shocked after Heating 10 min. |
| 0 | 990,000 | 89,000 | ..... |
| 5 | 810,000 | 61,500 | 35,300 |
| 10 | 790,000 | 57,000 | 34,500 |
| 15 | 357,500 | 51,000 | 29,500 |
| 20 | 164,500 | 37,100 | ..... |
| 25 | 137,500 | 29,600 | 24,500 |
| 30 | 101,000 | 25,600 | 23,400 |
| 35 | 94,000 | 22,350 | 12,500 |
| Value of k | 0.0292 | 0.0180 | 0.0108 |

TABLE VI—SINGLE DETERMINATION OF VELOCITY COEFFICIENT OF DEATH RATE AT 98° C.

| Time after Inoculation Min. | Viable Bacteria per cc. | | |
|-----------------------------|-------------------------|----------------------|----------------------|
| | Unshocked Bacteria | Shocked after 2 min. | Shocked after 4 min. |
| 0 | 125,000 | 6,600 | 5,600 |
| 2 | 51,000 | 5,900 | 5,200 |
| 4 | 30,000 | 5,400 | 4,800 |
| 6 | ..... | 4,700 | 4,600 |
| 8 | 26,000 | 3,000 | 3,100 |
| 10 | 14,700 | 2,200 | 2,500 |
| 12 | 5,500 | 920 | ..... |
| Values of k | 0.1106 | 0.0504 | 0.0257 |

It is evident that the experimental error for results such as given in Table VI should be rather large because of the difficulties in rapid manipulation, slowness with which tubes acquire a new temperature, and inaccuracies in correct estimation of time.

TABLE VII—SUMMARY OF THE VALUES OF k OBTAINED FOR DIFFERENT TEMPERATURES

| Temperature | Value of k for Unshocked Bacteria | Value of k for Shocked Bacteria | Value of k for Shocked Bacteria |
|-------------|-------------------------------------|-----------------------------------|-----------------------------------|
| 90° | 0.0029 | 0.0025 | 0.0021 |
| 80° | 0.0115 | 0.0136 | 0.0059 |
| 80° | 0.0106 | 0.0104 | 0.0065 |
| 85° | 0.0127 | 0.0107 | ..... |
| 90° | 0.0384 | 0.0285 | ..... |
| 90° | 0.0290 | 0.0180 | 0.0108 |
| 100° | 0.1106 | 0.0504 | 0.0257 |

A summary of the values of k is given in Table VII. It will be noted that in one case only does the velocity coefficient of the death rate of shocked bacteria rise higher than the unshocked. An examination of this

table apparently justifies the statement that the rate of death of bacteria at high temperatures is not increased by preliminary heating and "shocking" by cold. The bacteriological utility of the blanching in the cold pack process of canning probably should not be ascribed to shock.

Is there, then, any bacteriological justification for the process of blanching in food canning? A can of food is sterile and will certainly keep in consequence whenever the number of living bacteria present, or the number of those which can multiply in the canned food, has been reduced to fewer than one to the can. The fact that sporulating bacteria die off at high temperatures in substantial conformity to the law governing monomolecular reactions emphasizes the point that the larger the number of bacteria initially present in the can, the longer under the same conditions will it take to sterilize. Blanching may be of some value because the initial application of hot water followed by cold not only kills many bacteria but removes them from heavily contaminated products in very large numbers. It is probable that there is some bacteriological justification for the blanching process because of this initial cleansing.

It may be noted that Bushnell's experiments on blanching were not in all cases, strictly speaking, blanching in the sense used in the cold pack process. This author demonstrated that if a food is heated, chilled, and heated, the total time of heating required to sterilize is as great as though there had been no chilling. This does not prove, however, that if the material had been immersed in boiling water, then in cold water, that the cleansing action may not have increased the ease of sterilization. This could be determined by quantitative determinations of the spores removed by this process. It is not improbable in many cases that the time of sterilization required with and without blanching would be practically identical, indicating that the number of bacteria (spores) removed was not very great. This is indicated by other results of Bushnell's where true blanching was practiced. A comparative study should also be made of the composition of the liquid of canned foods, vegetables in particular, which have been blanched with that from unblanched. Very slight differences in the acidity (hydrogen ion concentration) of the liquid under the two conditions might influence markedly the time needed for sterilization.

CONCLUSIONS

1—Comparisons of the velocity coefficients of the death rates of bacterial spores may be made to determine the effect of various conditions, such as temperature.

2—Bacterial spores are apparently not made more sensitive to heat by preliminary heating followed by chilling.

3—Blanching as a preliminary to the cold pack process of canning does not have bacteriological justification on the basis of increased susceptibility of the bacteria to sterilization because of "cold shock."

4—There is probably some bacteriological justification for blanching because of the marked cleansing

action of this process, resulting in the introduction of smaller numbers of spores initially into the canned product. It is probable that the time required for sterilization varies with the initial contamination; it is desirable therefore to reduce this as much as possible.

BACTERIOLOGICAL LABORATORIES
IOWA STATE COLLEGE
AMES, IOWA

THE NATURE OF THE RECOMBINED POTASH IN CEMENT MILL DUST

By ALBERT R. MERZ AND WILLIAM H. ROSS

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In a previous publication¹ an estimate was made of the quantity of potash annually recoverable as a by-product in the flue dust of the cement mills of the United States. Attention was also called to the fact that in cement dusts which have been recovered a portion of the potash in the dust has been found to be insoluble in acids; a second portion insoluble in water, as determined by the official methods of the Association of Official Agricultural Chemists, but readily soluble in acids, while the remainder of the potash is soluble in water. In the oil-fired plant of the Riverside Portland Cement Company, where cement dust was first collected for its potash content, the greater part of the potash in the dust is readily water-soluble. This dust also contains some acid-soluble and acid-insoluble potash, but the proportions of these present are too small to be of practical significance. However, when dust was later collected at plants where coal is used for fuel it was found that in such plants the acid-soluble potash may constitute the greater part of the total potash in the dust and thereby greatly depreciate the value of the dust for sale as a fertilizer. This observation was first made at the plant of the Security Cement and Lime Company by Mr. R. C. Haff, Chief Chemist, and Mr. R. D. Cheesman, at that time Assistant Chemist of the Company. In explanation of the result the view was advanced by R. J. Nestell and E. Andersen,² of the Western Precipitation Company, that the potash occurring in the acid-soluble form was due to a recombination within the kiln of the volatilized potash with the siliceous ash particles of the coal used for fuel.

In a recent article by N. S. Potter, Jr., and R. D. Cheesman³ the view is advanced, on the other hand, that there is no recombination of the volatilized potash with the siliceous ash particles, but that the water-insoluble potash in the dust is due to the potash in the ash of the coal used for fuel and in the raw mix carried over mechanically in the dust. After quoting passages from articles by Nestell and Anderson⁴ and by the authors,⁵ the statement is made that the potash content of the coal ash had hitherto been quite neglected in considering the sources of the potash occurring in cement dust.

¹ W. H. Ross, A. R. Merz, and C. R. Wagner, U. S. Dept. Agr., *Bulletin* 572.

² *THIS JOURNAL*, 9 (1917) 646.

³ *Ibid.*, 10 (1918), 109.

⁴ *Ibid.*, 9 (1917), 646.

⁵ *Ibid.*, 9 (1917), 467, 1035.

TABLE I—POTASH IN CEMENT DUST SAMPLES FROM DIFFERENT SOURCES

| PLANT | Fuel | Water-soluble K ₂ O in Percentage of | | Acid-soluble, Water-insoluble K ₂ O in Percentage of | | Acid-insoluble K ₂ O in Percentage of | | Total K ₂ O | |
|---|------|---|--------------------------------|---|--------------------------------|--|--------------------------------|------------------------|--------------------|
| | | Dust | Total K ₂ O in Dust | Dust | Total K ₂ O in Dust | Dust | Total K ₂ O in Dust | In Percentage of Dust | Per Bbl. of Cement |
| Atlas Portland Cement Co., Northampton, Pa. | Coal | 1.69 | 19.65 | 5.47 | 63.60 | 1.44 | 16.74 | 8.60 | 1.74 |
| Alpha Portland Cement Co., Cementon, N. Y. | Coal | 2.92 | 41.59 | 3.41 | 48.59 | 0.69 | 9.83 | 7.02 | 2.73 |
| Security Cement & Lime Co., Hagerstown, Md. | Coal | 6.79 | 59.57 | 4.06 | 35.61 | 0.55 | 4.83 | 11.40 | 2.61 |
| Riverside Portland Cement Co., Riverside, Cal. | Oil | 9.76 | 91.62 | 0.73 | 6.85 | 0.16 | 1.51 | 10.65 | 2.13 |

In making our calculations from the analyses already referred to of the average potash volatilized from the different plants of the country in terms of the cement produced we made reference as follows to the matter of potash in coal:

"In making this calculation no account was taken of the potash in the coal which at most would not amount to more than a few tenths of a pound per barrel of cement. Any potash present, however, would tend to increase the value given for the amount of potash volatilized. Cf. R. K. Meade, "Portland Cement," 2nd ed., p. 179."¹

At the plant where R. K. Meade carried out his investigations, 110 lbs. of coal were consumed per barrel of cement produced. The potash in the coal amounted to 0.16 per cent and evidence was given that of the coal ash formed in the kiln only about one-half escaped with the dust.² On this basis, the quantity of potash in the dust that had coal as its source would amount to only 0.09 lb. per barrel of cement. This value is so small as to be practically within the limits of experimental error and when it is considered that the potash in coal is almost entirely in the water-insoluble form it was decided to omit in our calculations the yield of potash from this source.

In Table I are given analyses of four cement dust samples for acid-insoluble, acid-soluble, and water-soluble potash.

In the case of the first sample listed in Table I, the water-soluble potash amounts to 1.69 per cent of the dust and the water-insoluble potash to 6.91 per cent. These analyses were made on a sample of dust which was especially collected in such a way as to represent the entire dust as it escapes from the kiln rather than that which is collected by present commercial methods. In any dust the potash that is carried over mechanically cannot exceed the total percentage occurring in the raw mix multiplied by a certain factor which depends on the degree to which the dust has been calcined before escaping from the kiln. At the plant under consideration 600 lbs. of raw mix are required to yield 1 barrel (380 lbs.) of cement. If it be assumed that the dust undergoes a 50 per cent calcination³ then the factor referred to will amount to 600/490. The potash in the raw mix of this same plant amounts to 0.74 per cent. It follows, therefore, that in the dust of this plant the potash carried over mechanically will

amount to not more than 0.91 per cent¹ of the dust. This leaves a balance in the dust of 6.00 per cent of water-insoluble potash, amounting to 69.8 per cent of the total, which, according to Potter and Cheesman, comes from the ash of the coal used as fuel. Expressed in terms of the cement produced this would be equivalent to 1.22 lbs. per barrel.

In Table II are given the analyses for potash of several coal samples received from different cement plants where potash-bearing dust is now being collected. It will be noted that the average of the values found for the total potash in coal ash is less than half that reported by Potter and Cheesman.² The first sample listed in the table represents the coal used in the plant under discussion at the time the analysis was made of the potash in the raw mix and cement. If the assumption is correct that there is no recombination of potash and even if it be granted that all of the ash from the coal escapes from the kilns with the dust, then at least 530 lbs. of coal would have to be burned in this plant per barrel of cement in order to give the quantity of water-insoluble potash that is actually found. This quantity of coal is much in excess of what is actually used and the excess would be still more marked if proper allowance were made for the coal ash that does not escape from the kilns. Again, if the coal were responsible for the excess of water-insoluble potash found in the second dust listed in Table I, upwards of 500 lbs. of coal would have to be used per barrel of cement, or 1000 lbs. if only 50 per cent of the coal ash escapes from the kiln. Either value is greatly in excess of that used in any cement plant in the country. The conclusion must therefore be reached that in these plants, at least, the ash of the coal and the dust carried over mechanically are not the only sources of the water-insoluble potash of the dust. The only other possible source is the potash that has been volatilized in the process of burning and which has undergone a recombination during its passage from the kiln. More direct evidence in support of this is furnished when a dust from oil-fired kilns like those of the Riverside Portland Cement Company is ignited in the presence of a coal ash. This brings about, as will be shown later, a marked reduction in water-soluble potash and a corresponding increase in water-insoluble potash. A recombination of a portion of the soluble potash originally present in the dust to make a water-insoluble com-

¹ The true value will actually be considerably less than this, owing to the fact that part of the potash silicate in the raw mix is decomposed in the process of burning and also to the dilution of the dust by the addition of the volatilized potash.

² *Loc. cit.*

¹ U. S. Dept. Agr., *Bulletin* 572, p. 8.

² "Portland Cement," 2nd ed., p. 179.

³ Paper (pp. 38, 39, 43) by W. A. Schmidt, presented at the Meeting of Amer. Inst. of Mining Engineers, Globe, Arizona, Sept. 21, 1916.

TABLE II—POTASH IN COAL ASHES

| PLANT | Ash in coal Per cent | Potash in Percentage of Ash | | | Total Potash in Coal Per cent |
|-------------------------------------|----------------------------|-----------------------------|------------------|--------------------|--|
| | | Water- soluble | Acid- soluble | Acid- insoluble | |
| Atlas Portland Cement Co..... | 12.6 | 0.07 | 0.50 | 1.28 | 1.85 |
| Alpha Portland Cement Co..... | 14.4 | 0.09 | 0.42 | 1.14 | 1.65 |
| Clinchfield Portland Cement Co..... | 12.8 | 0.09 | 0.67 | 2.28 | 3.04 |
| Security Cement and Lime Co..... | 7.8 | 0.04 | 0.61 | 1.41 | 2.06 |
| Tidewater Portland Cement Co..... | 15.6 | 0.07 | 0.46 | 1.39 | 1.12 |

bination must therefore have taken place. The fact of the recombination of potash having thus been established, the following experiments were undertaken to determine the nature of the compound formed.

POSSIBLE FORMS OF POTASH COMBINATION

In the case of coal-fired kilns the potash that is volatilized in the hottest part of the kiln will first come in contact with the ash of the coal and the principal constituent elements of any dust that could be collected at this point should consist of the alkalis, aluminum, silicon, sulfur, oxygen, and carbon. As this dust passes from the kiln it would be diluted with lime and the other constituents occurring in the raw mix. It has long been known that when a mixture of the elements first mentioned is ignited in the proportions of about 25 parts of clay to 25 of soda to 3 of carbon and 15 of sulfur there is formed a sodium aluminum sulfosilicate known as ultramarine or artificial lapis lazuli. The natural product is represented by the formula $\text{Na}_4(\text{NaS}_3\text{Al})\text{Al}_2(\text{SiO}_4)_3$. Other related minerals are Haüyite, $\text{Na}_2\text{Ca}(\text{NaSO}_4\text{Al})\text{Al}_2(\text{SiO}_4)_3$, and Nosalite, $\text{Na}_4(\text{NaSO}_4\text{Al})\text{Al}_2(\text{SiO}_4)_3$.

Ultramarine is insoluble in water but is readily decomposed by dilute acids and is able to withstand a red heat when heated out of contact with lime. These properties of ultramarine and the method of its formation suggested the possibility at first that the recombined potash in cement dust may be an artificial compound analogous to the artificial sodalites, but having soda replaced by potash.

It is well known, however, that if the constituents used in making ultramarine are taken in such proportions, or ignited under such conditions that ultramarine is not formed, there is then obtained instead an amorphous product or glass. Ordinary glass is considered as an alkali silicate with a silicate of one or more bases, the alkali being sodium or potassium and the base usually calcium or lead. These are commonly used in the form of such raw materials as silica, lime, and the carbonate or sulfate of sodium or potassium. When the sulfate is used some carbon is also added as a reducing agent, which facilitates the liberation of the sulfur during the process of fusion. It is thus seen that the same constituents are to be found in the dust of the hottest zone of a cement kiln as are used in the manufacture of window or bottle glass, though not necessarily present in the proportions used for making glass.

The properties of the glass produced from the constituents mentioned depend entirely on the proportions taken. Increasing the alkali content of a glass increases the solubility of the alkali in the product, while an increase in the silica content has an opposite effect. For equal contents of silica the glass which contains the most lime and the least alkali is the most

resistant. A high proportion of lime with respect to the silica, however, would make a product insoluble in water but very soluble in acids. By varying the proportion of the constituents it is thus possible to prepare glasses in which the alkali present is mostly soluble in water, mostly acid-soluble, mostly insoluble in acids, or the glass may be of such nature that considerable amounts of any two or three of the forms of potash may be obtained. It would thus seem that it might be possible to calculate the solubility of the alkali in a glass from the proportion of the constituents taken, or *vice versa*, but we have not been able to locate any formula by which this may be done.

These considerations with regard to glass formation suggested another possible explanation of the nature of the recombined potash in cement dust, in addition to that already mentioned in discussing the sulfo-silicates. Owing to the extreme fineness of the potash-bearing portion of the dust no evidence respecting any of its combinations could be secured from a microchemical examination of the dust. The fact that the recombined potash is slowly hydrolyzed also precluded the possibility of separating it from the rest of the dust for chemical analysis. It was therefore decided to make a study of the subject in an indirect way by igniting artificial mixtures so prepared as to approximate in composition that of cement dust as it is found in different parts of the kiln.

COMBINATION OF POTASH IN ARTIFICIAL MIXTURES

In the zone of the kiln where the greater part of the potash is volatilized the latter will necessarily first come in contact with the ash of the burning coal in an atmosphere of sulfur dioxide and carbon dioxide. In the first set of experiments, 3 g. of ash were accordingly ignited with 0.9 g. of K_2O as potassium sulfate, at temperatures of 600°, 1000° and 1300°. The ignitions were repeated, using the same amount of potash in the form of the carbonate. The ignitions were all made in an open platinum dish in an oxidizing atmosphere. In a second set of experiments, 1.5 g. of carbon (lampblack) were thoroughly mixed with the corresponding mixtures used in the first set of experiments and ignited at the same temperatures in closed wrought-iron vessels shaped like a J. Lawrence Smith crucible. In this way the ignitions were made under reducing atmospheric conditions. Under cement kiln conditions, the ash-potash mixture as it passes through the kiln would be diluted, as already pointed out, with a new constituent in the form of lime. In a third set of experiments, 3 g. of lime (CaO) were therefore mixed with each of the mixtures described in the first and second set of experiments and the ignitions again carried out under the same conditions as before. The results obtained are given in Table III.

TABLE III—EFFECT OF LIME AND OF CARBON ON THE COMBINATION OF POTASH WITH COAL ASH

| MIXTURE | K ₂ O in Percentage of Total in Mixture | | | | | | | | | | | | | | | |
|--|--|-------------------------------|----------------|-----------------|-------------------------------|----------------|------------------|-------------|-------|-------------------------------|----------------|------------|-------------|-------|-------------------------------|----------------|
| | Unignited | | | Ignited at 600° | | | Ignited at 1000° | | | Ignited at 1300° | | | | | | |
| | Water-soluble | Acid-soluble, water-insoluble | Acid-insoluble | Water-soluble | Acid-soluble, water-insoluble | Acid-insoluble | Water-soluble | | | Water-soluble | | | | | | |
| | | | | | | | In residue | Volatilized | Total | Acid-soluble, water-insoluble | Acid-insoluble | In residue | Volatilized | Total | Acid-soluble, water-insoluble | Acid-insoluble |
| Ash + K ₂ SO ₄ | 94 | | | 90 | 5 | 5 | 60 | 0 | 60 | 35 | 5 | 3 | 9 | 12 | 86 | 2 |
| Ash + K ₂ SO ₄ + Carbon..... | 94 | 2 | 4 | 90 | 2 | 9 | 28 | 0 | 28 | 54 | 18 | 18 | 26 | 44 | 50 | 6 |
| Ash + K ₂ SO ₄ + CaO..... | 94 | 2 | 4 | 93 | 1 | 9 | 86 | 12 | 98 | 2 | 0 | 21 | 66 | 87 | 11 | 2 |
| Ash + K ₂ SO ₄ + CaO + Carbon..... | 94 | 2 | 4 | 92 | 1 | 7 | 44 | 6 | 50 | 40 | 10 | 49 | 41 | 90 | 8 | 2 |
| Ash + K ₂ CO ₃ | 94 | 2 | 4 | 74 | 26 | 0 | 17 | 0 | 17 | 71 | 12 | 3 | 2 | 5 | 95 | 0 |
| Ash + K ₂ CO ₃ + Carbon..... | 94 | 2 | 4 | 73 | 27 | 0 | 29 | 0 | 29 | 38 | 34 | 24 | 15 | 39 | 61 | 0 |
| Ash + K ₂ CO ₃ + CaO..... | 94 | 2 | 4 | 95 | 5 | 0 | 86 | 14 | 100 | 0 | 0 | 25 | 65 | 90 | 4 | 6 |
| Ash + K ₂ CO ₃ + CaO + Carbon..... | 94 | 2 | 4 | 86 | 14 | 0 | 54 | 14 | 68 | 24 | 8 | 13 | 43 | 56 | 40 | 4 |

The proportion of potash taken for the experiments listed in Table III amounted to about 20 per cent of the unignited ash and potassium carbonate (or potassium sulfate) mixtures, or about 10 per cent when the mixture also contains lime. This would represent about the maximum ratio of potash to coal ash that would ordinarily be met with in any cement kiln. With a view to testing out the effect of using a smaller proportion of potash, a second series of experiments was run, using one-third as much potash as in the first series. The results are given in Table IV.

The analyses for water-soluble and total potash in the different mixtures as given in Tables III and IV were made by the official methods of the Association of Official Agricultural Chemists. The acid-soluble potash was determined by boiling for 1/2 hr. in a 5 per cent hydrochloric acid solution, using 75 cc. of acid per gram of ash taken. For the determination of water-soluble potash the old Official Method was used rather than the one adopted last year, as the former was more convenient for our purpose. Both of these methods, as well as that used for the acid-soluble potash, are entirely arbitrary and duplicate results are not likely to agree very closely unless the analyses are carried out each time in exactly the same way. When making the analyses care was therefore taken to follow the same procedure in each case as closely as possible.

The proportion of potash volatilized was determined by noting the difference between the total potash taken and the total remaining in the residue. In a similar way the acid-insoluble potash was found by taking the difference between the total in the residue and that which was acid-soluble. In cases where the values obtained by difference are small, any small change in either of the original values will produce a comparatively large difference in the result. The experimental error for acid-insoluble and volatilized potash was therefore rather large when the values represented by these determinations were low. For higher values and also for those values obtained by direct analysis closely agreeing results were obtained.

An examination of the values given in Tables III and IV will show that the results obtained with potassium sulfate did not differ in any very marked manner from those obtained with the carbonate, particularly when the ignitions were made at the higher temperatures. At 600° with the ash-potash mixture the carbonate is more reactive than the sulfate, but a noticeable combination takes place with both salts even at this temperature. At 1000° the extent of combination is

much more marked than at 600°, and at 1300° this is still greater than at 1000°. This tendency of the potash to combine with coal ash is so great that little or no loss of the former may occur even when ignited at 1300° for 40 min. It is to be noted also that in every case the extent of the combination was greater when the lower proportion of potash was used in the mixture.

The effect of adding carbon to the ash-potash mixture did not seem to have any pronounced effect on the results when considered as a whole. In this set of experiments, as in the first, the carbonate was more reactive than the sulfate at 600°, but both salts behaved in much the same way for the other temperatures. This would indicate that the potash combination is in the nature of a potash slag or impure glass rather than a sulfo-silicate. To test out the effect of using a siliceous material known to be entirely free from sulfur, a portion of the ash was ignited with carbon, treated with dilute hydrochloric acid, and the residue, which was then washed and dried, was ignited with potassium carbonate with and without carbon. Essentially the same results were obtained as before. These experiments thus furnish no evidence in favor of the view that the recombined potash in cement dust is in the nature of a sulfo-silicate.

The time of ignition of the experiments listed in Tables III and IV was 40 min. It was found, however, that the time of ignition could be shortened somewhat without much change in the results. Thus when the ash-potassium sulfate mixture given in Table IV was ignited for 10, 20, 30, and 40 min. the proportion of the added potash that underwent combination amounted to 82, 89, 91, and 93 per cent, respectively.

The addition of lime to the ash-potash mixture, as shown in Tables III and IV, brought about a decided change in the results as was to be expected. This basic constituent being less volatile than the alkalis, is able to replace the latter in their combinations with siliceous materials when ignitions of the mixtures are made at a sufficiently high temperature. It thus happened that the same results were obtained when coal ash and potassium sulfate (or carbonate) were first ignited at 1000° alone and then subsequently at the same temperature with lime as when but one ignition was made of all three compounds. In both cases the greater part of the potash remained or was obtained in a water-soluble form. In this set of experiments, however, as in the case of those made with ash and potash alone, the proportion of water-soluble potash in the

TABLE IV—EFFECT OF LIME AND OF CARBON ON THE COMBINATION OF POTASH WITH COAL ASH

| MIXTURE | K ₂ O in Percentage of Total in Mixture | | | | | | | | | | | | | | | |
|---|--|-------------------------------|----------------|-----------------|-------------------------------|----------------|------------------|-------------|-------|------------------|-------------|-------|----|----|----|----|
| | Unignited | | | Ignited at 600° | | | Ignited at 1000° | | | Ignited at 1300° | | | | | | |
| | Water-soluble | Acid-soluble, water-insoluble | Acid-insoluble | Water-soluble | Acid-soluble, water-insoluble | Acid-insoluble | Water-soluble | | | Water-soluble | | | | | | |
| | | | | | | | In residue | Volatilized | Total | In residue | Volatilized | Total | | | | |
| Ash + K ₂ SO ₄ | 84 | 4 | 12 | 59 | 16 | 25 | 12 | 0 | 12 | 37 | 51 | 2 | 10 | 12 | 52 | 36 |
| Ash + K ₂ SO ₄ + Carbon..... | 84 | 4 | 12 | 66 | 12 | 22 | 11 | 0 | 11 | 31 | 58 | 2 | 19 | 21 | 71 | 8 |
| Ash + K ₂ SO ₄ + CaO..... | 84 | 4 | 12 | 79 | 1 | 20 | 62 | 0 | 62 | 38 | 0 | 37 | 54 | 91 | 9 | 0 |
| Ash + CaO + K ₂ SO ₄ + Carbon.. | 84 | 4 | 12 | 71 | 7 | 22 | 62 | 0 | 32 | 47 | 21 | 26 | 39 | 65 | 14 | 21 |
| Ash + K ₂ CO ₃ | 84 | 4 | 12 | 47 | 46 | 7 | 4 | 0 | 4 | 84 | 12 | 2 | 1 | 3 | 45 | 52 |
| Ash + K ₂ CO ₃ + Carbon..... | 84 | 4 | 12 | 43 | 55 | 2 | 5 | 0 | 5 | 82 | 13 | 2 | 0 | 2 | 51 | 47 |
| Ash + K ₂ CO ₃ + CaO..... | 84 | 4 | 12 | 68 | 24 | 8 | 34 | 0 | 34 | 66 | 0 | 29 | 54 | 82 | 17 | 1 |
| Ash + K ₂ CO ₃ + CaO + Carbon. | 84 | 4 | 12 | 66 | 22 | 12 | 44 | 0 | 44 | 39 | 17 | 39 | 34 | 72 | 25 | 3 |

ignited residue was less with the lower than with the higher percentage of potash in the mixture.

When carbon was added to the ash-potash-lime mixtures, the proportion of water-soluble potash remaining after ignition was then found to be considerably below the corresponding values obtained without carbon. The effect of the carbon was thus to diminish the action of the lime in setting free or keeping in a water-soluble form the potash in the mixture. It was observed that ignition at 1300° for 40 min. reduced the ash-potash-lime mixture to a hard clinker, but when carbon was added and the mixture ignited as before in a closed vessel it remained as a powder and no clinking whatever took place. It would seem therefore that the presence of the carbon serves as a protective coating between the lime and the other constituents, thus diminishing at the same time the sintering of the mass and the action of the lime on the alkali silicates.

Further evidence in support of this view was furnished by igniting both with and without carbon a mixture of feldspar and lime in the proper proportion to make cement. Both mixtures were ignited for 1/2 hr. at the same temperature (1300°) in similar wrought-iron containers, excepting that the one containing the carbon was loosely closed at the top while the other was left open. After ignition, the carbon-free residue was found to be clinkered to a hard mass, while that containing the carbon remained as a fine powder. An analysis of each residue for water-soluble, acid-soluble, and acid-insoluble potash showed, as indicated in Table V, that the feldspar was decomposed to a much greater extent in the carbon-free mixture than in that to which carbon was added.

TABLE V—DECOMPOSITION OF FELDSPAR BY IGNITION WITH LIME WITH AND WITHOUT CARBON

| MIXTURE | K ₂ O in Percentage of Total in Mixture | | | | | |
|------------------------------|--|------|-------|-------------------------------|----------------|-----------------------------------|
| | Water-soluble | | Total | Acid-soluble, water-insoluble | Acid-insoluble | Total K ₂ O in mixture |
| In residue | Volatilized | | | | | |
| Feldspar + CaO... | 20.0 | 75.4 | 95.4 | 4.6 | 0.0 | 5.12 |
| Feldspar + CaO + Carbon..... | 23.5 | 18.2 | 41.7 | 43.4 | 14.9 | 5.12 |

This action of the carbon in decreasing the proportion of water-soluble potash furnishes an explanation of the results obtained by one of us when the Security and Cementon dusts were ignited first in open and then in closed vessels.¹ The latter dust differed from the former in containing a comparatively high percentage of free carbon amounting to 9.26 per cent of the dust. In the case of ignition in open vessels any carbon present would be burned off, limestone would be reduced to the oxide, and in the light of the results

obtained with the prepared mixtures it would be expected that a greater or smaller proportion of the recombined potash would therefore be set free, depending on the amount originally present. This was found to be true, for in the case of the Security dust, which contained 6.3 per cent of water-soluble and 11.4 per cent of total potash, the potash which was water-soluble was increased by ignition in an oxidizing atmosphere at 850° from 60 per cent to 95 per cent of the total present. The water-soluble potash in a sample of the Cementon dust on the other hand, which contained only 2.9 per cent of water-soluble and 7.0 per cent of total potash, was increased only from 41 to 73 per cent of the total by the same treatment.

The results obtained with the prepared mixtures also indicate that when a cement dust containing carbon is ignited in a closed vessel there would be less water-soluble potash in the residue than when ignited in an oxidizing atmosphere and that whether the treatment will actually bring about an increase or decrease in the water-soluble potash will depend on the relative proportion of water-soluble to recombined potash originally present in the dust. The experimental results in this case were likewise found to be in agreement with what was predicted. Thus when the Cementon dust, containing originally 9.6 per cent of free carbon, was ignited at 850° for 40 min., the water-soluble potash was actually decreased from 41 to 30 per cent of the total, while in the richer Security dust when the same amount of carbon was added and ignited in the same way the water-soluble potash was increased from 60 to 65.4 per cent.

In view of the foregoing observations it would seem probable that the proportion of recombined potash in those dusts which contain free carbon might be reduced to some extent if more of an oxidizing atmosphere were maintained in the kilns during the burning of the cement.

From the experiments described it might also be predicted that the addition to the raw mix of a salt of sodium, as sodium chloride, would bring about a reduction of the recombined potash as has actually been observed at the plant of the Security Cement and Lime Company. It is known that when sodium chloride is ignited with feldspar a replacement of the potash in the feldspar by the soda takes place,¹ showing that the sodium aluminum silicate formed is more stable when ignited with potash than is the corresponding potash salt in the presence of soda. When sodium chloride

¹ A. R. Merz, *This Journal*, 10 (1918), 106.

¹ H. P. Bassett, U. S. Patent No. 1,072,686.

occurs in the dust of a cement kiln there is, therefore, likely to be a replacement of the recombined potash in a way analogous to that brought about by lime.

RECOMBINATION OF VOLATILIZED POTASH WITH THE SILICEOUS PARTICLES OF THE RAW MIX

As already pointed out in Tables III and IV, very little combination of potash with coal ash takes place in the carbon-free mixtures when lime is present and the proportion combined is less in the higher than in the lower potash mixtures. It would be expected, therefore, that since lime is intimately mixed with the silicates of the raw mix in cement manufacture there would be only a limited recombination, in an oxidizing atmosphere, of the volatilized potash with the siliceous particles of the raw mix. In the presence of carbon the extent of recombination might be expected to be somewhat greater. To gain further experimental evidence on this point portions of a sample of raw mix from the Security Cement and Lime Company were ignited at 1000° to drive off carbon dioxide and then with different proportions of potassium sulfate with and without carbon. The results, as shown in Table VI, are in keeping with what was expected from the preceding experiments.

TABLE VI—COMBINATION OF POTASH ON IGNITION WITH CEMENT RAW MIX

| MIXTURE | K ₂ O in Percentage of Total in Mixture | | | K ₂ O in Percentage of Total in Mixture | | |
|--|--|--------------|----------------|--|--------------|----------------|
| | Before Ignition | | | After Ignition | | |
| | Water-soluble | Acid-soluble | Acid-insoluble | Water-soluble | Acid-soluble | Acid-insoluble |
| Raw Mix + K ₂ SO ₄ ... | 96.4 | 2.0 | 1.6 | 92.4 | 7.3 | 0.3 |
| Raw Mix + Carbon... | 96.4 | 2.0 | 1.6 | 83.0 | 15.5 | 1.5 |
| Raw Mix + K ₂ SO ₄ ... | 90.1 | 5.6 | 4.3 | 76.8 | 21.4 | 1.8 |
| Raw Mix + Carbon... | 90.1 | 5.6 | 4.3 | 30.3 | 64.3 | 5.4 |

Further evidence with regard to the recombination of volatilized potash with the raw mix was shown in experiments with dust from the Riverside Portland Cement Company, where oil is used for fuel. The total potash in the sample amounted to 10.65 per cent of the dust and the water-soluble potash to 91.61 per cent of the total. On igniting the dust alone at 1000° for 40 min. there was an actual increase in water-soluble potash which now amounted to 94.8 per cent of the total. When ignited with carbon, however, the water-soluble potash decreased to 70.4 per cent of the

TABLE VII—RECOMBINATION OF POTASH IN RIVERSIDE DUST WITH AND WITHOUT ADDED COAL ASH

| MIXTURE | K ₂ O in Percentage of Total in Mixture | | | | | | | | | |
|--|--|--------------|----------------|------------------|-----|------|--------------|----------------|--|--|
| | Unignited | | | Ignited at 1000° | | | | | | |
| | Water-soluble | Acid-soluble | Acid-insoluble | Water-soluble | | | Acid-soluble | Acid-insoluble | | |
| | | | | In | r | e | Volatilized | Total | | |
| Riverside dust + Carbon..... | 91.6 | 6.9 | 1.5 | 94.8 | 3.3 | 98.1 | 1.9 | 0.0 | | |
| Riverside dust + Carbon..... | 91.6 | 6.9 | 1.5 | 70.4 | 6.9 | 77.3 | 10.2 | 12.5 | | |
| Riverside dust + Ash..... | 78.3 | 9.4 | 12.3 | 62.9 | 1.2 | 64.1 | 27.1 | 8.8 | | |
| Riverside dust + Ash + Carbon | 78.3 | 9.4 | 12.3 | 9.6 | 5.2 | 14.3 | 79.7 | 5.5 | | |
| Riverside dust + 1/2 Ash..... | 86.7 | 7.8 | 5.5 | 86.8 | 3.5 | 90.3 | 9.7 | 0.0 | | |
| Riverside dust + 1/2 Ash + Carbon..... | 86.7 | 7.8 | 5.5 | 70.0 | 7.0 | 77.0 | 20.4 | 2.6 | | |

total, showing that a combination took place to some extent between the soluble potash naturally occurring in the dust with the siliceous material which originally came from the raw mix. When the acidity of the dust was increased by the addition of coal ash and the mixture ignited as before, the extent of the recombination of the potash in the dust was much more marked, as was anticipated, than in the corresponding experiments

without ash. This is shown by the values given in Table VII which represent the results obtained when one part of dust was ignited with an equal weight of dust alone and than with 1/2 part of carbon.

ACID-SOLUBLE POTASH FROM PARTIALLY DECOMPOSED SILICATES IN THE DUST

In the dust from a cement plant there may be found different particles that have been subjected to all the variations of temperature that prevail in the different parts of the kiln. It thus happens that of those potash silicates which ultimately are carried over into the dust a certain fraction has been ignited sufficiently to be completely decomposed, while a further portion has undergone no decomposition at all. Between these extremes are to be found silicates which have been subjected to intermediate temperatures of burning and in consequence must have undergone a more or less partial decomposition. It therefore occurred to us that while the potash in such partially decomposed silicates might not be readily water-soluble, it might, however, be slowly water-soluble or readily soluble in acids and thus behave in a way similar to the recombined potash of cement dust. To test this point, uniform mixtures of feldspar and lime in the right proportion to make cement were ignited in a platinum dish for different lengths of time at 1000°, and again at 1300°.

TABLE VIII—SOLUBILITY OF POTASH IN FELDSPAR PARTIALLY DECOMPOSED BY IGNITION WITH LIME

| Time of Ignition Min. | K ₂ O in Percentage of Total in Mixture | | | | | | | |
|-----------------------|--|--------------|----------------|------------------|------|-------|--------------|----------------|
| | Ignited at 1000° | | | Ignited at 1300° | | | | |
| | Water-soluble | Acid-soluble | Acid-insoluble | Water-soluble | | Total | Acid-soluble | Acid-insoluble |
| | | | In residue | Volatilized | | | | |
| 15..... | 10.5 | 33.2 | 56.3 | 34.0 | 8.6 | 42.6 | 55.1 | 2.3 |
| 30..... | 9.4 | 43.0 | 47.6 | 32.8 | 57.8 | 90.6 | 7.4 | 2.0 |
| 45..... | 7.8 | 50.8 | 41.4 | 8.2 | 89.1 | 97.3 | 2.7 | 0.0 |

It was found, as shown by the results given in Table VIII, that the residue obtained in each experiment contained both water- and acid-soluble potash. When the ignition was made at 1300° for 45 min. the greater part of the potash was volatilized and no acid-insoluble potash remained in the residue. When ignited at 1000° the residue contained some acid-insoluble potash, but the greater part was in a form soluble in dilute acid but insoluble in water. It may be concluded, therefore, that the greater part of the acid-soluble potash in the dust from oil- or gas-fired kilns is due to a partial decomposition of the potash silicates originally occurring in the raw mix. In the dust from coal-fired kilns a corresponding percentage of the potash will be acid-soluble for the same reason; but because the quantity of this potash is limited by the total in the raw mix and also because of the recombined potash that may be present, this acid-soluble potash, due to the partially decomposed silicate, may amount to only a comparatively small percentage of the total acid-soluble potash present in the dust.

SUMMARY

1—The water-soluble potash in cement dust owes its source (a) to the volatilization of potash in the burning of the cement, (b) to the decomposition of pot-

ash silicates of the raw mix carried over mechanically in the dust, and (c), in the case of coal-fired kilns, to the ash of the coal which may yield up a portion of its potash through the action of the lime in the dust. The first-mentioned source is ordinarily much the most important.

2—The water-insoluble but acid-soluble potash of cement dust is due (a) to a recombination of a portion of the volatilized potash with the ash of the coal used for fuel, (b) to a recombination to a much smaller extent, and only under certain conditions, with the siliceous material originally occurring in the raw mix, and (c), to a partial decomposition of the silicates of the raw mix and also of any coal ash which is carried over mechanically in the dust.

3—The acid-insoluble potash in cement dust is due to undecomposed silicates and coal ash carried over mechanically in the dust and to a recombination of the volatilized potash with the ash of the coal when the amount volatilized is low.

4—The portion of the potash in the dust which has undergone recombination is of the nature of a potash slag or impure glass. When the amount of potash volatilized is low, and particularly in the presence of carbon, some recombination may take place with the siliceous material of the raw mix as well as that of the ash.

5—It is probable that the extent of the recombination would be reduced if the burning of the cement were done under oxidizing rather than reducing atmospheric conditions.

6—The extent of recombination would also probably be reduced by any procedure that would introduce lime or sodium chloride into the dust at the hottest part of the kiln.

7—The greater the amount of potash volatilized, the lower will be the proportion that will undergo recombination in the dust.

BUREAU OF SOILS
U. S. DEPT. OF AGRICULTURE
WASHINGTON, D. C.

LABORATORY AND PLANT

RESULTS OF FURTHER COÖPERATIVE WORK ON THE DETERMINATION OF SULFUR IN PYRITE CHECK SAMPLE NO. 4¹

By H. C. MOORE

The July 1915 and December 1916 numbers of THIS JOURNAL contain reports of the coöperative analyses of pyrite for sulfur. This report may be regarded as covering a continuation of the work described in the former reports.

The first two reports pointed out anew several sources of error in this determination, especially in connection with the Lunge method and its various modifications. They also proved the Allen and Bishop Method to be practically free from these errors, and the results by

this latter method to be much nearer the truth, and while the discrepancy between the maximum and minimum results was rather wide, by excepting a few results, evidently extreme, the agreement was uniformly better.

The purpose of the investigation covered by this report was to continue the work, using only one sample, to invite a larger number of laboratories to participate, to search for the weaknesses, if any, in the Allen and Bishop Method, and to acquaint a larger number of analysts with this method. There was a very generous response to the invitation, and results were received from thirty-nine (39) laboratories, including the work of fifty-one (51) analysts, as follows:¹

C. Clifton Howes
J. M. Coleman
W. E. Dickinson
Gascoyne and Company
Paul Rudnick (analysts W. J. Imig, R. A. Greene)
J. O. Holbrook
Wiley and Company
F. F. Chapman
L. C. Drefahl (results from eight (8) branch laboratories)
P. R. Sabin
W. R. Austin and F. K. Wanner
W. S. Allen (results of four analysts)
C. A. Butt
E. Fitzpatrick (results of two analysts)
W. J. Rattle and Son
A. Stanley Fox
C. C. Nitche
V. A. Moore
Harry Johnson
J. A. Root
Crowell and Murray
W. D. Richardson (result of four analysts)
C. B. McComas
F. J. Bartholomew
McCandless Laboratory
M. H. Coblenz
E. W. Magruder and J. H. Parkins
C. N. Hoadley
Hardee Chambliss
H. M. George
N. F. Borg
H. C. Moore
R. D. Caldwell
H. M. Hutson
J. D. Clark, Jr.
S. Brown

Davison Chemical Company
Planters Fert. and Chem. Company
International Agl. Corporation
Gay Street
Armour and Company
Southern Fert. and Chem. Company
Gay Street
E. I. du Pont de Nemours and Company
Grasselli Chemical Company

American Zinc Company of Illinois
Tennessee Chemical Company
General Chemical Company
International Agl. Corporation
Nichols Copper Company
501 Commercial Bank Building
Aetna Explosives Company
Mineral Point Zinc Company
Armour Fertilizer Works
Standard Oil Company
Anaconda Copper Mining Company
406-11 Perry-Payne Building
Swift and Company
Armour Fertilizer Works
N. J. Zinc Company of Illinois
Rhodes Building
F. S. Royster Guano Company
F. S. Royster Guano Company
Mountain Copper Company
Commercial Acid Company
Empire Zinc Company
Butterworth-Judson Company
Armour Fertilizer Works
Armour Fertilizer Works
Armour Fertilizer Works
Armour Fertilizer Works
Armour Fertilizer Works

Baltimore, Md.
New Orleans, La.
Columbia, Tenn.
Baltimore, Md.
Chicago, Ill.
Savannah, Ga.
Baltimore, Md.
Wilmington, Del.
Cleveland, Ohio

E. St. Louis, Ill.
Nashville, Tenn.
Laurel Hill, N. Y.
Atlanta, Ga.
Laurel Hill, N. Y.
Cleveland, Ohio
New York, N. Y.
Depue, Ill.
Chrome, N. J.
Bayonne, N. J.
Anaconda, Mont.
Cleveland, Ohio
Chicago, Ill.
Baltimore, Md.
Palmerton, Pa.
Atlanta, Ga.
Macon, Ga.
Norfolk, Va.
Martinez, Cal.
E. St. Louis, Ill.
Canon City, Col.
New York, N. Y.
Atlanta, Ga.
Atlanta, Ga.
Atlanta, Ga.
Atlanta, Ga.
Atlanta, Ga.

¹ Presented before the Fertilizer Division at the 56th Meeting of the American Chemical Society, Cleveland, September 10 to 13, 1918.

¹ Not listed in the same order as given in the subsequent tabulation of results.

The sample used for this work, designated as Check Sample No. 4, is a Canadian pyrite. A large sample was ground to pass an 80-mesh screen and very carefully mixed for a considerable length of time so as to insure uniformity. The sample was then spread out in a thin layer and individual bottles filled by taking small portions from several places. The bottles were tightly stoppered and sealed. It is confidently believed that the samples sent out were uniform and that discrepancies in results are not due to non-uniformity of samples. This opinion is confirmed in part by the results obtained by five analysts in this laboratory on five separate sealed portions, which results appear in Table II. This opinion is further confirmed by the fact that the agreement between most of the laboratories familiar with the modified Allen and Bishop method is very close.

The instructions accompanying the sample were as follows:

INSTRUCTIONS FOR COLLABORATORS IN COÖPERATIVE WORK ON THE DETERMINATION OF SULFUR IN PYRITE

SAMPLE

The sample for this work is marked No. 4, is a sample of Canadian ore, and has been ground to pass an 80-mesh screen and requires no further preparation.

MOISTURE

Dry 5 g. in an oven at 100° C. for one hour.

SULFUR

METHOD I. MODIFIED ALLEN AND BISHOP METHOD—Transfer 0.5495 g. to a tall form beaker, 300 to 400 cc. capacity, and add 6 to 8 cc. of a mixture of 2 parts by volume of liquid bromine and 3 parts carbon tetrachloride. Cover beaker, and after allowing to stand for 15 min. at room temperature, with occasional shaking, add 10 cc. concentrated nitric acid and let stand at room temperature with occasional shaking for 15 min. longer. Heat below 100° (placing beaker on a piece of asbestos on top of the steam bath is convenient), until all action has ceased and most of the bromine has been expelled. Now place the beaker in the rings of the steam bath and evaporate to dryness. (Evaporation is greatly hastened by raising the cover glass with one or more bent glass rods.) Cover residue with 10 cc. concentrated hydrochloric acid and again evaporate to dryness, keeping beaker covered as before.

DEHYDRATE THE SILICA by leaving the beaker on the steam bath, or in an air bath at 100° C. for from 1/2 to 1 hr.

EFFECT SOLUTION by moistening the residue with 1 cc. concentrated hydrochloric acid followed by 50 cc. hot water and rinse down cover, riders, and sides of beaker. Remove riders, replace cover glass, and warm until solution is complete. Then allow to cool for about 3 min.

REDUCE IRON by adding 0.1 g. of powdered aluminum and shaking beaker (covered) to thoroughly mix with the liquid. (Sufficient aluminum powder must be added for complete reduction of the iron but any considerable excess is to be avoided. Subsequent filtration is facilitated by having the excess aluminum small.) When reduction to ferrous iron is complete, as indicated by the color of the solution, and the latter has cooled sufficiently so that no "misting" is noted in the beaker, rinse down cover glass and sides of beaker.

FILTER to remove insoluble matter, or excess aluminum powder, through an 11 cm. or 12 1/2 cm. paper (B and A, grade A, S and S 590, or Munktell No. 0) into an 800 cc. beaker and wash the residue thoroughly with hot water.

DILUTE the filtrate to a volume of 650 cc. with cold water,

add 2 1/2 cc. concentrated hydrochloric acid, and stir to mix thoroughly.

PRECIPITATE sulfate by adding 50 cc. of cold 5 per cent barium chloride solution, without stirring, and in single drops at the rate of about 5 cc. per min. A precipitating cup, designed by Allen and Bishop, or a capillary tube connected to a burette or suitable container is convenient for this purpose. When the barium chloride has been added, mix the solution by stirring, and let settle for 2 hrs. or, preferably, over night.

FILTER through a No. 4 porcelain Gooch crucible (35 cc. capacity) having a fixed bottom and packed with a thick layer of asbestos. After the clear liquid has run through the filter, rinse the precipitate into the crucible by means of a stream of cold water, thoroughly police the inside of the beaker and after transferring all of the precipitate wash 6 times in the crucible with cold water.

DRY THE PRECIPITATE in the drying oven for about 1/2 hr. A longer period of drying is a protection against breaking the crucible during the subsequent ignition, also against spattering of the precipitate.

IGNITE THE PRECIPITATE by heating the crucible in a moderate flame for a minute or two, then igniting to constant weight over the full flame of a Fletcher, Meeker, or similar burner, or in an electric furnace at 1600° F.

THE PER CENT OF SULFUR is found by dividing the weight in grams of barium sulfate by 4 and multiplying by 100.

NOTE—An electric hot plate, having suitable temperature control, is a convenient substitute for a steam bath, but the surface temperature of the plate should not much exceed 100° C. else some of the free sulfuric acid is lost by volatilization.

METHOD II—Follow your usual methods and describe briefly the details used.

NOTES

1—Run a blank test to determine and correct for any sulfur present in the reagents used. The bromine and carbon tetrachloride should be tested before using, as some lots of these reagents marked C. P. have been found to contain considerable amounts of sulfur compounds. Baker and Adamson's make of these reagents, marked pure, and specified to be free from sulfur compounds, have been found satisfactory.

2—For packing Gooch crucibles, long fibered Italian asbestos (if obtainable) which has been prepared by scraping up into lint and digesting with strong hydrochloric acid to remove impurities, is especially recommended.

3—The method of Allen and Bishop as originally presented by the authors may be found among the original communications, *Eighth International Congress of Applied Chemistry*, Vol. 1, pp. 33 to 51.

4—When igniting the barium sulfate it is advisable to observe the precaution proposed by Folin.¹ To avoid mechanical loss the crucible should be provided with a cover and bottom. If a porcelain Gooch crucible is used the cover for a platinum crucible may serve as a bottom, the crucible resting on the platinum lid which is supported by a triangle. The flame is applied to the platinum lid. Folin states that unless this precaution is observed, mechanical loss of barium sulfate follows.

REMARKS

1—Please supplement your report with any comments you care to make.

2—When reporting results please give individual results as well as averages and in order that there may be no misunderstanding report moisture, sulfur (wet basis), and sulfur (dry basis).

3—Please state whether or not you have had previous experience with the Allen and Bishop method, either as originally proposed or as slightly modified under Method I above. Also state if you have found any difficulties or objectionable features

¹ *J. Biol. Chem.*, 1 (1906), 149.

TABLE I—PYRITE CHECK SAMPLE NO. 4 PER CENT SULFUR ON DRY BASIS

| ANALYST No. | H ₂ O Per cent | Mod. | | Orig. A. and B. Lunge | Mod. A. and B. Lunge | | Misc. A. and B. | Mod. Misc. | ANALYST No. | H ₂ O Per cent | Mod. A. and B. Lunge | | Misc. A. and B. | Mod. Misc. |
|-------------|---------------------------|-----------|----|-----------------------|----------------------|----------|-----------------|------------|--|---------------------------|----------------------|--|-----------------|------------|
| | | A. and B. | B. | | A. and B. | B. | | | | | A. and B. | B. | | |
| 1..... | 0.02 | 41.28 | | 41.31 | ... | ... | ... | ... | 34..... | 0.21 | 41.92 | ... | ... | ... |
| 2..... | 0.14 | 41.42 | | 41.09 | ... | ... | ... | ... | 35..... | 0.24 | 41.92 | ... | 42.14 | ... |
| 3..... | 0.23 | 41.44 | | ... | ... | ... | ... | ... | 36..... | 0.16 | 41.96 | ... | 41.30 | ... |
| 4..... | 0.24 | 41.49 | | ... | 41.39(b) | ... | 41.27(a) | ... | 37..... | 0.25 | 41.96 | ... | 41.54 | ... |
| 5..... | 0.22 | 41.51 | | ... | ... | ... | ... | ... | 38..... | 0.12 | 41.98 | 41.90 | ... | ... |
| 6..... | ... | 41.51 | | 41.60 | ... | ... | ... | 41.35(c) | 39..... | 0.12 | 41.99 | ... | 41.49 | ... |
| 7..... | 0.20 | 41.53 | | ... | ... | ... | ... | ... | 40..... | 0.19 | 41.99 | ... | 41.17 | ... |
| 8..... | 0.21 | 41.54 | | 41.56 | ... | ... | ... | ... | 41..... | 0.13 | 42.03 | ... | 40.06(m), (s) | 42.34(l) |
| 9..... | ... | 41.55 | | ... | ... | ... | ... | 41.62(d) | 42..... | 0.07 | 42.09 | 42.15 | ... | ... |
| 10..... | 0.17 | 41.60 | | 41.63 | ... | ... | 41.66(e) | ... | 43..... | 0.18 | 42.11 | 42.18 | ... | ... |
| 11..... | 0.21 | 41.66 | | ... | ... | 41.66(e) | 41.94(f) | ... | 44..... | 0.08 | 42.36 | 41.95 | ... | ... |
| 12..... | 0.16 | 41.68 | | ... | 40.90(g), (s) | 41.40(h) | ... | ... | 45..... | 0.21 | 42.39 | ... | ... | 42.34(o) |
| 13..... | 0.18 | 41.68 | | ... | ... | ... | ... | ... | 46..... | 0.11 | 42.50 | ... | 40.96(p) | ... |
| 14..... | 0.18 | 41.68 | | 41.78 | ... | ... | ... | ... | 47..... | 0.17 | ... | ... | ... | 41.90(q) |
| 15..... | 0.21 | 41.69 | | ... | ... | ... | ... | ... | 48..... | 0.03 | ... | 41.51 | ... | ... |
| 16..... | 0.27 | 41.70 | | 41.65 | ... | ... | ... | ... | 49..... | 0.25 | ... | ... | 41.25(r) | ... |
| 17..... | 0.17 | 41.71 | | ... | ... | ... | ... | ... | 50..... | 0.12 | ... | 41.51 | ... | ... |
| 18..... | 0.21 | 41.71 | | ... | ... | ... | ... | ... | 51..... | 0.10 | ... | 41.71 | ... | ... |
| 19..... | 0.13 | 41.71 | | 41.84 | ... | ... | ... | ... | AVERAGE, | 0.16 | ... | ... | ... | ... |
| 20..... | 0.23 | 41.72 | | ... | ... | ... | ... | 41.89(c) | SUMMARY OF RESULTS OBTAINED BY 51 ANALYSTS IN 39 LABORATORIES | | | | | |
| 21..... | 0.16 | 41.73 | | 41.51 | ... | ... | ... | 41.99(i) | Method of Analysis | Allen and Bishop Mod. | Origin. | Misc. Modifications of A. and B. Lunge | Misc. Methods | |
| 22..... | 0.21 | 41.73 | | ... | ... | ... | ... | ... | No. analysts..... | 46 | 19 | 4 | 12 | 9 |
| 23..... | 0.17 | 41.74 | | ... | ... | ... | ... | ... | No. laboratories..... | 36 | 15 | 3 | 10 | 8 |
| 24..... | 0.17 | 41.76 | | ... | ... | ... | ... | ... | Maximum..... | 42.50 | 42.18 | 41.94 | 42.14 | 42.34 |
| 25..... | 0.22 | 41.77 | | ... | ... | ... | ... | ... | Minimum..... | 41.28 | 41.09 | 41.25 | 40.96 | 41.35 |
| 26..... | 0.12 | 41.79 | | 41.74 | ... | ... | ... | ... | Average..... | 41.80 | 41.70 | 41.53 | 41.44 | 41.89 |
| 27..... | 0.02 | 41.81 | | 41.74 | ... | ... | ... | ... | It is interesting to note that of the 46 results reported by the modified Allen and Bishop method: | | | | | |
| 28..... | 0.13 | 41.81 | | 41.78 | ... | ... | ... | 41.79(j) | 36 are between 41.50 and 42.00 incl. and average 41.82 | | | | | |
| 29..... | 0.10 | 41.83 | | 41.69 | ... | ... | ... | ... | 22 are between 41.60 and 41.90 incl. and average 41.74 | | | | | |
| 30..... | 0.12 | 41.86 | | ... | ... | ... | ... | ... | 19 are between 41.65 and 41.85 incl. and average 41.73 | | | | | |
| 31..... | 0.16 | 41.86 | | ... | ... | ... | ... | ... | | | | | | |
| 32..... | 0.10 | 41.92 | | 41.73 | ... | ... | ... | ... | | | | | | |
| 33..... | 0.12 | 41.92 | | 41.59 | ... | ... | ... | ... | | | | | | |

(a) Practically same as modified A. and B. except CCl₄ omitted and precipitation done in smaller volume.

(b) Nitro-hydrochloric acid together with bromine and CCl₄ used to effect solution and then analysis completed by Lunge method.

(c) No details of method given.

(d) 0.458 g. in 250 cc. copper assay flask with 10 cc. H₂O, 10 cc. CCl₄, 15 cc. each HCl and HNO₃ saturated with bromine and all at 40° and let stand at room temperature for 15 min. Heat very gradually and evaporate to 5 cc. Add 5 cc. HCl and 5 g. NH₄Cl and heat until bubbling ceases. Add 5 cc. HCl, 25 cc. H₂O, boil, filter, dilute to 200 cc., and to this solution heated to boiling, add slowly 25 cc. of a boiling solution of 10 per cent barium chloride and 150 cc. H₂O. Boil 5 min., settle 45 min in warm place, filter, etc., Wt. × 30 = per cent S.

(e) 0.5495 g. dissolved in 30 cc. HNO₃, 10 cc. HCl, and 0.2 to 0.3 g. KClO₃ in 325 cc. Kjeldahl flask. Room temperature at first, finally increasing heat until residue is paste, add 10 cc. HCl and evaporate as before, repeat twice. Add 2 cc. HCl and 50 cc. water, reduce with aluminum powder, and finish as by modified A. and B.

(f) Same as (e) except using NaBrO₃ instead of KClO₃.

(g) Solution by Lunge method using HNO₃ and HCl.

(h) Solution by A. and B. method, completing analysis by Lunge method.

(i) Average of results by (s) modifications of combined A. and B. and regular method.

(j) 0.5 g. in No. 3 beaker, add few drops H₂O and 1 g. KClO₃ and mix. Add 20 cc. HNO₃, cover and let stand cold 20 min., then add 20 cc. nitric chloride mixture and place on steam plate and heat until solution is complete. Rinse down cover and sides of beaker and evaporate to dryness. Evaporate twice more with HCl. Add 25 cc. 1 : 3 HCl and heat for 40

min. Filter and make ammoniacal while hot but do not heat. Have volume 300 cc. and add excess BaCl₂ solution. Add HCl to dissolve iron precipitate and stir thoroughly, but do not boil. Let stand over night, filter, etc.

(k) 0.2727 g. dissolved in 250 cc. beaker about same as in (j) and after evaporation take up in 12 cc. HCl and heat until foaming ceases. Then dilute until beaker is about 2/3 full, heat and precipitate with 25 cc. hot 10% BaCl₂ solution. Boil few minutes and filter after 1/2 hr.

(l) 0.625 g. in 250 cc. flask, 1/2 to 1 cc. bromine added, 15 cc. HNO₃ and 5 cc. HCl. Let stand at room temperature for about 15 min., and heat 2-3 hrs. on water bath. Add 25 cc. HCl, heat until solution is complete, make to volume and take 100 cc. aliquot, dilute to about 250 cc., nearly neutralize with NH₄OH, boil, add NH₄OH to slight excess, boil off excess of NH₃, add BaCl₂ slowly with stirring, and boil a few minutes. Add slowly excess HCl, boil few minutes, and let stand 3 to 5 hrs. or over night, filter, etc.

(m) Modified Lunge method solution in HNO₃ and HCl.

(n) Same as (m) except bromine added with HNO₃ and HCl.

(o) Same as (l) except used 0.5 g. sample.

(p) Same as (m) except made solution in HNO₃, HCl, and KClO₃.

(q) No description given of method used.

(r) Sample dissolved in 1/2 g. KClO₃ and 10 cc. HNO₃ saturated with KClO₃, cover beaker, and quickly bring to boil. Evaporate finally at low heat. Evaporate again with 10 cc. HCl. Take up with 2 cc. HCl and 60 to 75 cc. H₂O, and reduce iron with granular aluminum. Filter and dilute to 300 cc., add 5 cc. HCl, boil and precipitate hot with 10 per cent BaCl₂ solution, added slowly and with stirring. Let settle 1 1/2 hrs., filter, etc.

(s) Omitted from average.

in this method and how you regard it as compared to other methods.

4—Considerable time and work are required to properly arrange and classify a large number of results for easy reference and you are urgently requested to make your report by August 1 or as soon thereafter as possible.

ATLANTA, GA., June 1917

The results received from the thirty-nine (39) laboratories appear in Table I.

It is somewhat disappointing that the discrepancy between the maximum and minimum results by the modified Allen and Bishop method is so great, but as noted in the Summary of Table I, by omitting the extreme results, the agreement becomes very good indeed, and the average remains practically the same. It may be further stated that the results of those analysts who are thoroughly familiar with the original or the modified Allen and Bishop method are in very close agreement. The variation from the average by the modified Allen and Bishop method was, with but very few exceptions, not to exceed, plus or minus, 0.25 per cent sulfur. While the maximum discrepancy by the Lunge method is not so great as by the modified

Allen and Bishop method, yet the agreement by the latter method, with few exceptions, is much closer. It seems to be true in this case, as in most others which the writer has observed, that in the analysis of check samples, when the same method or apparently the same details of analysis are employed, elimination of a few of the extreme results does not affect the average.

The reasons for the discrepancies by the original or modified Allen and Bishop method have not been apparent. Except in a few cases, the observance of the following recommendations will probably eliminate most of these:

1—In the oxidation and solution of the sample the initial reaction should not be allowed to proceed too rapidly and sufficient time should be allowed to elapse after adding the bromine and carbon tetrachloride mixture. Several have recommended that the time of standing be increased from 15 to 30 min. It has also been shown that evaporation at too high temperature and allowing the beaker to remain on the hot plate at this high temperature causes loss of free sulfuric acid.

2—Carbon tetrachloride and some lots of bromine often contain some sulfur compounds, causing high blanks which are undesirable. Several have recom-

mended that glacial acetic acid be substituted for carbon tetrachloride as a carrier for the bromine, as this can be obtained absolutely free from sulfur more generally than carbon tetrachloride.

3—Care should be taken in the ignition of the barium sulfate in Gooch crucibles. One laboratory reported a long series of results showing the effect of different periods of heating, indicating clearly that barium sulfate underwent decomposition. This is probably true only in rare cases. Some laboratories observe the precaution, after the ignition of the barium sulfate, of adding a drop or two of strong sulfuric acid and again igniting. One laboratory reported a long series of results, showing a continued loss in weight following several periods of ignition. Folin¹ refers to this and recommends that when Gooch crucibles are used, they be protected from direct action of the flame by setting the crucible on a platinum lid or some similar arrangement. Ignition in this manner and over a direct flame have yielded the same results in our laboratory. It seems likely that the error in personal manipulation is the cause of some of the discrepancies in the extreme results, though just how, or at what stage in the analytical procedure, is not known. In this laboratory uniform results have always been obtained both by the original and modified Allen and Bishop methods, the latter being preferred. The figures in Table II illustrate this uniformity.

TABLE II—RESULTS OBTAINED ON PYRITE SAMPLE No. 4 IN LABORATORY OF ARMOUR FERTILIZER WORKS, ATLANTA, BY THE MODIFIED ALLEN AND BISHOP METHOD

| By whom analyzed, etc. ¹ | H ₂ O Per cent | Sulfur (DB) Per cent | |
|---|------------------------------|--|-----------|
| Analyst "A" Thoroughly familiar with method..... | 0.21 | 41.69 41.68 41.65 41.68 41.68 41.74 | Av. 41.69 |
| Analyst "B" Man who makes most of the sulfur determinations..... | 0.18 | 41.72 41.71 41.67 41.67 41.63 | Av. 41.68 |
| Analyst "C" Had made previously a few determinations by this method..... | 0.21 | 41.68 41.69 41.75 | Av. 41.71 |
| Analyst "D" A new man who had never seen or used the method before but who had used the Lunge method..... | 0.17 | 41.68 41.81 41.76 | Av. 41.77 |
| Analyst "E" A colored helper who has only once before made a determination by this method. He is a careful worker and able to follow instructions intelligently..... | 0.17 | 41.67 41.78 41.81 41.68 | Av. 41.74 |

¹ Each man selected a separate sealed bottle of sample, worked at different times and entirely independently, and followed strictly the details given. The individual results reported above include all that were obtained. No single result was omitted. The maximum difference between 22 results on 5 separate samples by 5 analyses is 0.18 per cent and the maximum difference between results on 3 samples by 3 men who had had previous experience with the method is 0.12 per cent.

It would be interesting to know at which step or steps in the analytical procedure errors are most likely to creep into the work, so that the necessary precautions could be pointed out generally and applied. The writer's rather extensive experience with the method has failed to disclose sources other than those included in the three mentioned above. In order to discover, if possible, other causes and at just what stage or stages these errors occur, the following plan was proposed in a report sent out several months ago to all collaborators:

¹ *J. Biol. Chem.*, 1 (1906), 273.

That a sample of sulfuric acid, approximately half normal, or of such strength that 50 cc. would equal 2 g. of barium sulfate, be sent out and that the following tests on this solution be made:

A—Titrate 50 cc. against pure sodium carbonate, and against any other standard solutions you may have.

B—Precipitate 50 cc. after dilution directly with barium chloride solution, cold, as by the Allen and Bishop method.

C—Add to 50 cc. of the solution ferric chloride about equal to the iron equivalent of pyrite, evaporate to dryness, and finish as by the modified Allen and Bishop method.

D—Add to 50 cc. of the solution ferric chloride as above, reduce directly with aluminum powder, and finish as by the modified Allen and Bishop method.

Results by the above procedure would check up the method in all of the important stages and should serve to help to point out at what stage in the analytical operation most of the errors creep in. There are some objections to this scheme, for example, the errors in measuring exact portions, but with a carefully calibrated pipette the errors for measuring would be so small as compared to the errors in results on pyrite samples that this objection would not be so important. The accuracy of the measured portions could be confirmed by weighing.

The response to this proposal was not very general, owing to present conditions and pressure of regular work. Such a plan of cooperative work would check up the analytical scheme in its various stages and should, it seems, show each analyst the main cause of his discrepancies. If the interest seems sufficient to warrant the effort, this plan may be proposed again at a later date.

TABLE III—SUMMARY OF RESULTS FROM 15 OF THE 17 COLLABORATORS—1915

| | A and B Method Sample No. 15095 | | Miscellaneous Modifications and Lunge Method Sample No. 15096 | |
|---|------------------------------------|------------------|--|------------------|
| | No. 15095 | Sample No. 15096 | No. 15095 | Sample No. 15096 |
| Number of analyses | 6 | 6 | 18 | 17 |
| Max. per cent sulfur ¹ | 39.59 | 47.87 | 40.00 | 47.88 |
| Min. per cent sulfur..... | 39.15 | 47.31 | 38.60 | 46.60 |
| Average per cent sulfur.... | 39.47 | 47.49 | 39.18 | 47.28 |

¹ All results for sulfur are on dry basis.

TABLE IV—SUMMARY OF RESULTS REPORTED BY LABORATORIES HITHERTO THOROUGHLY FAMILIAR WITH THE ALLEN AND BISHOP METHOD, EITHER IN ITS ORIGINAL OR MODIFIED FORM—1916

| | SAMPLE No. 1 Same as No. 15095 in Table III | | | SAMPLE No. 2 Same as No. 15095 in Table III | | | SAMPLE No. 3 Same as No. 15096 in Table III | | |
|--------------------|---|---------------------|---------------------|---|---------------------|---------------------|---|---------------------|---------------------|
| | Method 1(a) | Original A and B | Modified A and B | Method 1 | Original A and B | Modified A and B | Method 1 | Original A and B | Modified A and B |
| Number of analyses | 13 | 4 | 5 | 12 | 4 | 5 | 10 | 3 | 5 |
| Maximum.... | 53.27 | 53.14 | 53.34 | 39.82 | 39.64 | 39.89 | 47.33 | 47.26 | 47.39 |
| Minimum.... | 52.60 | 52.71 | 52.89 | 39.18 | 39.13 | 39.50 | 46.91 | 47.17 | 47.12 |
| Average.... | 52.98 | 52.96 | 53.11 | 39.53 | 39.46 | 39.63 | 47.22 | 47.23 | 47.28 |

(a) Method 1 is same as the modified Allen and Bishop method described previously in this paper.

TABLE V—METHOD 1, INCLUDING ONLY LABORATORIES FAMILIAR WITH ALLEN AND BISHOP METHOD AND OMITTING THE MAXIMUM AND MINIMUM RESULTS IN CASE OF EACH SAMPLE—1916

| | Sample No. 1 11 | Sample No. 2 10 | Sample No. 3 8 |
|--------------------|-----------------------|-----------------------|----------------------|
| Number of analyses | | | |
| Maximum..... | 53.14 | 39.66 | 47.32 |
| Minimum..... | 52.74 | 39.42 | 47.18 |
| Average..... | 52.99 | 39.53 | 47.24 |

The writer feels that the main purpose in this cooperative work on the determination of sulfur in pyrite has been largely accomplished, namely, that it has been shown that the Lunge method in its various modifications gives results between quite wide limits, and in the hands of most analysts, at least, is not to be com-

pared in accuracy and reliability to the original or modified Allen and Bishop method. Further, that the latter method is an excellent one, easy and simple of manipulation. Many laboratories hitherto unfamiliar with this method have now adopted it, either in its original or modified form, with the result that in future better agreement among laboratories on this determination may be expected.

Tables III, IV, and V give a brief summary of the work for the two previous years.

It will be noted in Table V, comparing results of Samples 2 and 3 with results on the same samples for the previous year, that the results on Sample 2 for both years are in close agreement, but in case of Sample 3, results are considerably lower than those in 1915. The reason for this is that Sample 3 is a sample of Spanish ore, which oxidizes quite rapidly when finely ground, and when samples for 1916 were bottled up after remixing the large portion, a distinct odor of SO_2 was observed.

CONCLUSIONS

The conclusions arrived at for the work of previous years seem to apply equally to that of the present year and are as follows:

1—The disagreement by the Lunge method is about in line with past experience.

2—The agreement by the Allen and Bishop method, either the original or the modified, is much better and in the hands of analysts experienced with the method yields results in close agreement, closer, in fact, than is the case with most analytical determinations.

3—The Allen and Bishop method is recommended to all chemists as an accurate method for determination of sulfur in pyrite.

The writer wishes to thank again all those who have so generously participated in this undertaking for their work and valuable suggestions. It is hoped that all who have taken part feel amply repaid for their efforts and it is believed that in future a better agreement between laboratories for the determination of sulfur will be observed.

ARMOUR FERTILIZER WORKS
ATLANTA, GEORGIA

A PAPER TEARING-RESISTANCE TESTER

By H. N. CASE

Received August 9, 1918

To anyone making a review of the literature on strength tests for paper, the subject would appear simple and quite well defined.

After making tests on the Mullen "pop tester" and the Schopper tensile machine, the writer was therefore surprised to find that the results often bore no relation to the usefulness of the paper. For example, two papers were to be compared for use in making "tension envelopes." The one was a rope Manila and the other a short fibered offset paper. These results were obtained:

| | Rope Stock Lbs. | Offset Stock Lbs. |
|--|-----------------------|-------------------------|
| Weight per ream, 500 — 24×36 inches.... | 79 | 79 |
| Mullen test..... | 54 | 58 |
| Tensile strength on Schopper tester | Kg. | Kg. |
| With grain..... | 12.6 | 14.0 |
| Across grain..... | 6.5 | 7.0 |

From these tests the offset sample would appear a good match in strength to the rope stock. But envelopes made from the offset stock proved worthless.

An off-hand examination of these two papers with the fingers showed a great difference in the tearing quality as is to be expected when the difference between their compositions is considered. A Schopper folding tester would, no doubt, have shown a great difference between these papers, but none was at hand.

A means was then sought for measuring the tearing quality of paper. The method finally adopted gave the following results on the two samples mentioned:

| TEARING RESISTANCE | Rope Stock Grams | Offset Stock Grams |
|--------------------|------------------------|--------------------------|
| With grain..... | 240 | 95 |
| Across grain..... | 250 | 125 |

The test as now used has many disadvantages, but gives reliable information, particularly when used along with the Mullen tester. A low Mullen test and a high tearing resistance is sometimes a highly desirable condition. The Mullen tester shows the hardness and rigidity, while the tearing resistance shows the fiber strength and the extent of peeling. A wrapping paper that peels when tearing is certainly superior to one that does not.

The effect of humidity variation upon the results obtained with the tearing-resistance tester has not yet been worked out. The indications are that these tests are not affected to the same extent as those made on the Schopper folding tester.

The details of making the test are as follows:

Twelve strips, 1 in. by $2\frac{1}{2}$ in., are cut from samples representative of the lot to be tested. Six of them are cut with the long dimension parallel to the grain of the paper, and six are cut across the grain. These are cut with the scissors, as shown in Fig. 1. It is easier to slit the test piece to about $\frac{1}{2}$ in. from the end of the strip and then to cut off the end AA', so that the slit stops $\frac{1}{4}$ in. from the end. A knife slit is not to be recommended; neither should the tip of the scissors be used at the end of the slit.

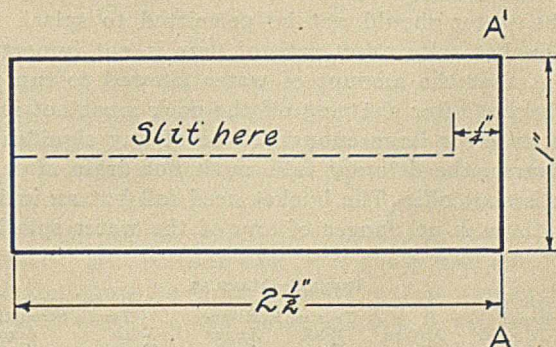


Fig. 1

The apparatus (Fig. 2) is provided with a set of three buckets of different sizes, so that when filled with water a range of weight from 15 to 600 g. can be obtained. One of these buckets is selected according to the strength of the paper.

The test piece is clamped, as shown, and the water allowed to run slowly into the bucket until the two parts of the piece completely separate. The cock is

instantly shut off and the bucket with the water and lower clamp weighed. The weight in grams is taken as the tearing-resistance number. It will be noticed in making these tests, that there often is an initial tear when only a small amount of the load is applied. This tearing stops before the final maximum load is reached.

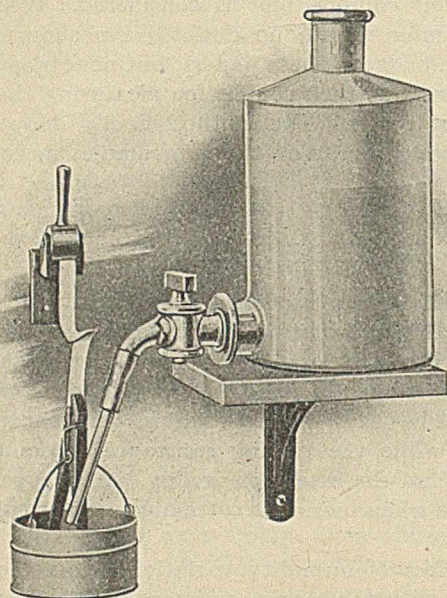


FIG. 2

If a tearing distance of more than 1/4 in. is used, the peeling effect will have more influence upon the results. Several attempts have been made to measure the tearing resistance of paper when it is torn for a considerable distance, but the great irregularity in formation and the peeling tendency discourage these methods. Also, no very satisfactory results can be obtained by clamping the slit test piece described above in a Schopper tensile machine and then measuring the load required to separate the two pieces.

The exact width and length of the strip is of little importance, except in the case of very stiff cards, such as postcard stock.

The water should not be permitted to splash into the bucket. Its exact rate of flow is not important, except that the amount of water allowed to run into the bucket after shutting off the cock must not introduce an error large enough to be of any significance. Of course, the delivery tube must not drain after the cock is shut off. The bucket need fall but an inch so that there is no danger of any of the water splashing out.

| Weight per Ream 500—24 × 36" Lbs. | Mullen Test | Tearing Resistance | | Schopper Tensile Strength | |
|---|-------------|--------------------|--------------|---------------------------|--------------|
| | | With Grain | Across Grain | With Grain | Across Grain |
| 43 | 17.7 | 47 | 43 | 5.1 | 3.5 |
| 50 | 18.8 | 41 | 49 | 6.5 | 3.2 |
| 50 | 23.1 | 39 | 46 | 7.3 | 5.5 |
| 60 | 28.4 | 68 | 73 | 8.7 | 5.8 |
| 60 | 23.0 | 39 | 50 | 7.7 | 5.0 |
| 70 | 18.9 | 49 | 47 | 6.7 | 5.1 |
| 70 | 61.0 | 88 | 111 | 14.5 | 5.3 |
| 80 | 54.0 | 240 | 250 | 12.6 | 6.5 |
| 80 | 54.9 | 92 | 118 | 15.4 | 5.7 |
| 80 | 22.0 | 93 | 99 | 7.4 | 4.5 |
| 86 | 67.4 | 96 | 133 | 20.6 | 6.5 |
| 86 | 74.1 | 96 | 148 | 21.2 | 5.9 |
| 124 | 29.2 | 95 | 74 | 9.4 | 6.6 |
| 125 | 97.0 | 196 | 217 | | Over 29 |
| 125 | 87.0 | 214 | 226 | 23.6 | 12.8 |
| 126 | 32.0 | 115 | 122 | 11.6 | 8.5 |
| 200 | 96.0 | 444 | 418 | | Over 29 |

TABLE II—KRAFTS FROM DIFFERENT LOTS OF PAPER MADE BY SEVERAL MILLS

| Weight per Ream 500—24 × 36" Lbs. | Mullen Test | Tearing Resistance | |
|---|-------------|--------------------|--------------|
| | | With Grain | Across Grain |
| 19 | 13 | 34 | 44 |
| 19 | 18 | 43 | 50 |
| 21 | 10 | 29 | 40 |
| 22 | 21 | 63 | 113 |
| 23 | 14 | 25 | 48 |
| 24 | 23 | 45 | 76 |
| 25 | 21 | 28 | 30 |
| 26 | 24 | 56 | 73 |
| 27 | 16.5 | 26 | 36 |
| 27.5 | 21 | 34 | 41 |
| 28 | 23 | 50 | 52 |
| 29 | 24 | 39 | 40 |
| 30 | 25 | 31 | 44 |
| 30 | 19 | 30 | 68 |
| 30 | 16 | 32 | 33 |
| 31 | 20 | 45 | 56 |
| 32 | 24 | 43 | 57 |
| 32 | 21.5 | 49 | 67 |
| 33 | 21.5 | 57 | 69 |
| 33 | 19 | 35 | 32 |
| 34 | 21 | 49 | 66 |
| 34 | 23 | 45 | 86 |
| 34 | 25 | 55 | 66 |
| 35 | 33 | 65 | 126 |
| 35 | 19 | 49 | 59 |
| 36 | 20 | 45 | 81 |
| 36 | 25 | 48 | 71 |
| 36 | 24 | 45 | 73 |
| 37 | 21 | 52 | 58 |
| 37 | 24 | 42 | 80 |
| 40 | 21 | 62 | 61 |
| 40 | 24 | 53 | 62 |
| 42 | 32 | 63 | 96 |
| 48 | 34 | 73 | 93 |
| 50 | 43 | 130 | 209 |
| 50 | 46 | 59 | 71 |
| 50 | 48 | 101 | 126 |
| 51 | 43 | 95 | 180 |
| 52 | 35 | 77 | 92 |
| 54 | 37 | 80 | 94 |
| 55 | 60 | 111 | 128 |
| 58 | 54 | 115 | 130 |
| 60 | 38 | 50 | 78 |
| 60 | 44 | 102 | 124 |
| 62 | 39 | 84 | 86 |
| 66 | 68 | 128 | 152 |
| 68 | 44 | 102 | 124 |

TABLE III—WRAPPERS

| Weight 500—24 × 36" Lbs. | Mullen Test | Tearing Resistance | |
|--------------------------------|-------------|--------------------|--------------|
| | | With Grain | Across Grain |
| 53 | 42 | 53 | 27 |
| 65 | 46 | 62 | 12 |
| 73 | 53 | 59 | 20 |
| 57 | 63 | 56 | 32 |
| 73 | 65 | 65 | 32 |
| 72 | 69 | 103 | 42 |

TABLE IV—ENAMELS

| Weight per ream, lbs. 500—25 × 38 in..... Rag content, per cent..... Mullen test, lbs..... Schopper test, kilos | Tearing Resistance | | |
|---|--------------------|-----------|------------|
| | Low-Grade | Low-Grade | High-Grade |
| 500—25 × 38 in..... | 66 | 67 | 65 |
| Rag content, per cent..... | None | 3 | 50 |
| Mullen test, lbs..... | 21 | 20 | 23 |
| Schopper test, kilos | | | |
| With grain..... | 4.7 | 5.9 | 5.3 |
| Across grain..... | 3.3 | 3.0 | 3.0 |
| Tearing resistance, grams | | | |
| With grain..... | 19 | 19 | 27 |
| Across grain..... | 23 | 25 | 31 |

TABLE V—MISCELLANEOUS

| SAMPLE | Weight Found | Tearing Resistance | | | SERVICE |
|----------------|--------------|--------------------|--------------|-------------|-------------------|
| | | With Grain | Across Grain | Mullen Test | |
| 1—Enamel..... | 25 × 38—60 | 18 | 25 | 17 | Fair |
| 2—Enamel..... | 25 × 38—60 | 10 | 18 | 17 | Too brittle |
| 1—Draw sheet.. | 0.010 in. | 104 | 139 | 68 | Not satisfactory |
| 2—Draw sheet.. | 0.010 in. | 146 | 151 | 70 | Satisfactory |
| 3—Draw sheet.. | 0.010 in. | 180 | 190 | 82 | Very satisfactory |
| 1—Cover stock. | 25 × 38—143 | 93 | 100 | 39 | Not satisfactory |
| 2—Cover stock. | 25 × 38—145 | 140 | 175 | 60 | Satisfactory |
| 3—Cover stock. | 25 × 38—145 | 200 | 175 | 72 | Very satisfactory |
| 1—Tag stock... | | 590 | 670 | 150 | Not satisfactory |
| 2—Tag stock... | | 820 | 800 | 150 | Satisfactory |
| 3—Tag stock... | | 1110 | 800 | 155 | Satisfactory |
| 1—Envelope.... | 24 × 36—60 | 41 | 52 | 14 | Good |
| 2—Envelope.... | 24 × 36—60 | 33 | 83 | 12 | Fair |
| 3—Envelope.... | 24 × 36—58 | 36 | 36 | 18 | Fair |

The tables above will show the relation of the tearing-resistance number to other tests. The data is representative of a large amount of routine testing done during the past three years. No attempt was made to pick out abnormal samples.

Discrepancies between the Mullen and tearing-resistance numbers are more often found in testing

Manilas than krafts. The old "point per pound" standard is a fairly reliable one in the case of krafts; still there are several instances shown in Table II where soft kraft samples have a greater tearing resistance than the Mullen test would indicate.

ADVANTAGES OF TEARING-RESISTANCE TEST

1—The comparative length of the fiber and the peeling qualities of the stock are shown in the result.

2—Sizing does not increase the tearing resistance to such an extent as it does other tests.

3—The apparatus is simple and depends upon no springs or gauges. It is applicable to both light and heavy papers.

4—The amount of grain in the paper is shown.

5—The load is applied with an unchanging rate of increase.

DISADVANTAGES OF TEARING-RESISTANCE TEST

1—The testing is tedious.

2—There is an apparent disadvantage due to the sensitiveness of the test in that the individual tests on the same sample vary so greatly that even the average of these tests appears unreliable until it is observed that the tearing-resistance numbers of different grades of paper show much greater distinction between the grades than the corresponding Mullen, Ashcroft, or Schopper tests. In a series of tests on Manilas, the Mullen tests ranged from 10 to 97, while the tearing-resistance figures ran from 15 to 450. In sensitiveness, the tearing-resistance tester resembles the Schopper folding machine.

The above method of testing the strength of paper is not submitted with the idea that it is the final word in paper testing, but only to awaken interest in developing more satisfactory methods of specifying paper quality.

PRINTING PLANT LABORATORY
SEARS, ROEBUCK AND COMPANY
CHICAGO, ILLINOIS

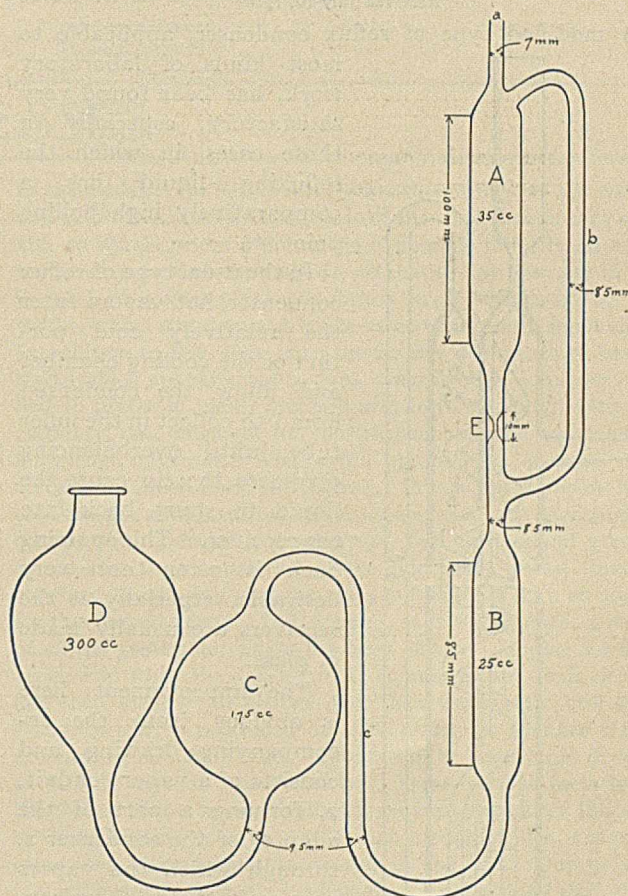
ABSORPTION PIPETTES

By E. VAN ALSTINE
Received July 13, 1918

While using the Parr carbon apparatus for determining both carbonate and total carbon in soils, it seemed desirable to have an absorption bulb which would be effective and rapid, and yet which would not contain glass beads or glass rods. In order that the absorption may be complete and rapid it is necessary that the gases come in close contact with the absorption liquid and if beads or rods are to be dispensed with the next best means is to bubble the gas through the liquid. The accompanying diagram is of an apparatus designed by the writer to accomplish this.

The size here shown is best for absorption of a volume of carbon dioxide up to 100 cc. from a volume of 100 to 200 cc. of air. Bulb A has an outside diameter of about 22 mm. and a capacity of 35 cc.; bulb B, an outside diameter of about 20 mm. and a capacity of 25 cc. Bulbs B and C together should hold as much as the volume of the unabsorbed gas, and bulb D

should hold somewhat more than this volume so that there may always be an excess of strong absorption liquid. A piece of capillary tubing, 1.3 mm. inside diameter and 10 mm. long, is inserted at E. The outside diameter of the tubing used is 7, 8.5, and 9.5 mm. as indicated. If absorption from a smaller volume of air is made, a pipette with smaller bulbs A and B and a smaller capillary at E should be used. If absorption from a larger volume of air is to be made, then bulbs C and D should be larger and bulb A should have a capacity of 40 or 45 cc., but the volume of bulb B should not be changed.



When gas enters at *a*, it quickly forces the liquid from tube *b* and bulb B through tube *c* into bulb C. Such gas as still remains to be forced into the pipette must pass through bulb B, the sides of which are being continually wet by the liquid dripping slowly through the capillary tube E. It must then bubble through this liquid, which collects in the lower bend of tube *c*. By the time bulb A is about half emptied, all of the gases have been forced out of the carbon apparatus and in a few more seconds A will become emptied, about half filling bulb B. While this is taking place the gas which filled B is forced through tube *b* into bulb A, thus being kept in motion. When bulb A is emptied the largest part of the gas has been trapped in bulb C by the liquid in bulb B, and when drawn back into the Parr apparatus it must bubble through this liquid.

It is not necessary to shake the apparatus to insure rapid action as must be done when bulbs without

beads or rods are used, yet absorption is as rapid as with either.

These pipettes may be made by any good glass blower, or they may be obtained for about \$5.00 each from Mr. Paul Anders, Urbana, Illinois.

COLLEGE OF AGRICULTURE
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

NEW REFLUX CONDENSER

By JAMES J. BAJDA

Received July 10, 1918

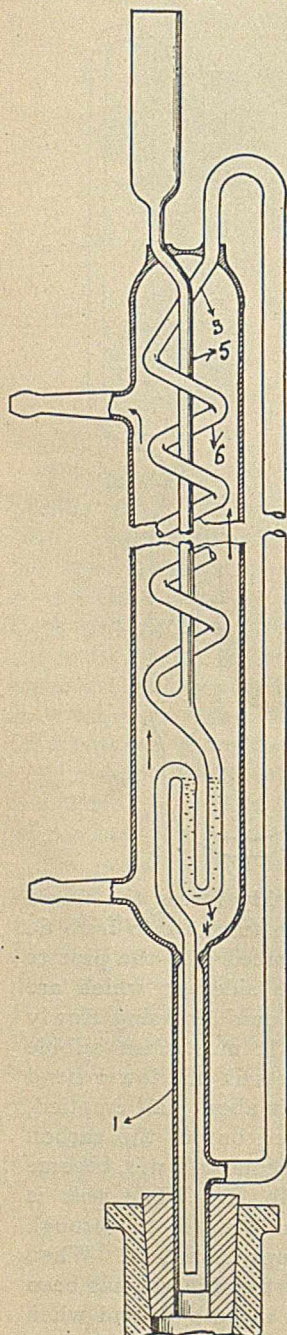
A modified type of reflux condenser, applicable to most kinds of laboratory work, has been found very satisfactory, especially in those cases in which the refluxing liquid has a comparatively high boiling point.

In the usual type of reflux condenser, hot vapors enter the relatively cold portion of the cooling chamber and allow the condensed liquid to collect in the inner tube, until overbalancing pressures therein cause the liquid to spurt back into the receiver. This spurting back is often not very desirable, especially as the receivers are usually made of glass.

The improvement here is obvious from the accompanying drawing and consists of a vapor conduit, 2, forming a part of the adapter of the condenser 1, through which the vapors pass and are led therefrom into the upper part of the condensing coil 3. The condensate flows into the trap 4, by means of which is provided regular and undisturbed flow into the receiver. Any tendency to disturb the balanced relation of the condensed liquid in the trap will find outlet through one arm of the Y-tube which leads upwardly and axially, 5, through the cooling coil 6.

The flow of cooling water in a direction opposite to

that of the condensates diminishes the strain on the glass.



FLUSHING, L. I.
NEW YORK

MELTING POINT OF ROSIN

By T. LINSEY CROSSLEY

Received August 2, 1918

Certain large buyers of rosin have recently specified a melting point limit for this material. Samples have been submitted for this test, but without specifying how the test was to be carried out.

Properly speaking, rosin, like asphalt, has no definite melting point, therefore, any specification aiming to grade it by reference to its behavior on heating should state the method for obtaining results.

Schwalbe and Kuderling¹ not only state melting points but record results to fractions of one degree and claim to differentiate between certain rosins by their melting points.

Several methods have been used to determine the quality of rosin as indicated by its action on heating. The closed capillary tube, of such general application, is used largely but, unless conditions of heating and observation are closely controlled, results are not uniform with different operators.

The following results were obtained on the same four samples by methods indicated:

| Rosin | 1/4 in. Column ° F. | 1/8 in. Column ° F. | Film ° F. | Capillary ° F. |
|--------|-------------------------------|-------------------------------|----------------------|----------------------|
| 1..... | 174-184 172-183 ... | 169-172 169-172 165-173 | 150 146 ... | 146 145 154(a) |
| 2..... | 176-187 174-185 ... | 174-182 167-176 ... | 147 135 136 | 154 147 153 |
| 3..... | 161-167 161-157 ... | 149-151 145-146 ... | 120(b) 134 126 | 128 130 ... |
| 4..... | 153-155 147-155 149-153 | 145-147 144-145 ... | 135 133 ... | 138 136 ... |

(a) Heated until clear.

(b) Probably mechanical weakness of film.

The first three methods were carried out as follows: Glass tubes of about $\frac{3}{16}$ in. inside diameter and 2 in. long were prepared. These were dipped in melted rosin so that on cooling there was left inside the tube a column of rosin of the required depth. In the case of the method marked "Film" the foot of the glass tube was heated slightly and applied carefully to the surface of the molten rosin so that upon cooling a thin film only of the rosin was formed. The tubes were attached to the thermometer in such a way that the bottom of the tube with the rosin was located about the center of the mercury bulb. The thermometer with tube attached was immersed in cold water in a 400 cc. beaker with the bottom of the rosin column 1 in. below the surface. The temperature was raised about 3° per minute.

In the cases of $\frac{1}{4}$ in. and $\frac{1}{8}$ in. columns, it will be noted that two temperatures are given. The lower temperature indicates the point at which the rosin is soft enough for the water to enter the tube, the other being the point at which the water breaks through. The result is of course merely the point at which the viscosity is so reduced that it is overcome by the pressure of 1 in. of water. It is necessary that the heating should be well regulated. If heat is applied too rapidly it will naturally result in a higher final temperature and a wider spread between the two points.

¹ "Rosin Studies," *J. Soc. Chem. Ind.*, 30, 1397.

The capillary tube method was carried out as follows: Tubes about 1 mm. in diameter were prepared and sealed at one end. The rosin was pulverized between two pieces of paper. About 2 cm. of the tube were filled with the powder, and it was attached to the thermometer as in the other cases, being also immersed in cold water and heated as before.

A reading glass was used to observe the result and the point at which the particles coalesced was noted as the melting point. It was not found advisable to carry the heating until the whole of the rosin in the tube became clear as this increased the range of personal error. There was found to be a more definite

indication and closer agreement when the point of coalescence was noted.

The results obtained by the "Film" method are for practical purposes the same as those obtained by the "Capillary" method, but the tests are prepared more rapidly and with much less trouble, especially in the hands of unskilled assistants. The end-point is definitely established by the penetration of the water.

In all of these tests recently boiled water should be used, otherwise the rising bubbles of dissolved gases interfere in several ways.

43 SCOTT STREET
TORONTO, ONTARIO

ADDRESSES

THE FUTURE OF THE AMERICAN DYE INDUSTRY¹

By W. H. NICHOLS, President, American Chemical Society

When war was forced upon the world in 1914, the chemical industry of England, France, Russia, and Italy was quite unprepared for the tremendous demands made upon it, some of the most insistent being for materials hitherto unmade in any of those countries, due to the shrewd policy pursued by the Germans for many years in anticipation of the event. The chemical industry of the United States was in far better state of preparation and, as is well known, was able to fill the gaps. On our own entry into the war, it appeared to those in authority at Washington that large additions should be made to the chemical output. To accomplish this result, our Government thought best to construct largely, and to assist certain individuals and corporations in doing likewise. As the chemical industry was thoroughly prepared to take care of the requirements of our own country before the war, it is fair to assume that it is in position to do so when we return to lines of peace. It is therefore manifest that a number of works in which the Government is interested will not be needed, and it is hoped that the manufacturers who so bravely and liberally contributed to the increase in output, will not now find themselves in competition with governmental plants. While I am informed the Government will take careful account of this, and will do what it can to protect industry already organized when the war began, I believe the potential injury should be alluded to in order that the large gathering of manufacturers here might be in position to express itself should it so desire.

The fortunes of the chemical industry are naturally bound up with the fortunes of industry at large, and the same rules which apply to any other industry would apply in almost every case to the chemical. If the country returns to its pre-war state of manufacturing capacity, the chemical industry will be able to take care of itself and any demands that are made upon it. Therefore, its future will be identical with the future of all the great undertakings with which we are involved. I have not thought it best to take up your time with discussing general details, knowing that these will be considered in the ordinary course of events.

I have thought that with the limited time accorded me, I might be of some service in calling specific attention to an industry which is practically new in this country, which is vital, and which absolutely needs encouragement; in fact, all the encouragement which can be forthcoming from every source. I refer to the manufacture of coal-tar dyes and medicinal preparations which up to 1914 were produced almost exclusively either in whole or in part by the great German concerns. Owing

to the fact that for nearly forty years these concerns had earned and obtained a practical monopoly of the whole world, they were able to charge prices which made it possible to write off all or the greater part of their plants, so that to-day they are in the position of having plants, doubtless largely increased by war orders, which stand on the books at comparatively small sums. In addition to this, they have the further advantage of having works which are perfected to date, whereas other countries have had to invest in plant, and will still have to do so, with the certainty that much of its construction may be scrapped as knowledge advances. With a full appreciation of these difficulties, manufacturers of England, France, and Japan have received the strongest kind of encouragement from government coöperation, financial and otherwise, and Switzerland permits by its laws the combination of the chief color works, three in number, in such way that processes and patents may be pooled for the common good. In Germany, as is well known, a union of all the great color works has been effected, binding for fifty years, and while the various units composing the same do not lose their identity, or control over their works, etc., still their activities will be controlled by their ability to produce stated products at minimum costs. Profits will be pooled and divided as already agreed; losses likewise. These various facts leave the United States as practically the only great country this side of China frankly open to the German assault, which is sure to come and which should be nipped in the bud. Our present protective tariff is entirely inadequate. I understand that plans have been completed to ship goods already prepared in immense quantities from Sweden, Holland, Switzerland, etc., so that their German origin will be carefully camouflaged.

Of the several branches of chemical industry, at the outbreak of the war, none bulked so large in the eye of the public as the coal-tar dyes and none so gripped public attention. The reason is now not difficult to determine. While the coal-tar dye and its directly related industries do not occupy a leading rank in the world's activities when measured by the customary and usual standards, such as those of labor employed, capital engaged, value of output, tonnage of output, power consumption, and the like, yet their products did perform almost, if not wholly, indispensable functions in very varied industrial operations of exceeding magnitude, importance, and ramification. It is this *functional* value, rather than any *intrinsic* direct money value, that now determines the importance in which the public holds these products. Out of this new viewpoint as applied to coal-tar dyes has grown an entirely new public conception of utility which the public has embodied in the now widely-current expression of "key" or "pivotal" industries by which emphasis is very decidedly placed upon functional importance, and other considerations are deliberately relegated far to the background.

¹ Address to the Chamber of Commerce of the United States, Atlantic City, December 6, 1918.

The public has decided to have all "key" industries firmly established at home.

Just before the war the world's total coal-tar dye production was under, rather than over, \$100,000,000 in value and approximately 250,000 short tons in weight, probably not in excess of 50,000 persons of all ages and positions engaged in their production from primary coal-tar products; in the United States just over 3,300 tons, valued at \$2,470,096, were produced, employing not over 530 persons but using almost entirely foreign-made "intermediates;" but these 530 persons produced other articles valued at \$1,126,699, tonnage not stated. Similarly, the above 50,000 persons produced other things such as medicinals, photographic developments, and the like of unknown value and tonnage, the world's average pound-value of dyes thus being 20 cents, and of the United States production 37.5 cents.

On account of the unavoidably mixed and therefore uncertain nature of all general statistical information on this subject, both in this country and abroad, it is hazardous to attempt great detail; the following is a very rough attempt to sketch the outline and a few of the details of this very complicated business.

With the above reservations in mind, it may be stated for the purpose of rough comparison only that in making dyes from primary coal-tar products, the world's pre-war labor per capita production in terms of dyes was not less than 5 tons per annum; in the United States just over 6 tons of dye for labor per capita were produced, but using foreign-made intermediates.

From a recent publication of the United States Tariff Commission, it appears that we had in this country in 1917, 81 establishments producing dyes, or dyes and intermediates, and 119 establishments making intermediates only; that 19,643 persons were so engaged, producing 23,000 tons of dyes or just over one ton of dye per person engaged per annum. If this be the proper interpretation of that publication, then it discloses an efficiency in tonnage production of about one-fifth of the pre-war efficiency in terms of persons engaged. Of the approximately 300 intermediates needed for our normal dye requirement, 134 were made here in 1917 as against but a very small number, perhaps five, made here in 1914. In 1917 we made no fewer than 180 chemically different dyes and all from intermediates of domestic manufacture. Of the variously estimated 500 or 600 chemically different dyes imported in the fiscal year 1913-14, 154 were made here in 1917 from domestic intermediates, in addition to 18 not then imported and 8 of not now known composition; our imports in that year totaled 23,000 tons; our 1917 production tonnage was a trifle higher; the tonnage imported in 1913-14 of the above 154 dyes amounted to 13,500 tons or 60 per cent of the total 1913-14 importation. Hence, our domestic dye industry in 1917 was directing its efforts very intelligently towards the production of those individual dyes of major importance to the industries requiring this class of products, and in producing substitutes for other dyes since much of its needed material had to be diverted to other uses for one or the other of the belligerent countries including, of course, our own country.

This whole business is made up of a host of different finished products calling for a multitude of semi-finished products representing an individual consumption of the widest conceivable range both as to tonnage or poundage as the case may be, and in values as are now set forth in sketchy outline.

For 383 presumably chemically different dyes imported in 1913-14 and for which values and poundages are known totaling 18,000 tons, the annual importation is 47 tons; of these 383 dyes only 67 are equal to or above this average tonnage, and 316 dyes are below it; the largest individual shipment amounts to 4,253 tons and the smallest to $\frac{1}{17}$ of a ton; 30 dyes are less than $\frac{1}{2}$ ton; the total value of these 18,000 tons was \$6,496,882, or an individual value of \$26,479; the individual annual values

range from \$1,090,773 to \$43. Some dyes (value not given) were imported in amounts even as small as 9 lbs. for the year.

In considering the future of our domestic dye industry it must not be lost sight of that with proper combination of physical plant and proper elimination of duplicated effort the German dye industry could reduce the total number of persons engaged; maintain, if not even increase, the output tonnage, and increase the annual tonnage output for labor per capita. It seems not unreasonable to expect that this might ultimately be one and one-half times the pre-war figure or say approximately eight tons per person engaged per annum.

In any event, the foregoing annual production of one ton of dye per person engaged in our domestic industry for 1917 must be considerably improved if our industry is to be permanently on a sound competitive footing. This apparently poor showing of efficiency must not be construed unfavorably to American effort; it is an unavoidable and wholly to be expected result of the conditions under which our chemists have been compelled to work by circumstances wholly out of their control, or the control of the public.

Our pressing and paramount problem has been to get these goods; matters of cost, labor-efficiency, and the like were wholly secondary; the goods had to be made. In the synthetic organic chemical industry, of which the coal-tar dye business is the largest factor, many ways of making one and the same thing are generally open and it calls for much experience, which can be gained only through time-consuming manufacturing effort, to decide which is the most efficient and the cheapest way. Our chemists did not have time or opportunity to enter into these refinements, they had to begin at the very beginning, and having found one way that would give them commercially usable products they bent their energies towards making that way, no matter how defective it might be, produce the greatest weight of goods in the shortest possible time, regardless of refinements as to efficiency and wastes. That was not a mistaken policy under the circumstances. Time and the goods were the essence of the problem; everything else was supremely secondary; the large domestic industries and needs dependent thereon had to be helped out of an emergency and they were effectively helped. This is not an apology: our chemists are in no sense under any obligation whatever to apologize; it is merely an explanation.

Having made this most important contribution toward winning the war, toward keeping our domestic industries going even though knowing all the time that from the point of view of efficiency his then manufacturing methods were woefully defective and wholly inconsistent with professional standards, should not the American chemist now be given an opportunity to improve the efficiency of the methods heretofore employed, or to devise new and better ways so that we can have this key industry firmly established at home? He must have these opportunities if he is successfully to weather the stress of foreign competition. It is not a question of raw or basic chemicals; we have all of these, except Chilean nitrate, in domestic abundance, and to spare, and at prices as low as anywhere. There is no magic in attaining the highest efficiency but it requires slow, painstaking, and voluminous investigation and testing to arrive at this maximum. Our chemists have the necessary training, skill, ingenuity, and resourcefulness to accomplish this. What they need is proper opportunity, and to be relieved from this production pressure, in order that they may improve their methods. Such a procedure is very costly. Who will foot the bills and how? These are not matters that can be successfully solved in a laboratory; they require try-out on manufacturing dimensions and under manufacturing conditions and hence are inseparable from actual manufacturing plants operating for commercial ends. For that reason our governmental research agencies cannot effectively aid in the solution of the problems

confronting our dye manufacturers. This work, therefore, devolves wholly upon the manufacturers themselves. Since the normal pre-war competitive manufacturer's value of our total annual dye consumption is not over \$10,000,000 for several hundred, possibly one thousand, widely different products, including intermediates and dyes, most of them of small individual value and tonnage, it is clear from our past experience that our manufacturers cannot themselves finance this expensive undertaking of refining and improving all needful manufacturing processes so as to have this key industry in its substantial entirety firmly established here. Our Federal legislators must find effective ways and means of lifting this financial burden and production-pressure from our dye makers while they are perfecting their processes and increasing the variety of their output.

We, of course, have a protective tariff. In my opinion this alone will not accomplish the purpose, nor do I think that it will do so even in connection with the anti-dumping law now in force. As stated before, in England, Japan, France, and Italy, the respective governments have taken more direct action ranging from direct government financial participation to guarantee of dividends. Yet these measures seem in the opinion of some not to promise success. Additional help in the way of complete prohibition of imports of all dyes or that device modified by permitted importations of limited amounts of specified dyes not then made at home, under government license, all for a limited number of years, have been seriously proposed abroad. This problem is rendered the more difficult by the very practical and important consideration that dyes enter commerce not only as such and in packages like kegs, casks, and barrels, but also on finished commodities such as textiles, leathers and leather goods, printed and painted articles, and an uncounted host of other things. It might even be necessary to prohibit the importation not only of dyes and the like as such, but also all articles, like textiles, which are dyes or colored with such dyes except where we have domestic sources of all the dyes involved in any shipment.

From this it is clear that this problem is not only complex, but exceedingly difficult; that the best minds in foreign friendly countries are not agreed as to the needful helps; that the more this phase of the subject is studied, both here and abroad, the more drastic the proposed measures become. It is also clear that half-way measures cannot promise success. Since we are really determined to have this particular key industry firmly established at home, we must be prepared to pay the full price and we ought to be prepared to pay rather more than "just enough" in order to make ultimate success not only certain but speedy of accomplishment.

If public measures are taken for the purpose of establishing this key-industry at home, it is perfectly clear that those who enter into or remain in it are in duty bound to make the country not merely seemingly but actually and intrinsically independent of all foreign competitors by producing not only the staples and the specialties in quality, quantity, and cost equal to anything offered from abroad, but also to lead or at least to keep abreast of the highest foreign developments by assiduous, intelligent and resourceful research, both scientific and technical, of the whole field and all its ramifications.

Just how this shall all be brought about, no man can with any confidence say to-day, but surely our dye-makers, our users of dyes, and our importers of dyes and materials into which dyes enter, can find by patriotic and clear-headed conference and coöperation ways and means that will commend themselves to our legislative and other government officials as being best designed to accomplish the will and desire of the American public which has been repeatedly and determinedly expressed and in a way that cannot be ignored.

Given a fair chance, with confidence that there will be no

outside interference for a certain period, it is my conviction that the American dye industry will not only stand alone, but that it will lead the world.

THE PROBLEMS OF THE DYESTUFF INDUSTRY¹

By F. W. TAUSSIG, Chairman, United States Tariff Commission

It is not necessary for me to rehearse the events of the last three years or the facts of the present situation. You are familiar with the history of the industry and with its problems. You know well the extraordinary story—the unique dominance of the German industry before the war, the passive acquiescence of most countries in that dominance, the virtual cessation of imports during the war, the rapid growth of the dyestuff manufactures in this country and in others. You know too that there is impending an equally sudden transition to new conditions. It is these new conditions that now demand our attention. I shall not weary you either with congratulations on the achievements of the past, or warnings about the possibilities of the future. Nor shall I undertake any discussion of general questions of industrial policy or general problems of reconstruction. I shall confine myself to the problem which is before the dyestuffs industry now and here.

Before considering, however, the possible lines of legislative action for the immediate future, I shall ask your attention to one general proposition, simple and unquestionable in itself, but of special relevancy at this time.

Stability is of the first importance for any industry and at all times. Business can accommodate itself to almost any conditions, provided they be steadily maintained. This is true as regards prices and wages, banking and monetary systems, income taxes and taxes on business, and, not least, as regards tariff duties. It is quite as important, probably more important, that duties should be settled as that they should be high or low, well- or ill-adjusted. It is imperative to know on what basis business calculations may be made.

Not only is this the case with regard to an individual business or a particular industry; it is true also as regards the prosperity of the country at large. Vacillation and uncertainty in tariff policy are probably more harmful than any extreme of high duties or of low duties. The good results which are obtainable through a protective system endure only if such a system is maintained consistently for a considerable period—if time is given for the development of domestic industries, for growth under assured conditions, for the introduction of improved methods through long-continued experiment. And similarly, the good results which are obtainable under a policy of free trade are dependent upon its maintenance over a long period. They can come only through steady competition among foreign producers and domestic distributors, and the adjustment of export trade as well as of import trade to larger volume. A consistent policy followed for a considerable stretch of time is in either case essential for the attainment of the desired results.

Let us now look at the situation which is to be expected in the immediate future in this country, and look at it frankly and openly. Let us not disguise the facts by vague generalities, by pleasant words, by rose-colored optimism. The truth, plainly stated, is that the outlook for stability is poor. Indeed, the prospects are of the slightest for anything in the nature of a settlement of the tariff. Consider the obvious facts of the political situation. We are at the beginning of the short session which closes the 65th Congress. In the 66th Congress, which will be in session from March 4, 1919, to March 4, 1921, there will be no unification of control and hence there can be no

¹Address before American Dyestuffs Manufacturers Association, New York City, December 6, 1918.

unification of policy. One party will have a majority in the House of Representatives; the Administration itself is of another party; the Senate will be very evenly divided. Not only is this the case, but the traditional division of opinion and policy on the tariff will not only be maintained, but is likely to be accentuated. The controversy on the protective policy will go on, and will be conducted on party lines. That controversy, it need hardly be said, is not between protection and free trade. The practical issue is one of degree—whether there shall be high and strong protection all around, or limited and moderate protection. But the cleavage is clear. I shall not undertake to say whether a permanent settlement will ever be reached in this country; but it would seem certain that not even such a provisional settlement as comes by the enactment of a general tariff law is within the bounds of probability for the next two or three years.

Further, we must expect a certain amount of political maneuvering. Legislation will be proposed and debated, not so much with an expectation that it will be enacted, as with a design to make plain what is the policy proclaimed to the country, and therefore promised as likely of adoption if a more conclusive political settlement is reached. The drafted bills will be very much in the nature of a political platform. And if, by chance, any legislation is adopted by the present Congress, or by the next, it will be tentative and provisional, presumably to be revised in the Congress to follow.

In other words, nothing in the nature of a settlement of the tariff question, even for a period of four or eight years, is to be expected before the Presidential election of 1920 and the establishment of a new administration for the period beginning with March 1921. Until that date the country will not know where it is, or whither it is moving, as regards this important factor in its industrial prosperity. Whatever is done in the way of legislation during the session of Congress which begins in 1919 can hardly be more than provisional.

In forecasting the immediate future in this way, let me not be understood to impute blame to any individual or any party. No arraignment is made, no criticism implied. The situation is the simple consequence of our constitution. It is an inevitable concomitant of the system of checks and balances. Our Government was not designed to be under unified control, nor is it adapted for the prosecution of a single-minded policy. The election of a new Congress in the middle of a presidential term was expressly intended to give a check on the uncontrolled maintenance in power of any party or any administration. It is idle for us to speculate in connection with such problems as we are here discussing, whether the system of checks and balances in this respect operates well. The mid-term elections have always brought perplexing consequences, and they will continue to do so. It is not a new thing in our history that legislation has become hesitating, uncertain, affected by political maneuvers and sometimes by political pretenses, because of the patent fact that power was divided and that a settlement one way or the other was for the time being impossible. This was the situation in 1911-12, the era of the well-known pop-gun tariff bills. It is precisely the present situation. The uncertainty is most regrettable, but is clearly there. We should be like the ostrich who buries his head in the sand if we refused to view it openly or if we failed to observe the consequences to which it leads. We must face things as they are.

It may be asked, however, whether some particular phases of the tariff question cannot be rescued from the general predicament and dealt with irrespective of party differences. Is it not possible that the dyestuffs industry can be treated by itself? Can it not be rescued from political strife? Is there not some chance that it will be considered upon its merits, without regard to political complications, and disposed of as an urgent matter needing immediate attention? Cannot this brand be rescued from the burning?

There are grounds for hoping that special attention will be given to this industry, and that its case will be regarded as unique. Some promise of an attitude of this sort can be inferred from the enactment, two years ago, of the revised duties upon dyestuffs which are now in force. As you need not be reminded, a special title was contained in the revenue act of 1916, imposing revised and increased duties upon intermediates and upon dyestuffs. The legislation then put into effect was admittedly not satisfactory in every respect, yet it was an earnest of the recognition of a peculiar situation. Moreover, the present administration, irrespective of any general attitude to which it is committed on tariff questions, has viewed with concern the dependence of this country upon foreign dyestuffs and has coöperated in the endeavors to bring about, not only by legislation, but by departmental encouragement and support, the development of an American supply of dyestuffs.

Further, the industrial conditions are obviously different from those in many other industries. This is an entirely new industry. It is largely in the experimental stage. It has had a short and disturbed period in which to develop. It has not yet found itself in normal conditions. It is confronted by foreign competition from an industry which is not only long established and well equipped, but is organized in such way as to threaten ultimate danger to consumers as well as immediate danger to producers. And not least, it is closely connected with the military problems, because of the interrelations between explosives and dye products. These are matters familiar to all of you. Indeed, so far as a gathering like yours is concerned, there is no need of explaining wherein your industry stands in a class by itself.

Not only this, but it would be admitted on all hands that there are matters connected with tariff legislation which could readily be disposed of without raising any controversial questions. Not every measure relating to import duties is necessarily contentious. Take, for example, the matter of customs administration. This has long been in a confused and unsatisfactory state. Admittedly there is urgent need of an amendment and of clarification of the customs administrative laws. The Tariff Commission has prepared with great care a draft for such amendment, and has brought it to the attention of Congress in the hope that it may be disposed of without arousing political debate. Again, there are matters of classification and definition in the tariff laws, unexpected and undesired anomalies, which also can be disposed of on simple grounds of consistency and common sense. Problems of precisely this type arise in the dyestuffs act of 1916, and in the chemical schedule of the act of 1913. Our immediate question is whether the duties on dyestuffs can be brought to the attention of Congress in such a way as to obviate strife, or at least to minimize it, and to secure early and unbiased attention to the special difficulties of the case.

The answer depends upon the way in which the situation is approached and handled. It seems clear that any proposal of an extreme character would arouse opposition and would stir controversy. A radically new policy of any sort has little chance of being carried into effect. It seems equally clear that any great division of opinion among those who are interested in the industry and who have given special attention to its progress would have the same effect. If the manufacturers, consumers, importers, chemists, editors of chemical journals, the Tariff Commission itself—if all these come before Congress with different and discordant proposals, nothing is likely to be accomplished. Only if all concerned unite upon some moderate plan will it be possible to secure that unbiased and undisturbed attention which will result in legislation. If indeed there be a consensus of opinion in all quarters, then there is a possibility that the problem will be dealt with in a noncontentious spirit.

As you know, various plans and proposals have been suggested. Some of them must be characterized as extreme. It has been suggested that there be for a period of years an entire prohibition of importation. It has also been proposed, as an alternative, that there be something in the nature of discretionary prohibition. The alternative suggests that there be established a system of import license and import regulation, under which an administrative body shall have authority to permit foreign dyes to be imported in cases where domestic supply is non-existent or quite inadequate, the American market, however, being reserved completely for the domestic producers as regards commodities which they are able to supply, perhaps at high prices, but at all events, in adequate volume and of satisfactory quality. Of a different sort is a proposal for entirely remodelling the present plan of classification in the act of 1916, by the virtual abolition of the class of intermediates and by the application of the same rate of duty to all products which are beyond the stage of crudes. There is something to be said for each of them, and there are objections to each. My present point is that, whether they are good or bad, they seem to be now not feasible of early execution. They are radical beyond the limits to which measures must be confined which have a chance for enactment. Simplicity, moderation, no violent departure from existing methods and existing legislation—these seem to be the requisites of a feasible plan.

The Tariff Commission has given prolonged and careful attention to the dyestuffs problem. It has secured a thoroughly competent expert staff of its own. It has conferred in the most painstaking way with the officials of the Administration, with the representatives of the customs division of the Treasury, with consumers, and with manufacturers. It has proposed and elaborated a bill that conforms to the conditions which I have just indicated. That bill endeavors to make effective the policy adopted in 1916, and also to show the way to some moderate extension of that policy in new directions. The legislation of 1916 was in many respects a great improvement on what preceded. But defects have already appeared, and there is beyond question occasion for amendment. Evasion of some of the salient provisions of the present law is possible, especially through the importation of intermediates which are nearly advanced to the stage of finished dyestuffs. The bill prepared by the Commission goes over the list of commodities with care, rearranges the enumeration of intermediates and finished dyes in such a manner as to prevent evasion, and removes some anomalies which clearly need attention. It raises frankly the question whether the specific duty of 5 cents which was not applied by the act of 1916 to indigo and to all indigoids, whether or not obtained from indigo, to natural and synthetic alizarin, and to dyes obtained from alizarin, anthracene, and carbazol, should be made applicable to these now exempted commodities. This opens a question of policy, but one which, we may perhaps hope, will be dealt with irrespective of general party differences.

The measure which is proposed by the Tariff Commission may not be perfect, but we are confident that it represents a great improvement on what is now on the statute books. It is a measure of the sort which may be laid before Congress with propriety under any circumstances and at any time. It is the sort of measure upon which all concerned may unite, and which

may receive the sober and cool-minded attention of congressional committees and of Congress itself. This report is now in the hands of the printer and will be available for distribution at an early date.

If anything at all is to be done, it would seem that this is the practicable plan, and this the practicable procedure for bringing it to fruition.

In conclusion let me say a word about the Tariff Commission itself, its functions and its duties, as illustrated by this particular case. During the debates which preceded the establishment of the Tariff Commission, much was said about the need of a scientific settlement of the tariff question, and of the removal of that question from the domain of politics. This is Utopian. It is quite impracticable, and indeed undesirable, that the settlement of a great question of principle should be put into the hands of any administrative body. The commercial and industrial policy of the country must be settled by the people and by Congress, and cannot by any possibility be taken out of their hands. Certainly the Tariff Commission has no such high-flying ambition. It is soberly conscious of the limitations upon its possibilities, and of the character of the work to which it must confine itself. Its business is to prepare the way for the intelligent and well-considered application of whatever policy the people determine by their votes and Congress carries into execution by its legislation. Our business is to gather information and to take preparatory steps such as will enable Congress to act with light and to avoid ill-planned or misdirected efforts. This is an important and much needed kind of work. We have endeavored to do it in the particular case of the dyestuffs industry.

The Commission would not go so far as to say that all information which it is possible to get is at our command, still less suggest that all the information has been secured which it is desirable to have. As you know better than any one, the whole industry is in a stage of flux and transition the world over. In Great Britain, in France, in Switzerland, as well as in the United States, there are new developments. What will be the conditions of international competition in the future, what the prospects of the various branches of the growing industry in the United States, no one can now say. Nor can any one say, as I have explicitly pointed out, what industrial policy will finally be adopted by the United States. That policy cannot but be affected by the character and terms of the general international settlement. We cannot peer far into the future. For the moment we can follow only provisional lines of action.

The war is over, and with it the excitement and the shouting, the absorption in the task of the moment. Before us now are the problems of peace. We can no longer plan for what could be done and should be done under the conditions of war. And it is no longer profitable to utter words of encouragement and confidence, and perhaps of glorification, which were natural during the stress of conflict, but which now would simply obscure the troublesome facts of the new situation. These facts I have tried to face squarely, without concealment or equivocation or flattery. I trust that in so doing I have spoken in accord with your wishes, and perhaps have aided you in reaching a conclusion concerning the course of action which the representatives of your industry should follow.

FOREIGN INDUSTRIAL NEWS

By A. McMILLAN, 24 Westend Park St., Glasgow, Scotland

NEW VEGETABLE OIL

A sample of "piassava" oil from Sierra Leone, presumably a product of the palm from which the piassava fiber of commerce is derived or some related species, has been examined at the Imperial Institute, London. The oil was found to resemble palm

oil in odor, but was rather darker in color and more liquid. The results obtained in its chemical examination were similar to those recorded for palm oil and if it can be shipped to Great Britain in commercial quantities it should be saleable at prices similar to those realized for palm oil.

GERMAN AIRCRAFT

Reports recently prepared by the Technical Department, Ministry of Munitions, London, describe some types of German fighting biplanes. The following, taken from the *Times Engineering Supplement*, is a description of the two-seater Halberstadt machine, which bears the date April 14, 1918, and may be taken as the high-water mark of German two-seater aeroplane construction. It is well and strongly made, the principal points in its design being the single bay arrangements of wings, the conspicuous set-back of the main planes, freedom of the empennage from wires, tapering of the fuselage to a horizontal line at the rear, and the construction of the pilot's and observer's cockpit in one. Its general behavior in the air is good according to modern fighting standards, but it cannot be considered stable as there is a tendency to stall when the engine is on and to dive when it is off. Directionally owing to propeller swirl, the machine swings to the left, but with the engine off it is neutral. Pilots report that it is light and comfortable to fly. Its maneuverability is good, and this feature, in conjunction with the exceptionally fine view enjoyed by the pilot and observer and the field of fire of the latter, makes it a machine to be reckoned with as a two-seater fighter, although the climb and speed performances are poor, judged by contemporary British standards. In tests the climb to 10,000 ft. took 24½ min. and to 14,000 ft. just under 52 min. The greatest height reached was 14,800 ft. in 64 min. 40 sec., the rate of climb at this height being 50 ft. per min. At 10,000 ft. the speed was 97 miles an hour with the 180 h. p. standard high-compression Mercédès engine making 1,385 r. p. m.

BRITISH OPTICAL GLASS INDUSTRY

An account of the steps taken by the British Government to develop the manufacture of optical glass is given in the *Board of Trade Journal*. When war broke out, Britain was dependent on Germany for 60 per cent of its supplies; 30 per cent came from France and the balance of 10 per cent was made by Chance & Co., Birmingham, England. In January 1916, Messrs. Chance undertook to complete an extension of their works which would greatly increase their output and the Government undertook on their part that British optical glass would be used as far as possible for optical instruments required for naval and military purposes. Scientific research, the report states, into the chemical constituents and optical properties of the various kinds of glass has moved hand in hand with commercial production. In 1913 there were 11 types of optical glass made in England and the total home output was not great enough for home requirements. Now, however, 75 types of glass are made in this country. During the first quarter of 1918, English makers produced more than 90 times as much optical glass as was made during the first quarter of 1913. They are thus making glass at a rate nine times as great as the total consumption of the United Kingdom in the year before the war.

ITALIAN CHEMICAL INDUSTRY

The *Z. angew. Chemie* says that many new factories have been erected in Italy for the production of artificial manures and colors. The government seems to have taken much interest in the chemical industry. The "Anonima" concern was formed for the production of aniline colors with a capital of \$1,200,000. For the production of soda and chlorates, a company was formed in Genoa with a capital of \$500,000. The soap industry and glycerin production have grown up with the manufacture of soda, and carbolic acid crystals are prepared in the explosives factories of Piedmont. In Milan, the German specialties, antipyrin, aspirin, phenacetin, and lecithin, are produced. New works are established at Legno for the production of ammonium nitrate, while in Turin a rubber factory has been set up with a capital of \$800,000.

ALCOHOL FROM SEAWEED

Attention is being called by Sir Edward Thorpe to the possibilities of obtaining alcohol for motor fuel from seaweed. After commenting on previous attempts that have been made to obtain alcohol from non-alimentary materials, Sir Edward holds that certain seaweeds, all of which are abundant, may be made to yield considerable quantities of alcohol by suitable treatment. Thus it has been stated that 100 lbs. of red wrack is capable of yielding about 6 liters of alcohol and it is alleged that, under industrial conditions, this amount may be increased. If these statements can be verified we have in seaweed a ready and cheap source of alcohol and the possibility of employment to people whose livelihood was greatly impoverished by the loss to them of the kelp industry. A correspondent of the *Times*, London, remarking on the above statement, suggests that the use of peat would afford a cheaper method as it would be easier to handle. He also adds that it should not be forgotten that motor spirit can be obtained from various oils, and calls attention to certain oil-transformation processes on which Sir Oliver Lodge reported very favorably in October 1913.

SWITCHGEAR

A catalog issued by the General Electric Company who have now taken over works at Erith, England, deals with high-tension switchgear and sundry other appliances. Descriptions and illustrations are given of various types of three-phase, oil-break switches which are suitable for voltages up to 6,600, and can be arranged with automatic features, to open an overload, on reverse power, or when the voltage fails. Details are also furnished with dimension drawings in most cases, of truck-type switchgear, tension limiters and lightning arresters of various patterns, choking-coils, isolating links, high-tension plug fittings, relays, time limit fuses, and static leakage detectors. An underground switch-box for disconnecting high-tension cables is formed of cast-iron with a clamped-on lid. The three-phase switch inside is operated by an external hand wheel, the cables being brought in by a trifurcating box, and the case is filled with oil. Light loads up to 50 amperes at 6,600 volts can be broken satisfactorily.

ALLOYS OF LEAD AND MAGNESIUM

It is known, says *Engineer*, that the addition of small quantities of sodium or potassium or magnesium to lead hardens the metal considerably. If tin is added to either of these alloys its brittleness is somewhat diminished and its resistance to chemical action increased. According to *Metall und Erz*, an alloy of soft lead and magnesium which in moist air is slightly attacked on the surface is proof against such action when tin is added. The tin is equally effective in an alloy of lead and sodium. The hardness of these alloys may be increased by an addition of copper. The proportion of tin as of copper must not exceed 5 per cent. The proportion of sodium or magnesium should not be greater than 4 per cent.

BRITISH BOARD OF TRADE

During the month of October the British Board of Trade received inquiries from firms at home 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, 73 Basinghall St., London, E. C.

| | |
|---|---|
| Button moulds | Machinery for boot-cleaning |
| Corks with attachment for applying liquid renovator, evenly, to leather goods | Machinery for coating carbon paper |
| Corrugated steel fasteners for boxes | Metal tubes for shaving soap and brushes |
| Machinery for making sand-paper | Pattingers (small metal collar or cuff fasteners) |

AN INSTITUTE FOR COÖPERATIVE RESEARCH AS AN AID TO THE AMERICAN DRUG INDUSTRY

In order to gain as many views as possible concerning the proposed institute for coöperative research as an aid to the American drug industry, a symposium on which was printed in the last issue of *THIS JOURNAL*, reprints of that symposium were forwarded to many who would naturally be interested in the subject and their views thereon requested. These are printed below without any effort at editing as it is desired to have as unrestricted a discussion as possible of this important subject before the matter should take any definite line of organization. A number of other contributions on this subject have been promised and will be printed in our next issue.—[EDITOR.]

AMERICAN DRUG MANUFACTURERS' ASSOCIATION

Your proposal that a national institute for drug research should be established is, I believe, timely. Such an institute organized along broad lines will meet a very real present-day need of American drug and chemical manufacturers. It should, of course, be organized and financed in such a way as to leave it entirely independent of all outside influences so that without let or hindrance the search for truth could go forward and its findings be accepted everywhere at a 100 per cent valuation.

Not least among its practical benefits would be its possibilities as a training school from which our manufacturers could recruit their various scientific workers. Under present conditions when scientific workers are wanted, manufacturers do not know where to turn to get them.

Your proposal is so full of interesting possibilities that I know the members of the American Drug Manufacturers Association, representing as they do the principal American manufacturers of pharmaceuticals, biologicals, medicinal chemicals, surgical dressings, and essential oils, will want to hear directly from you on this subject, and I am, therefore, asking Secretary Woodruff to extend to you an invitation to address us at one of the sessions of our annual meeting to be held at the Waldorf Astoria, New York, in March next. You will receive a formal invitation in due time.

In the meantime a very general discussion of the subject by those competent to consider it may so crystallize the proposal as to enable you to present something very definite to our members at our meeting in March.—CHAS. J. LYNN, President, American Drug Manufacturers Association.

MANUFACTURERS

It is with great pleasure that I respond to your request to add my mite of information and suggestion to your proposed symposium upon the coöperation of science and industry, for in the last analysis this is what the proposed institute represents and embodies.

Ever since I returned from a two years' course of study in foreign universities in 1891, I have been preaching and advocating from platform and in print the coöperation of science and industry. I was first forcibly impressed with this idea when I applied to Prof. A. W. von Hofmann, of the University of Berlin, for an "Arbeit" and he took me into a room adjoining his private laboratory, and said, pointing to several tables filled with bottles, boxes, and bundles, "Select one from this assortment." Each parcel was a scientific problem seeking solution by some industry in the country and submitted to this University because these industries had been unable to solve it. These industries covered perfumes, flavors, cement, leather, medicines, coal, steel, dyestuffs, glass, textiles, etc., etc.

The industry reserved the right to own and control the result of any successful solution of the problem in whole or in part, and the chemist solving it received the credit and right to publish his result and perhaps benefited to some extent in the profits that resulted.

There were the university and the manufacturing plant coöperating for the mutual welfare of the common fatherland. The result has been the unprecedented growth of all industries, notably the chemical industry, in Germany. In our country this coöperation has been conspicuous by its absence and it required a great war to stimulate this industry. What is yet needed is the coöperation between science and industry and the present time is most auspicious for it, as many plants built to produce war materials must be converted into plants to produce peace materials. For this reason your present symposium is timely and its constructive and practical value reflect credit upon your judgment and energy. As to how the coöperation shall be accomplished, I beg leave to submit in concrete form some suggestions based upon years of thought and experience in the matter and after having read the several interesting papers and plans submitted by other members of the AMERICAN CHEMICAL SOCIETY and practically all friends of mine.

First, there should be organized under the sole auspices and direction of the AMERICAN CHEMICAL SOCIETY with the coöperation when requested of the American Medical Association, the American Pharmaceutical Association, the Hygienic Laboratory of the Marine Hospital Service, the Bureau of Chemistry of the Department of Agriculture, the American Drug Manufacturers Associations' Committee on Standards and Deteriorations, and such other associations as its board of trustees may determine, a biochemical institute.

Second, this institute should be built and established by money contributed for that purpose by individuals, associations, corporations, or anyone interested in the study of medicinal preparations and their effect upon the human or animal body. This should be contributed to the AMERICAN CHEMICAL SOCIETY for this specific purpose and be controlled and expended by that Society acting through a board of trustees of said institute, appointed by the AMERICAN CHEMICAL SOCIETY.

Third, on this board of trustees should be representatives of the several units coöperating and contributing to the fund and work, and the board should not be larger than twelve, and if possible, smaller.

Fourth, the institute should have a scientific director and staff of chemists, pharmacologists, bacteriologists, pathologists, etc., and should consider work upon, and solve, all such problems as are presented to it by any of its members or contributors.

Fifth, there should be an annual membership fee independent of and in addition to any contributions, which membership fee should be nominal and with fees for work actually done, also charged at reasonable rates, should constitute the income of the institute with which it should meet its expenses, salaries, etc.

Sixth, the institute should if possible be endowed so that the contributions made to build it should provide also for an endowment fund securely invested so as to provide an annual income to pay most of the fixed charges.

Seventh, the work of the institute should be divided into several departments:

A—Pharmacological, where substances are tested as to their therapeutic action upon animals.

B—Hospital dispensary, where patients are received and treated, either ambulatory or in wards, and upon which clinics are to be held to demonstrate the efficiency and effect of medicines.

C—Chemical, where synthetic and analytic work is done upon chemicals, drugs, animal products, etc., looking to develop some new therapeutical agent for the cure or alleviation of disease and suffering.

Eighth, the hospital dispensary department is an essential feature of this institute, for animal experiments alone are insufficient to prove the value of a medicine. This could be a separate or an existing hospital that would cooperate. It would, however, be preferable to have the hospital as in case of the Rockefeller Institute under the management and control as well as the roof of the institute.

Ninth, there should be established fellowships, endowed or provided by members or contributors, to serve the double purpose of providing a worker to undertake a specific piece of work for the founder of the fellowship and of developing and training a prospective employee for this kind of work.

It seems important that there shall be upon the board of trustees as well as upon the committee cooperating with the director of the institute in determining the nature of the problems to be undertaken by the institute itself, outside of the problems sent to it for solution, some business men, with scientific training if possible, so as to develop at least some practical useful products alongside of those of theoretical interest.

It is important that no one association other than the AMERICAN CHEMICAL SOCIETY should be permitted to dominate the management or policy of this institute. They should all be asked to cooperate as extensively and actively as they may desire, but the AMERICAN CHEMICAL SOCIETY should always retain the control of the institute.

In the same spirit no one industry or individual should be permitted to contribute sums that would justify and properly entitle him to dominate the institute because that would at once largely destroy much of its usefulness and influence. A democratically organized and representatively managed institution seems the proper plan to make a success in the twentieth century.

Best wishes for the ultimate establishment of your desirable, badly needed, and extremely humanitarian project.—A. R. L. DOHME, Sharp & Dohme, Baltimore, Md.

It is with much pleasure that I respond to your kind note under date of November 27 requesting my views concerning the establishment of an institution to be devoted to the study of the properties and actions of drugs. The wonder is that someone had not thought of this enterprise a long time ago. Its value and need goes without saying and I trust that it may in due course become an established fact.

While there are many pitfalls to be avoided in planning such a work, it is a clear-cut proposition after all and the gentlemen who have it in charge are certainly capable of steering it to a splendid result.

The proposed basis of a strong organization for the investigation of the fundamentals and general guidance, with another force to specialize on the various problems, is certainly a rational one and should meet with prompt response and support from those who are interested in the scientific aspect as well as the commercial possibilities.

As I see it, commercial houses are really the media through which valuable discoveries are made available, and it is pleasing to see that as time passes the prejudice against commercial exploitation of good things in a proper manner is passing away. You may depend upon the concern with which I am connected cooperating to the fullest.

We would consider it a great honor to be permitted to establish one of the first scholarships.—J. K. LILLY, President, Eli Lilly & Company, Indianapolis, Ind.

An experience covering thirty years, which period includes the rise and decline of the use of synthetic drugs, has made me wonder whether the advertising of these products has not done more harm than good and whether any drug is worthy of recognition and use by the medical profession if the demand for it would decline if the advertising were discontinued.

Soon after the introduction of antipyrine, antifebrine, and phenacetine there was such a swarm of synthetic products put on the market that the lists of new remedies increased to the size of volumes, and, as only a small fraction of these survived, the question naturally arises: Did the patients to whom they were administered have any better fate?

Unless a drug is good enough to make practitioners want to use it again, after they have once tried it, it ought not to be used at all. The vital question in this discussion is how to find out whether a synthetic has merit and, if this has been proved, then how to inform the world of its qualities and insure an ample supply of it without having the introduction of it made by those who are interested in its sale and who, therefore, will not be able to make impartial statements regarding its properties.

The instinct which leads the medical profession to protest against the patenting of remedies is a true one, because, if the thing is really potent to prevent suffering, it should not become a monopoly. Under present conditions it seems to be essential, in order to produce and market the product, that the producer should be assured of the monopoly of it for a given time, but this might be obviated if some such plan as follows were adopted:

An international commission, provided with an ample fund to compensate inventors and to conduct an international research laboratory, to ascertain the value of the drug and, if it is of value, authorize its manufacture and sale and at the same time make the official world-wide announcement as to its properties and effects, any manufacturer to be at liberty to produce and sell it, on the sole condition that he report to the international commission the entire quantity that he sells; the compensation of the inventor to be paid from the international fund and the amount of his royalty to depend upon the quantity of the drug sold; the international commission to determine the percentage of his royalty, which should be generous and could perhaps be better figured on the number of doses than on the number of pounds sold. Such a plan would do away with the evils of medical advertising and would avoid the inflated demand which we have so often experienced for drugs with very moderate merits and often very dangerous properties, a demand created by skillful propaganda and advertising on a huge scale. It would make the synthetic drugs available at moderate prices everywhere and it would stimulate the research chemist, because he would know that if his synthetic product should possess virtues making it worthy of use, he would receive his reward without going through the anxious ordeal of endeavoring to interest capitalists to manufacture and exploit it. Moreover, the prediction can be made with confidence that if such a plan were adopted the number of new synthetic remedies would diminish to such an extent that the medical profession could have a clear view of the situation and not be groping in a fog that necessarily causes distrust of all new remedies. It might well be that only one synthetic worthy of use would appear in a decade, and who shall say that humanity would not be the gainer?

Some manufacturers would continue the effort to develop and introduce their own synthetics, but this policy would be inadvisable and the practice would be reduced to a minimum if penalties were imposed on any one making misleading statements concerning a medicinal preparation, and the international

commission should have it as one of its duties to test the products on the market and confirm or disprove the claims made for them.

The international commission should receive recognition and should receive compensation adequate to secure scientists of the first rank and of the highest personal character. The suggested policy may seem paternal but is it really democratic when contrasted with the corrupt methods of the huge German color factories, with their staffs of experts concealing their processes from each other and teaching only one step to one group of workmen and trying to filch their secrets one from another and bribing the foremen in the dyeing establishments to pay high prices for old colors under new names, presenting an example of commercialized science, which should make every lover of truth and of liberty fight to exalt science to a position where she would be safe from such contamination.—WM. JAY SCHIEFFELIN, Schieffelin & Co., New York City.

In the December issue of the *Journal of Industrial and Engineering Chemistry* writers have quite fully discussed the desirability of an institute for drug research as originally outlined by Dr. Herty. A number of them have outlined plans for the formation and conduct of such an institute.

It seems to me that it is a mistake to limit the plan to the producing of new remedies or, indeed, to the study of synthetic medicines. Undoubtedly, however, a central medicinal research laboratory, such as has been outlined by the various workers, would be found to be of great usefulness and would undoubtedly invite the coöperation of the various societies and associations who have been and are now doing some work in this line, and would be a great boon to many manufacturers who often reach the limit in their own laboratories and who would be glad to pass on to an institute given over to pure research those problems which they feel they cannot pursue and which indeed they should not be called upon to pursue because of the wide-spread bearing upon the science of medicine.

It seems to me that the work of an institute put together as has been outlined would be much more far-reaching than that of any particular association or even of that fostered by departments of the general government.

During the great war a number of efforts were made to cultivate certain medicinal plants, although the number of varieties actually cultivated was very small but in most instances sufficient to avoid what might have been a famine. Unless we are to allow things to drift back to the pre-war status there is much yet to be done. For the most part the work has been done either by interested manufacturers or by the agricultural departments of the various states. The agriculturalists look upon the problem strictly from their own point of view, *viz.*, the growing of a crop that will pay. There yet remain many questions to be answered, such as the production of a better strain, the acclimatizing of certain plants of foreign origin, the improvement of methods of handling, preparation, and preservation. Here chemistry and pharmacology are both involved.

Again, we have a number of native products which would probably form efficient substitutes for those heretofore imported. For this latter there is need of thorough investigation.

Finally, it has been well stated that there is not a crying need for new drugs either natural or synthetic, but we do need to know more about some of the drugs which we already have at hand. I might put the thing in this way: look in the *Pharmacopoeia* and select a dozen of the most common vegetable drugs named therein, look up the literature as embraced in the *Dispensatory* and kindred works, and it will be seen that for the most part that which is written has come down from the ages and much of it is tradition. It has not been checked up or gone into since the original inception. What is known is for the most part historical, in respect to many of them there

is a statement as to what is believed to be the active principle, a routine statement as to the physical and therapeutic action, and that is all. When we come to check up the Galenical preparations made therefrom we find that these preparations have been put together sometimes empirically, that is to say, a certain menstruum of a certain strength is employed probably because it has always been employed and not always with regard to exhibiting the drug in its most potent form to fulfill its therapeutic action.

In brief, a long study could undoubtedly be made of a dozen or more of the most common drugs which we possess which would involve pharmacology, chemistry, and therapy. There remains much to be learned in the study of drugs and thus I believe that an institute of the character which has been outlined would be of great value to the healing art and would be welcomed by manufacturers and individual workers.—FRED. B. KILMER, Johnson & Johnson Laboratories, New Brunswick, N. J.

The first thing that strikes me after reading your editorial for September 1918 and the addresses in your December issue on "An Institute for Coöperative Research as an Aid to the American Drug Industry," is the utter candor of the discussions. The confession that we have no institute as yet in this country where therapeutic advances can be tried out in an unbiased fashion was a brave one to make. I knew this to be a fact. The impression that most Americans had was that medical colleges and the great hospitals of this country were open to this sort of research. As a matter of fact, neither of these have either the facilities nor the inclination required.

In the first place, I heartily agree that there should be such an institute as outlined in the various addresses. It should be free of governmental and commercial control. Pure research should be indulged in.

There are several points, however, at which I disagree with the thoughts expressed. I fully realize that the addresses made were more or less impromptu and simply to give a sense of direction and outline to the work proposed.

The chief objection is that too much stress is laid upon producing synthetic drugs. This is simply harking back to the German idea that man can improve on nature's handiwork. Why we should have synthetic salicylic acid and synthetic camphor as medicines, is beyond my comprehension. I feel sure that if the medical profession had not been misled by the clever German propaganda, they would never have accepted so freely the synthetic products made from the phenol group and the marsh gas group. To simply imitate what the Germans had made would be rather poor work for such an institute as is proposed, for we may rest assured that the Germans have continued their researches even during the war period, and if they intend to continue their before-the-war chemical activities, they will have made improvements on what was formerly introduced into this country from Germany.

In the next place, chemotherapy has assumed too prominent a place in the healing arts and has been stressed too much in the past. It is undoubtedly true that many new compounds of minerals and metals may be devised that would be more acceptable than have been the cruder products employed in the past. But if the institute is to be limited to this sort of work, it will fall short of its possibilities.

As I see the subject, such an institute should take up the entire field of organic chemistry, no matter from which field the raw materials are obtained—mineral, plant, or animal.

The whole question of plant substances as curative agents is really only in embryo. As a matter of fact, no general study has been made of plant substances during the last three or four decades, either in the United States or in any other country, with the possible exception, in a measure, of France. In this country, there has been a tendency on the part of pharma-

cologists to discredit plants upon rather flimsy ground. There has, in the later years, crept into the work of American pharmacologists the dangerous concept that to be effective a drug necessarily must be toxic. Such is far from the fact, as demonstrated by clinical experience.

Even such study as has been made in the past on plant substances, has been of rather crude character. Chemically they have been studied for starches, pectins, and other so-called inert matter, on the one hand, and on the other for alkaloids, glucosides, resins and resinoids, and so-called active principles.

Pharmacologically they have simply been studied from a mechanistic point of view, namely as excitants or depressants of the various organs, such as the heart, lung, kidneys, uterus, etc.

The problems of colloidal chemistry in relation to plane substances and the presence of ferments, open still another very large field for original research. If it be the intent of the organizers of the institute to so broaden the scope of their work, as to include all of these substances in their research, it will have the hearty support not only of manufacturers, but of all physicians generally.

It is important that the work of such an institute shall be investigative and advisory. It should never be clothed either directly or indirectly with dictatorial powers. The moment such dictatorial powers are assumed, the usefulness of the institute is in large measure negated. It must be borne in mind that science is ever progressive and that any facts that are proven are to be looked upon as signposts, indicating the road never to be looked upon as the end of endeavor.

Please do not misconstrue my statements above as in any way opposed to the institute. I simply wish to point out its possibilities and urge that there be no limitations to the study of substances to be employed in therapeutics. I assure you of my hearty support in every way possible, in the establishment and maintenance of such an institution.—CHAS. G. MERRELL, President, The Wm. S. Merrell Chemical Co., Cincinnati, Ohio.

PHARMACEUTICAL CHEMISTS

I am much interested in your editorial in the September issue, entitled "War Chemistry in the Alleviation of Suffering." It may be that a short review of my experiences in attempting to have tested several crystalline substances isolated from certain animal products of a glandular character may be interesting.

These crystalline bodies were the result of several years of tedious research. When the chemical work had been completed, I sought the services of a pharmacologist to make the necessary physiological tests, the results, concisely stated, being as follows: In accordance with my experience, there are in America a very limited number of pharmacologists, and only a few of these are well trained. A few of the better trained ones are in the employ of less than half a dozen large pharmaceutical manufacturing concerns, and their services are not generally available. The remainder and, generally speaking, the best, are associated with the universities, with the exception of those employed in work in endowed institutions, of which the Rockefeller Institute is the chief exponent. The pharmacologists of the universities have, as a rule, limited facilities, limited means, and are overworked. Much of their time, even that of the chief of laboratories, is given to teaching. In my experience, all of these university men are pleased to give advice and make suggestions, but can give no service for two reasons: first, because, as previously indicated, they have more work than they can do; second, and more particularly, because it is generally considered non-ethical to do work for industrial concerns. I would call your attention to Article 2, Section 3 of the Constitution of the American Society of Pharmacology and Experimental Therapeutics, which reads as follows: "No one shall

be admitted to membership who is in the permanent employ of any drug firm."

I have been able to locate several trained pharmacologists—part-time workers in universities—who would have been quite willing to have devoted part time to pharmacological work for the industrial concerns of which I am a member, had it not been for the section of the constitution just mentioned. Pharmacologists of experience and reputation will not, as a rule, devote either part time or entire time to industrial work, because there is a prejudice in professional circles against so doing.

At the present time we still have on hand the crystalline bodies before mentioned, and our investigation is held up until we can have these and other less pure preparations tested. Your suggestion for the establishment of an institute analogous to the Mellon Institute, in which adequate provision for laboratory tests of all kinds will be made, and to which, through the establishment of fellowships, the manufacturing organizations could send well-trained young men for working out specific problems, if carried out, would in my opinion result in a great service to all the people of this country and of the world.

There are one or two questions which I should like to ask in this connection. Are not well-trained young men for pharmacology extremely rare? Would it be practicable to have a corps of trained workers to whom products, preparations, and simple substances might be submitted for testing, and a charge made commensurate with the service given? I am sure that many industrial concerns will be interested in your proposition and will be willing to cooperate, but the only practical way to establish the institution, in my judgment, is to interest some philanthropist in furnishing funds for an endowment.—H. A. B. DUNNING, Hynson, Westcott & Dunning, Baltimore, Md.

To-day there is an insistent demand upon every organized profession, craft, or trade for public service designed to promote the general well-being of all. The public bestows its goodwill and support upon those organizations only that work continuously, forcefully, and creatively for public welfare. Neither chemistry as a science nor the AMERICAN CHEMICAL SOCIETY as an organization will ever outgrow the need for support and encouragement from other professions and from the multitudes untrained in science.

Chemistry has to-day come perilously near being regarded by many persons as useful only in the development of agents of destruction but the need of the science in preventing and curing disease should be and will be made known if the organized profession acting through the AMERICAN CHEMICAL SOCIETY found or control an institute devoted to chemical research on problems associated with the relief of pain and the preservation of health. For its own good name and repute and as evidence of its willingness to promote the public good, if for no other reasons, the Society should work actively for the founding of such an institute.

All of us earnestly desire that science and industry in America shall contain within America all essentials for development and be built upon such broad and strong foundations that any growth of whatever magnitude will be well supported. An institute of chemotherapeutical research will greatly help to place the drug industry of America upon such a solid basis. If approached, the industry will declare itself ready for this institute, will grant it large responsibilities, and will give it many opportunities to prove its worth.

Ample financial resources, coordination of many lines of study, enthusiastic workers, an impartial, exacting, and able board of control will answer the question, "What and who?" But there is another question that will be frequently asked, "Will their report be accepted by the people we wish to influence?" Upon the answer to this question depends largely the position of the institute in its relation to the drug, and associated biological and chemical industries.

Reputable houses in such lines want to know that articles of their production, or which they may plan to produce, are desirable therapeutic agents, but this knowledge has little or no value if kept to themselves. It must be told to others under conditions and for purposes that are legally and economically right. Furthermore, it must be told to a great number because each person may have few opportunities to use this knowledge though at each opportunity it becomes of great importance. These persons must be approached along many and diverse avenues and very many of them will be influenced to finally accept or reject this proffered knowledge by phenomena falling within their own fields of observation. Thorough consideration should be given at the outset to securing the acceptance of the institute's findings either in pure science or on problems arising from coöperation with industry.

Who shall be asked directly to accept these findings? Not the man in the street, let us decide at once.

Through what channels shall these findings be presented and how controlled?

Ignoring these questions will not prevent the asking; they bear directly upon the steps to be taken in effecting the organization of the proposed institute.

In deciding the merits of an article used for the cure of disease, the balance and other instruments of precise measurements upon which chemistry relies are not the only witnesses to be heard. Those who desire to reach truthful and widely-accepted conclusions in therapeutics, must tread cautiously and travel far.

To establish a testing laboratory for drugs, a research institute for the study of chemical therapeutic agents or of synthetic organic chemicals, or to demonstrate that chemistry should be more extensively applied in the study of suffering are each and all projects worthy of the best efforts of any ambitious society or group of men. Their accomplishment is more probable now than it has ever been before. The Advisory Committee to whom the New York Section resolutions were referred may well find that the organization or control of the proposed institute very properly falls within the Society's activities and that it is a feasible and practical solution of difficulties which frequently confront members of the Society.—A. D. THORBURN, Pitman-Moore Company, Indianapolis, Ind.

RESEARCH INSTITUTES

I have nothing to add to the statement made by my colleague Dr. P. A. Levene. The ideas which he expresses and the mode of procedure he proposes meet my full approval.—JACQUES LOEB, The Rockefeller Institute for Medical Research, New York City.

The reports of the symposium on the subject of a research institute for the development of chemistry as applied to medicine must be vitally interesting to all who are concerned with the development of a rational independence for our country, especially to any who are either from choice or necessity concerned with the narrower operations of any of the many particular sciences or businesses involved. That we may be able to re-direct a potent fraction of the enormous energy, which as a people we have recently so happily exerted for our own protection and the success of our friends, into an activity of this nature, is profoundly desirable.

Objections and difficulties obtrude themselves when the problem is viewed in detail and in the light of experiences which one can too easily recall from his memory. To me the chief of these was rendered negligible by the spirit displayed by those participants in the discussion of November 8 who most directly represented the industry. That Mr. Eldred should see so clearly that much of the outstanding activity of the past has been simply exploitation; and that Mr. Jayne should insist that the

future of the industry must depend upon the merit of the products rather than upon advertising, and also that the organization under discussion should tend to assure this by being strong enough in both ability and integrity to dominate the situation,—these are expressions of opinion which certainly can be considered a sufficient answer to the fancy that much of the energy of such an institution need be worn out in putting useless products or ideas in the scrap.

In general, then, I agree with the earlier participants to the discussion in believing that there is a distinct need for such an organization or institute. I think that the AMERICAN CHEMICAL SOCIETY is the only body at present organized which could hope so to combine the interests involved as to give the project a chance of success, and that it is highly desirable (from the point of view of one who is not a member) that the Society should take the necessary initial steps with promptness and vigor.

As to the scope of the work of such an institution, it is evident that each person will be biased by his particular experience, and it is possible that for the present it will be most helpful that each should express such views as those experiences have given rise to. My own belief is that the institute should concern itself primarily with research in the field of organic chemistry, especially synthetic, and that in its applied aspects particular attention should be paid to the field of pharmacology and therapeutics. Physiological chemistry, as it has been understood by most, and the analysis and processing of natural products as they have concerned the industry of the past will receive consideration secondarily as fields from which valuable indications for work may be drawn.

In carrying out the purpose effectively there will naturally be gathered together a certain number of research men of the highest possible standing. The problems of the institute as such will, as a matter of fact and regardless of the most careful planning in advance, be those in which these men become interested after they are collected together. Limitations on the freedom of choice of these men in their personal researches cannot, of course, be made. Over and above their individual interests it may, however, be expected that the staff of the institute individually and as an organization will assume certain broader duties. Thus they will endeavor to advance the interests represented by the institution by coöperative aid extended to others working in the field but not supported by the institution.

Concretely, active work is called for in an educational way among both chemical manufacturers and teachers of organic chemistry. Manufacturers need to be taught that there are near at hand large advantages to be derived from an exchange of ideas and products and that these advantages can for the most part be had without endangering in any way their proper possession of trade secrets. This is most certainly true if emphasis is laid on products and their properties rather than on processes. Teachers of chemistry need to be shown that while they are teaching their students processes and reactions in practical courses they may be of the greatest service by actually producing a wide variety of compounds which, if cared for, could be put to good use either by themselves or others. An important item in this educational work would be the maintenance of a working museum of chemicals, to which manufacturers and teachers and research workers should alike contribute, and from which properly qualified persons might withdraw samples and be furnished with reliable information as to where further supply might be obtained.

A working laboratory might by coöperation with manufacturers also be established where the latest models in apparatus should be installed and where qualified individuals, not on the institute staff, would be welcomed to put through particular processes and reactions required by their own researches but not otherwise available to them.

The services to be rendered by such an institute to manufacturers have been well developed by other parties to this discussion.

The control of the institution and its policies might well be divided in such a way as to separate in considerable measure the responsibility of the scientific work and the finances. The financial advisers might well be selected from among those who have shown a capacity to make money by reason of their knowledge of chemical processes, and who may have a "dollar a year" interest in promoting chemical and medical research.

The scientific control should be entrusted to a board of trustees or advisers which should be made up of a well-balanced combination of men who have succeeded in the field of, first, chemical research; second, medical research; third, the management of research activities in either chemistry or medicine; and fourth, industrial research in chemistry.

Such an institute at present would be faced at once with a fundamental question of policy, *i. e.*, the necessity of reaching a clear-cut decision as to its attitude toward patents on medicinal preparations. It is highly desirable that the institute, if it is established, should never have to consider this matter, but this can be avoided only by having an agreement reached between chemists and medical men on the patent question before the institute is put into operation.

The attitude of the medical profession on the patent question has seemed in the past to be clearly defined, but it has become apparent that the letter of the medical law does not fit modern conditions. It would, on the other hand, be a national calamity if the spirit of those articles in the code of ethics which absolutely prohibit a physician becoming party for profit to the exploitation of manufactured products in their application to medicine should be in any manner lost sight of. Would it not be well for properly appointed committees of the AMERICAN CHEMICAL SOCIETY and the American Medical Association working together to formulate a policy to which both professions could unhesitatingly subscribe as being in the public interest.—PAUL A. LEWIS, The Henry Phipps Institute of the University of Pennsylvania, Philadelphia, Pa.

In the December issue of the *Journal of Industrial and Engineering Chemistry* appear various addresses delivered at a meeting of the New York Section of the AMERICAN CHEMICAL SOCIETY, on a proposed institute for coöperative research by manufacturers, chemists, and investigators in the medical sciences: The objects of such an institute are outlined as (1) an aid for the development of the American drug industry by scientifically testing and establishing the values of their products and improving already existing products, and (2) a great central station for extensive chemotherapeutic investigations for the alleviation of human suffering, by finding new remedies and drugs as yet unknown. The two objects are, of course, intimately connected, and success in the attainment of the second would cause vast strides in the first.

The speakers at the symposium have already fully covered the field as to the fundamental principles which should govern the formation of such an institute. Certain ideas which have been advanced should be further emphasized to assure the success of such an institute on a large scale. Such a project naturally divides itself into two parts: (1) Coöperative research and pharmacological and therapeutic testing for the manufacturers and outside chemists, and (2) pure research for new remedies, which will involve a great deal of theoretical investigation on the relation of chemical constitution to pharmacological action by pharmacologists and organic chemists, aided by biochemists, bacteriologists, physical chemists, and other specialists as needed. Too much emphasis cannot be placed upon the second part of the institution, the pure scientific research. The institute, as I understand the plans, is a Peace institution as opposed to a War one, that is, one which is not

necessarily limited by time for the solution of its problems, but one which is building for all time, for the relief of suffering and the happiness of the human race. The testing division of the institute can deal with the immediate needs for improvements by the manufacturers, while the other part will concern itself with more prolonged problems which may take years for solution, but which, if solved successfully, will yield immense rewards in the advancement of knowledge, the relief of suffering, a tremendous stimulus of the drug industry, and great financial return. As an illustration, the problem of chemotherapy for any one of the better-known and widespread bacterial diseases is by no means a hopeless one, but one, however, which is to be solved only by such facilities and coöperation as outlined for this institute. The attempts which have already been made in the chemotherapeutic study of bacterial disease, although not eminently successful, would warrant a group of coöperative investigators giving their lives to the problem. If successful, the results would be more far-reaching than Ehrlich's salvarsan. As regards the personnel of such an institute, there is no question that eminent men and specialists of the highest order should be selected for the important posts. The investigators should be given the utmost freedom of action and the most perfect support possible. Every searcher after truth has found that the important end-result of many an investigation is far removed from the initial impetus that started it. One feature of the personnel which would seem desirable is that the institute should have some arrangement whereby it could secure temporary service from investigators in the universities and industries, because so frequently when a problem touches a field in which some investigator is an eminent master, it can be solved more accurately and quickly by this man than by any other.—E. K. MARSHALL, JR., American University Experiment Station, Washington, D. C.

UNIVERSITIES

Replying to your letter of November 27 requesting an expression of opinion on the subject of an institute for the study of drugs I will say that this is a subject which has long interested me.¹

The subject was so well covered at the recent symposium that I can add little. There is one point, however, which I think should be especially emphasized, the need of absolute freedom in research on the part of those in charge of such an institute; they should be free at any time to discontinue work on one class of compounds and take up the study of another class. Similarly they should be free to abandon research on one disease and take up that on another. The importance of this entire freedom may be illustrated by Ehrlich's discovery of salvarsan. This discovery is the most notable achievement in this field and since its very beginning has not been described. As I am probably the only person familiar with it, it may be of interest to record it; it illustrates the accidental way in which an important research may begin. Nocard visited Ehrlich's laboratory in 1902 and told of his work on certain pathogenic trypanosomes and Ehrlich requested him to send the institute an infected rat. A few days after Nocard's visit I, who was working in the Institute, received from Ehrlich a note (which I happened to keep), suggesting that I try the effects upon the trypanosomes of certain substances in which I was interested. Among the drugs suggested were certain dyes and some quinine derivatives (the study of one of which later led to the work on ethylhydrocuprein, a compound which seems to just miss being of value in an entirely different disease, *viz.*, pneumonia) and also atoxyl. (The mention of atoxyl in this note, which bears the date of Dec. 12, 1902, is of interest in view of the contention recently made that Ehrlich got the idea of trying the arsenic compounds, which ultimately led to salvarsan, from the work

¹ See, for example, *J. Am. Med. Assoc.*, 49 (1907), 1690.

of some English investigators some years later.) My own work was soon interrupted but it was continued by others. At first the relation of dyes to trypanosomes was studied, then the effects of certain arsenic compounds upon these organisms, and finally the effects of the arsenic compounds upon spirochetes. This led, after 7 years of intensive work, to the discovery of salvarsan. The point I wish to make is that had Ehrlich been limited to a study of the pharmacology of dyes (which might easily have been the case had his work at that time been financed by a dye manufacturer) he would not have discovered salvarsan. Similarly, had an unwise government restricted Ehrlich's researches to trypanosomes (in which the Berlin officials were deeply interested from their desire to find a means of checking the ravages of sleeping sickness in the German African colonies) the remedy for syphilis probably would not have been discovered. There has been a tendency in this country to restrict researches to definite subjects; this is shown by the large appropriation of the Government for the study of pellagra, for example, and of private endowments for cancer research.

In an institute of the kind proposed the chief investigators should have absolute freedom of research. But this would not preclude the inclusion of organizations within the institute to study the action of certain groups of chemicals (dyes and their precursors, for example) on the one hand, or remedies for certain diseases on the other. The inclusion of such organizations would be most desirable from every standpoint; it would give chemical manufacturers an opportunity to have their products tested for useful and also for possibly harmful properties, and it might encourage the manufacturers to contribute in various ways to the support of the institute. But the latter should be so well endowed as not to be wholly or even largely dependent upon support contributed for studies on specific subjects.

An institution along somewhat similar lines has recently been established at the Harvard Medical School. A group of public-spirited manufacturers (chiefly of New England) have provided funds for work in industrial hygiene, the problems to be undertaken to be determined by the faculty. In addition, certain manufacturers have provided funds for the investigation of special problems in which they are particularly interested. One of the functions of this organization will be the investigation of chemical compounds used in the industries in the hope that in the future such widespread injury to employees as has resulted in the past in certain chemical factories may be avoided.

As to the need of an independent, well-endowed institute of the character suggested at the symposium there can be no doubt. Such an institute should not only provide ample facilities for its own workers but an equally important function would be, as has already been suggested, to assist workers at university and other laboratories. In your editorial on "War Chemistry in the Alleviation of Suffering" you report a conversation with an organic chemist who was perplexed as to how he could get his products tested. A similar conversation is very likely to occur whenever two or three American pharmacologists are gathered together. "But where can I get such a compound?" is a very familiar question and the usual answer is, "You can not get it at all in America." And the compounds in question are often such as can be easily and cheaply made but the pharmacologist can not suspend his own special work to make them, even if he has the facilities and training to do so. Hence, an important function of such a proposed institute would be the providing, at cost, or at a moderate profit, of chemical compounds, drug plants, etc., to independent workers; the same effort should be made to supply outside investigators with such material as would be made to supply its own members.

It would surely seem that an institute of the kind suggested, which not only would have its own independent investigators but which would offer facilities for special workers and be of so much assistance to university and other investigators, should

appeal to broad-minded philanthropists; the studies in such an institute would surely contribute as much to the welfare of man as do the magnetic surveys, geophysical, embryological, anatomical, nutrition, and other institutes which have been founded in this country.

But the foundation of such an institute should not be interpreted by government and university officials as relieving them of a responsibility to foster work of this kind. The universities need pharmacological laboratories not only for research but for purposes of instruction, and the experience of the last few years should have convinced lawmakers that scientific investigation is too vital to the welfare of the country to be left to chance or charity. It has been estimated that the profits obtained from the people of the United States by German drug manufacturers in recent years would have enabled Congress to appropriate for such studies \$100,000 a year for a century or more.

It may not be generally known that when the late Surgeon General Wyman in 1902 secured the enlargement of the U. S. Public Health Service and of the Hygienic Laboratory he included a division of pharmacology; this was the first recognition of this subject on the part of the Government and was at a time when but two or three of the universities had independent chairs in pharmacology. It was General Wyman's idea that such a division should primarily endeavor to discover new drugs and that it should work in coöperation with the other divisions (chemistry, bacteriology, pathology, and zoölogy, including parasitology) of the laboratory and the score or more Public Health Service hospitals. But various circumstances have prevented this laboratory from fulfilling the high purposes which both General Wyman and Congress had in mind. This would seem to be an opportune time to urge Congress to increase the resources of this laboratory and to make the positions in it more attractive to investigators.

Finally, a few words may be added as to the functions of the universities in the development of work of this character. The contributions which university pharmacological laboratories (chiefly German) have made for the alleviation of suffering are often overlooked. Thus many of the most important drugs—drugs which have stood the test of time—discovered in the last 50 years, *i. e.*, since the development of scientific pharmacology, owe their origin to the investigations in university pharmacological or closely allied laboratories. The discovery of the action of chloral hydrate (the basis of most of the subsequent work on the halogen-containing hypnotics), paraldehyde, antipyrin, sulfonal, the urethane group of hypnotics, strophanthin, physostigmin, cocaine, the nitrites, theobromine and other purine diuretics, and the suprarenal extract, need only be mentioned. Yet pharmacology in the universities of the United States is in a primitive condition; in some institutions, owing to lack of funds, or in other cases to a failure to appreciate the full meaning of pharmacology, this subject is still combined with some other subject, always to the detriment of pharmacology.

While, however, the study of pharmacology by the Government and by the universities should receive every encouragement, an institute such as that proposed would fill a place not occupied at present and would be of more immediate interest to the members of the Chemical Society, and the institute would, in turn, profit more by their interest.

It is one of the tragedies of history that the means of relieving suffering for which the whole human race has most passionately yearned have at times been in the hands of man years or even centuries before their value was ascertained. Ether, for example, was well known for three centuries before its anesthetic properties were discovered; the crudest of pharmacological experiments would have shown that this drug had the pain-preventing properties dreamed of since the time of Adam. Carbolic acid, the use of which by Lister paved the way for

modern surgery with all that this means, had been known to chemists for years when Lister first used it. Chloroform, chloral hydrate, the bromides, cocaine, and many other valuable drugs had the same history. There can be no doubt that the present generation is overlooking equally or even more valuable drugs simply because few of the new compounds being discovered are tested from this point of view.—RED HUNT, Department of Pharmacology, Harvard University Medical School, Boston, Mass., and President, American Society for Pharmacology and Experimental Therapeutics.

The proposal for a national pharmacological institute as outlined in the addresses before the New York Section of the AMERICAN CHEMICAL SOCIETY on November 8, 1918, is most interesting. Dr. Herty's invitation to contribute something to the further discussion of this plan moves me to call attention to two points requiring further emphasis—the question as to whether the fundamental viewpoint is to be medical or chemical, and the problem of the relation of our universities to the proposed institute.

In the first place, what is to be the institute's chief object? As I understand it, the alleviation of human suffering by every possible means upon which the science of chemistry has a bearing. The alleviation of suffering being desired, whence must come the initiative? Obviously from the one who is in contact with the sufferer.

Indispensable as it is to pharmacological achievement, the chemical viewpoint cannot serve as the sole guide; medical sciences must be the starting point.

A concrete example may clarify this contention. A man wishes to discover the ideal antipyretic drug. He must first acquaint himself with the physiology (physical and chemical) of heat regulation. He must then gain a conception of the pathology of fever in general and determine the individual peculiarities of those forms of fever which require antipyretic treatment. He should proceed further to test upon animals and man at least one member of each of the best classes of antipyretics already known. He must determine their effects, if any, upon the normal regulation of bodily heat. This will require not merely accurate measurements of body temperature but studies of the total metabolism and of the separate mechanisms by which bodily heat is dissipated. A *sine qua non* is, of course, the exclusion of toxic side effects. Attention may then be turned to like tests upon febrile individuals. To clear up satisfactorily every point thus far involved would require more than a lifetime. Yet it is obvious that such preliminary investigations must precede consultation with his colleague in organic chemistry relative to the structural modification of the most promising drug. It is surely better that the pharmacologist spend his life in such a biologically directed search than in the promiscuous testing of those substances which the synthetic chemist happens to find easy of preparation or the industrial chemist discards as superfluous by-products.

Emphasizing again that we cannot dispense with the chemical viewpoint, let the guiding motive of an institute for the alleviation of human suffering be medical.

In the second place, what part should universities take in the work of the national pharmacological institute? I am inclined to the belief that it should be at least the major part. A multiplication of institutes devoted solely to research may, in time, defeat its own end by drawing away from the medical schools men who are not only efficient in research but in inspiring and training subsequent generations along lines of investigation. The supply of thoroughly trained pharmacologists is dangerously small at the present time. To furnish, however, a more adequate number in the future the medical investigator's profession must be made more attractive financially. This is the opportunity of the university.

The correlation of chemistry and therapeutics can, I believe, be far more extensively developed within the confines of the leading universities than it is at present. Broad pharmacologic vision is needed. By all means have a central national institute of the highest grade, provided it does not detract from the development of pharmacology in medical schools. In addition to the minor functions of the institute, such as the provision of a central chemical collection, library, etc., as well as a "censorship" for pharmacological suggestions which would be welcomed from all sources, *e. g.*, chemists, pharmacists, and medical practitioners, there might be attempted some sort of coördination of the work being done in the separate schools. Steps would, of course, be taken against violation of the independence of the individual investigators. In a given university, however, all departments concerned should, if adequately financed for the purpose, be willing to devote a generous amount of attention to the particular field of work which might be assigned to or selected by that particular school.

The division of topics should be along physiological lines. For example, chemists, pharmacologists, pathologists, and clinicians might concentrate in one university upon local anesthetics, in another upon cardiac and vascular remedies. Some schools might be best adapted to the investigation of the chemotherapy of certain diseases, for example, pneumonia, tuberculosis, or syphilis.

Upon the pharmacologist in each university would perhaps devolve the duty of representing the central institute and of coördinating the work.

Each department concerned should control one or more fellowships founded for the purpose of coöperation upon pharmacological problems. The organic chemist would, of course, supervise the synthetic work. The department of medicine would be equipped to provide the cases and make the clinical tests in a ward set apart for the purpose. The pathologist, bacteriologist, and serologist would be provided with everything necessary for developing their sides.

The pharmacologist, in addition to the work of coördination, would supervise the tests for toxicity, the necessary tests upon various organs in animals, and as far as possible in man; but he should do more. He should develop the relationship between the problem in hand and the much neglected field of general pharmacology.

General pharmacology must be made attractive to graduate students. Benefactors of the institute should be led to appreciate its fundamental importance. The relation of chemical constitution to physiological action is but one of its phases. We are, for example, practically in darkness as regards those questions which relate to the precise mode of action of chemical substances upon living cells. The mechanisms also of absorption, distribution, fixation, and excretion of drugs in the animal organism are but superficially understood.

The above outlined suggestion as to the part universities should play in forwarding the aims of the national pharmacologic institute offers one very distinct advantage, it provides for more extensive utilization in this type of work of facilities now available. They can be widely developed for coöperative investigation in chemistry and medicine if the authorities can be made to appreciate the extent of the opportunity.

Is our condition still so pitiful that Elihu Root is justified in saying of research and the problem of its organization, "It cannot be successful if parcelled out among a lot of universities and colleges to be done by teachers, however eminent, and students, however zealous, in their leisure hours?"¹

Pharmacology may be as much in need of national organization as are other sciences, but conditions must be made favorable for keeping it where it belongs,—in the university medical school.

¹ *Science*, 48 (1918), 533.

This is, I realize, but a one-sided presentation of the institute question. Numerous phases have been left untouched. It is, however, of the greatest importance that medical men should take the lead in such a movement and that medical schools should thereby be developed and not depleted.—HENRY GRAY BARBOUR, Yale University School of Medicine, New Haven, Conn.

The papers read at the meeting of the New York Section on November 8, 1918, and your editorial in the September issue of the *Journal of Industrial and Engineering Chemistry* on the subject of an institute for research on the pharmacology and the chemistry of medicinal substances have interested me greatly, not merely as a member of the AMERICAN CHEMICAL SOCIETY, but chiefly as an officer of the American Pharmaceutical Association.

This Association, founded in 1852, has been aptly called "the clearing house of American Pharmacy" and it has been the fond dream of some of its members¹ for twenty years that an undertaking similar to that now suggested by you might come into being.

During the past few years two steps in that direction have been taken by the Association. The first is the idea of federation of the national associations of American pharmacy—manufacturing, jobbing, retail, and educational—and a committee, of which I have the honor of being chairman, has been studying the question during the past year. The second movement in this direction has been the creation, by the Association, of a Committee on Research, of which I had the honor last year of being chairman, to which has been entrusted the dual duty of encouraging pharmaceutical research and of administering, under the care of the council of the Association, the American Pharmaceutical Association Research Fund.

This fund represents the net profits accruing from the publication and sale of the National Formulary, one of the standards under which the national food and drug law is administered. This book, originally a purely private enterprise of the Association, having thus become an official book of legal standards, the Association wisely decided that its profits should be used for the common weal rather than for the advantage of its members, hence the establishment of this research fund in 1916.

Half of the interest on this fund is available until the fund reaches \$100,000 and thereafter the entire interest may be devoted to research problems.

On January 1, 1918, the fund amounted to \$7,043.41, an amount that is constantly increasing as the sales of the National Formulary continue, and it is hoped to have the fund further augmented by gifts from other sources.

You may be interested in noting that quite a number of the members of the American Pharmaceutical Association research committee (consisting of H. V. Army, of New York, G. M. Beringer, of Philadelphia, J. A. Koch, of Pittsburgh, Henry Kraemer, of Ann Arbor, Mich., E. Kremers, of Madison, Wis., C. H. LaWall, of Philadelphia, F. B. Power, of Washington, W. L. Scoville, of Detroit, A. B. Stevens, of Ann Arbor, Mich., and H. M. Whelpley, of St. Louis) are members of the AMERICAN CHEMICAL SOCIETY.

With the information in hand you will note that the American Pharmaceutical Association has among its aims work along the same lines you advocate. As was well pointed out at the meeting of the New York Section by the representatives of the Bureau of Chemistry, of the Rockefeller Institute, and of the Mellon Institute, the work contemplated is so vast that the

several available agencies can attack the different phases of the same problem without friction and without unfriendly rivalry. But on the other hand, coöperation means unified and conserved energy, whereas competition means energy wasted by working at cross purposes. It therefore seems to me that from the beginning an attempt should be made to correlate our efforts along the lines of research.

It would be the height of bad taste for me to attempt to speak at this juncture for either the American Pharmaceutical Association or for its Committee on Research, but I am certain that my associates will agree with me when I say that "team work" will bring far better results than will the independent efforts of several organizations.—H. V. ARMY, College of Pharmacy, Columbia University, New York City.

The wisdom of the establishment of a national institute for drug research is so obvious, that one wonders why the subject needs discussion. Such discussion is not necessary for those engaged in any branch of medical research. It is well known that our most valuable drugs have untoward actions that the combined efforts of the chemist and pharmacologist could unquestionably improve, and the value of their combined efforts in all branches of therapeutics cannot be overestimated. A few specific instances may be cited. In cancer of the gastro-intestinal tract, or in any other region for that matter, life is made bearable or relatively comfortable by the use of opium alkaloids. However, the pain-relieving effects of morphine are offset by the serious drawback of its constipating action. Atropine is a valuable drug in menstrual troubles, but its action in drying the secretions of the mouth and in dilating the pupil almost precludes its use in these cases. Quinine, the specific for malaria, has many serious untoward actions collectively termed cinchonism. *Cascara sagrada*, our most valuable remedy for chronic constipation, because of the griping it frequently produces seriously handicaps its use. The salicylates in rheumatism, salvarsan or the iodides in syphilis, thymol in hookworm disease, etc., etc., are all valuable remedies, yet all produce untoward symptoms, and all have, because of these actions, been the cause of death. All of these drugs might be improved by modification, and substitutes might be found vastly superior to the original drug, substitutes that are not merely palliative, but curative.

Marked improvement in many preparations has been made by the substitution of an amido group here, or a nitro or ethyl radical there. These cases are so numerous that examples need hardly be given. The introduction of ethyl for the hydroxyl hydrogen in alcohol has given us our best anesthetic. The introduction of nitro groups for the corresponding hydrogen in glycerin has given us nitroglycerin, one of our best remedies for angina pectoris. The introduction of ethyl groups into acetone has given us some of our most valuable sedatives. The search for an artificial quinine has led to the discovery of our most valuable antipyretics. In fact, haphazard, almost blind, groping has unearthed so many valuable remedies that a scientific basis for prediction is almost established. The possible results of the combined efforts of the pharmacologist and the chemist in this way are almost unlimited. The one knows what might be expected from such substitutions and introductions, but cannot make these; or if he is able to do this, can accomplish but a small fraction of a great volume of obvious work. The chemist knows how to introduce and substitute any atom or radicle almost at will, yet, so far as physiological action is concerned, he must work rather blindly. The combined attack of two men trained in these different fields would be decidedly synergistic, and the possibilities are unlimited.

Besides a direct attack on the many scourges of mankind the work indicated will do much to clarify the mechanism of life itself, and so open the way to the counteraction of all bodily ills. The great problem of the action of optical isomers in itself

¹ See Eliel, *Proc. Am. Pharm. Assoc.*, 46 (1898), 225; Lyons, *Am. J. Pharm.*, 73 (1901), 137; Simon, *Ibid.*, 73 (1901), 138; Kremers, *Ibid.*, 73 (1901), 139; Scoville, *Ibid.*, 73 (1901), 86; Beal, *J. Am. Pharm. Assoc.*, 1 (1912), 1189; Wulling, *Ibid.*, 6 (1917), 780; Arny, *Am. J. Pharm.*, 73 (1901), 92; *J. Am. Pharm. Assoc.*, 2 (1913), 510; *Am. J. Pharm.*, 89 (1917), 175 and 448.

may open a fruitful field. The facts that certain moulds can ferment dextrotartaric acid and not levo; that yeast will ferment such sugars as *d*-mannose, *d*-glucose, or *d*-fructose, but will not ferment *l*-fructose, *l*-glucose, *l*-mannose, or *l*-galactose; and that dextrohyoscyamine, dextro-epinephrine, etc., are so much more potent than the levo forms, are full of suggestions for work that can be successfully attacked only by combined effort. Countless examples of promising fields of research might be cited, which few, if any, laboratories have either equipment or support to attack. For example, the recent work of Kendall in isolating the hormone of the thyroid gland, now used in the treatment of goiter, required tons of material; cancer of old age is thought by some to be due to deficiency of thymus hormone, but just at present no laboratory, because of the expense and the amount of thymus needed, can begin work on such a suggestion. All such problems could be hopefully engaged by an adequately equipped national institution for drug investigation, or a national institute of pharmacology or chemotherapy. The expense of such an institute must be considerable, but in comparison with its importance and its possibilities for human welfare and the relief of suffering, any expense is relatively small.—HUGH MCGUIGAN, College of Medicine, University of Illinois, Chicago, Ill.

The several titles of papers presented in the symposium give indications of almost fundamental differences in conceptions of the objects sought in founding an institute of research such as has been proposed.

The editor speaks of "An Institute for Coöperative Research as an Aid to the American Drug Industry," clearly suggesting a purely utilitarian direction, while others who participated in the discussion appear to entertain ideas of research in pure science as a part, at least, of the functions of such an institute.

I am in hearty sympathy with the effort to develop American synthetic drugs, and take it that one may discuss the problem either from an idealistic, or a practical, point of view. The idealistic is of value as suggesting the general direction toward which the practical should develop so far as is possible within its limitations, and these limitations will depend upon the breadth of view of those whose interest in the problem can be aroused.

Without attempting to outline the scope of an ideal research institute completely, one may suggest a starting point, and the ideal research institute should have no limitations of development. Certainly it is highly desirable that it should include as much of the following organization as possible, but, on the other hand, there is no reason why a beginning should not be made long before it is possible to secure all that is desired. A university in its simplest form has been defined as consisting of a student and his preceptor seated on a log, but no one has ever successfully outlined an absolutely ideal university, or attempted to place any limitation on its scope. An institute of the character proposed would be almost, if not quite, equal to a university in scope.

In its simplest form it might begin with a laboratory accommodating a competent chemist and a capable pharmacologist. The need would soon be felt for capable assistants in both fields, and this in turn would lead to the demand either for a special hospital equipped for clinical study of synthetic drugs which the pharmacologists had found deserving of such study, or for affiliation with an established hospital where such studies could be made, the first being ideal, the second an approach to it.

The clinical study of drugs is far more difficult than the chemical and pharmacological as a rule. The problems of clinical study embrace all of those of the pharmacologist and many peculiar to therapeutics, hence, the hospital should have well-equipped laboratories of bacteriology and clinical pathology, and in time, others in addition.

More important by far than the mere number and variety of the several departments in such an institute, and even of the

capabilities of those who occupy the chief positions, is the question of its organization, especially with reference to the attitude of those who investigate the pharmacologic and therapeutic uses of newly discovered agents.

There is discernible in the discussion a note of enthusiasm regarding the probable financial returns resulting from such an institute of research. It is only human to look for financial rewards, and there is no reason why the chemist who discovers a valuable product should not profit from his discovery, but abundant experience teaches that it would be dangerous to permit those who decide upon the pharmacologic and therapeutic virtues of a product to profit by their opinions. It is obviously just as meritorious for the pharmacologist and the clinician to discover the disadvantages of a drug as it is to point out their partial advantages, and it is equally obvious that it would be wrong in principle to permit an arrangement whereby it would be to the interest of the pharmacologist or the clinician to render a favorable report.

Furthermore, it seldom happens that a single pharmacologic or therapeutic investigation results in conclusions that do not undergo important revision in the light of subsequent experience, but there is a strong tendency to attempt to justify a previous favorable opinion concerning a remedial agent, when subsequent experience shows that it is less valuable than the investigator had been led to suppose, and this is especially true when one has induced others to invest money on the strength of his opinion, or where he profits by the exploitation of it.

Naturally, if the pharmacologist and the clinician are debarred from profiting by the results of their favorable opinions, they must be protected against loss of position and other disadvantages as the consequence of them; in other words, they should be insured entire freedom of action in the broadest sense of the word.

These conditions entail difficulties, and it has been whispered more than once that the near relatives of eminent scientists have profited financially through the successful exploitation of remedial agents, and not a few men of eminence have been suspected of profiting by the sale of preparations, their faith in the virtues of which was not shared by the majority of physicians. Of course, the difficulties presented offer no argument against the establishment of such an institute, but they do call for most careful consideration, and they render it imperative that such an institute shall be under the direction of an independent, conscientious, capable director.

Everyone is familiar with the fact that several of the great chemical firms engaged in the manufacture of dyestuffs in Europe have introduced great numbers of synthetic drugs that have proved profitable in the extreme, but, on the other hand, this exploitation has gone far toward creating a condition of therapeutic chaos, in which physicians and writers of textbooks have been largely dependent on the statements of those who were directly or indirectly interested in the exploitation of these drugs.

It is suggestive, to say the least, that when the Council on Pharmacy and Chemistry of the American Medical Association undertook to prepare a list of all of the really essential drugs used in the treatment of the sick it included only about a score out of the many hundreds of synthetic drugs which have been introduced within the past thirty years with such optimistic therapeutic claims.

Dr. Abel had this in mind when he formulated the two conditions that were requisite for such an institution: "(1) A sufficient endowment to make the institute independent of outside influences. (2) The Board of Trustees of this institute must see to it that those selected for the leading positions are men of ability and promise, whose one interest is research of a high order, whether in the field of pure or of applied science."

It is hardly necessary to say that I realize that the plan for

such an institute involves a great deal of study and that one can do no more in a brief discussion of this sort than call attention to some of the phases of the problem that must be given most thoughtful consideration if the institute is to become a great force for good rather than merely a means for securing the exploitation of synthetic products that offer means of making money.

There is one point that I do not feel inclined to pass over without a word of comment, though I am not in a position to enter into a complete discussion of it at this time. I refer to the coöperation of the several departments of existing medical schools. There is no inherent reason why there should not be the freest coöperation between the institute and such departments of medical schools; on the contrary, it would be an evidence of weakness should it be impossible to secure such coöperation. It is quite true, however, that pharmacologists in medical

schools often feel impelled to refuse to investigate proposed remedies, because experience has shown that a favorable opinion might be used in the exploitation of the substance, while equally important disadvantages were ignored.—ROBT. A. HATCHER, Department of Pharmacology and Materia Medica, Cornell University Medical College, New York City.

The institute, especially according to the draft of Professor Abel, would promise to facilitate the sort of coöperation between research and industry that is absolutely necessary for the national development of the field: a coöperation which is very difficult without some such mechanism.

I should be very glad to help to further the plan to the extent of my ability.—TORALD SOLLMAN, Pharmacological Laboratory, Medical Department, Western Reserve University, Cleveland, Ohio.

SCIENTIFIC SOCIETIES

REPORT OF THE COMMITTEE ON THE ANALYSIS OF COMMERCIAL FATS AND OILS¹

To the Division of Industrial Chemists and Chemical Engineers, American Chemical Society:

Your Committee on the Analysis of Commercial Fats and Oils, begs leave to report as follows:

This Committee has been meeting regularly, holding, as a rule, one meeting each month, for the past several years, and has adopted methods of analysis, after much coöperation work, on September 22, 1916, January 13, 1918, and September 4, 1918.

The methods adopted on September 22, 1916, and January 13, 1918, were published as TENTATIVE STANDARD METHODS FOR THE SAMPLING AND ANALYSIS OF COMMERCIAL FATS AND OILS, in the *Journal of Industrial and Engineering Chemistry*, 10, (1918), 315.

The Committee begs leave to present herewith a reprint of the TENTATIVE STANDARD METHODS FOR THE SAMPLING AND ANALYSIS OF COMMERCIAL FATS AND OILS already published, with corrections, and also a typewritten copy of the methods adopted September 4, 1918, which have not as yet been published.

The Committee desires that all of these methods be now referred to the *Supervisory Committee on Methods of Analysis*, of which Dr. W. F. Hillebrand is chairman, for final recommendation and adoption by the AMERICAN CHEMICAL SOCIETY, as standard methods.

The membership of this Committee is at present as follows:

| | |
|-----------------------------------|------------------|
| W. D. Richardson, <i>Chairman</i> | P. Rudnick |
| W. J. Gascoyne | L. M. Tolman |
| H. J. Morrison | J. J. Vollertsen |
| J. R. Powell | |

As the Committee is still working on further methods of analysis, which are important to the fat and oil industry, it requests that it be continued in existence by the Division until this work is completed.

SWIFT AND COMPANY
CHICAGO, ILL.

W. D. RICHARDSON
Chairman

CORRECTIONS TO TENTATIVE STANDARD METHODS FOR THE SAMPLING AND ANALYSIS OF COMMERCIAL FATS AND OILS

To September 4, 1918

SAMPLING²

2. SAMPLING FROM CAR ON TRACK—(b) *When contents are liquid.*

Add to this paragraph the following sentence: "In place of the device described above, any sampler capable of taking a

¹ Presented at the Cleveland Meeting of the American Chemical Society, September 10 to 13, 1918.

² THIS JOURNAL, 10 (1918), 315.

sample from the top, bottom, and center, or from a section through car, may be used."

ANALYSIS

SOLUBLE MINERAL MATTER

In the sentence reading "Ash the residue in a muffle, to constant weight, taking care that the decomposition of carbonates is complete, etc.," insert the words "alkaline earth" before the word "carbonate."

UNSATONIFIABLE MATTER

Under DETERMINATION strike out the last sentence reading, "When the unsaponifiable matter runs over 5 per cent, etc.". Add immediately after the sentence which now reads, "Repeat extraction at least four more times, using 50 cc. petroleum ether each time," the following: "More extractions than five are necessary where the unsaponifiable matter runs high, say over 5 per cent, and also in some cases where it is lower than 5 per cent, but is extracted with difficulty."

WIJS METHOD FOR THE DETERMINATION OF IODINE VALUE

Change heading to read IODINE NUMBER—WIJS METHOD.

Under PREPARATION OF REAGENTS—*Wijs Iodine Solution*—(2). The sentence "Or dissolve 6.5 g. of resublimed iodine," should read "13 g. of resublimed iodine."

Add under PREPARATION OF REAGENTS—*Wijs Iodine Solution*, a third paragraph, reading as follows: "There shall be no more than a slight excess of iodine, and no excess of chlorine. When the solution is made from iodine and chlorine, this point can be ascertained by not quite doubling the titration."

METHODS OF ANALYSIS ADOPTED SEPTEMBER 4, 1918

MELTING POINT

APPARATUS—*Capillary tubes* made from 5 mm. inside diameter thin-walled glass tubing drawn out to 1 mm. inside diameter. Length of capillary part of tubes to be about 5 cm. Length of tube over all 8 cm.

Standard thermometer graduated in tenths of a degree. 600 cc. beaker.

DETERMINATION—The sample should be clear when melted and entirely free from moisture, or incorrect results will be obtained.

Melt and thoroughly mix the sample. Dip three of the capillary tubes above described in the oil so that the fat in the tube stands about 1 cm. in height. Now fuse the capillary end carefully by means of a small blast flame and allow to cool. These tubes are placed in a refrigerator over night at a temperature of from 40 to 50° F. They are then fastened by means of

a rubber band or other suitable means to the bulb of a thermometer graduated in tenths of a degree. The thermometer is suspended in a beaker of water (which is agitated by air or other suitable means) so that the bottom of the bulb of the thermometer is immersed to a depth of about 3 cm. The temperature of the water is increased gradually at the rate of about 1° per minute.

The point at which the sample becomes opalescent is first noted and the heating continued until the contents of the tube becomes uniformly transparent. The latter temperature is reported as the melting point.

Before finally melting to a perfectly clear fluid, the sample becomes opalescent and usually appears clear at the top, bottom, and sides before becoming clear at the center. The heating is continued until the contents of the tube become uniformly clear and transparent. This temperature is reported as the melting point. It is usually only a fraction of a degree above the opalescent point noted. The thermometer should be read to the nearest $\frac{1}{2}$ ° C., and in addition this temperature may be reported to the nearest degree Fahrenheit if desired.

CLOUD TEST

PRECAUTIONS—(1) The oil must be perfectly dry, because the presence of moisture will produce a turbidity before the clouding point is reached.

(2) The oil must be heated to 150° C. over a free flame, immediately before making the test.

(3) There must not be too much discrepancy between the temperature of the bath and the clouding point of the oil. An oil that will cloud at the temperature of hydrant water should be tested in a bath of that temperature. An oil that will cloud in a mixture of ice and water should be tested in such a bath. An oil that will not cloud in a bath of ice and water must be tested in a bath of salt, ice, and water.

DETERMINATION—The oil is heated in a porcelain casserole over a free flame to 150° C., stirring with the thermometer. As soon as it can be done with safety, the oil is transferred to a 4 oz. oil bottle, which must be perfectly dry. One and one-half ounces of the oil are sufficient for the test. A dry Fahrenheit thermometer is placed in the oil, and the bottle is then cooled by immersion in a suitable bath. The oil is constantly stirred with the thermometer, taking care not to remove the thermometer from the oil at any time during the test, so as to avoid stirring air bubbles into the oil. The bottle is frequently removed from the bath for a few moments. The oil must not be allowed to chill on the sides and bottom of the bottle. This is effected by constant and vigorous stirring with the thermometer. As soon as the first permanent cloud shows in the body of the oil, the temperature at which this cloud occurs is noted.

With care, results concordant to within $\frac{1}{2}$ ° C. can be obtained by this method. A Fahrenheit thermometer is sometimes used because it has become customary to report results in degrees Fahrenheit.

The oil must be tested within a short time after heating to 150° C. and a re-test must always be preceded by reheating to that temperature. The cloud point should be approached as quickly as possible, yet not so fast that the oil is frozen on the sides or bottom of the bottle before the cloud test is reached.

NOTES ON THE ABOVE METHODS

MELTING POINT

A melting point is the temperature at which a solid substance assumes the liquid condition. If the solid is a pure substance in the crystalline condition the melting point is sharp and well defined for any given pressure. With increased pressure the melting point is lowered or raised, depending on whether the substance contracts or expands in melting. The lowering or raising of the melting point with pressure is very slight and ordinarily is not taken into consideration. Melting point determina-

tions are commonly carried out under ordinary atmospheric pressures without correction. The general effect of soluble impurities is to lower the melting point, and this holds true whether the impurity has a higher or lower melting point than the pure substance (solvent). Thus if a small amount of stearic acid be added to liquid palmitic acid and the solution frozen, the melting point of this solid will be lower than that of palmitic acid. Likewise the melting point of stearic acid is lowered by the addition of a small amount of palmitic acid. A eutectic mixture results when two components solidify simultaneously at a definite temperature. Such a mixture has a constant melting point and because of this and also because both solid and liquid phases have the same composition, eutectic mixtures were formerly looked upon as compounds. The phenomenon of double melting points has been observed in the case of a number of glycerides. Such a glyceride when placed in the usual capillary tube and subjected to increasing temperature quickly resolidifies only to melt again and remain melted at a still higher temperature. This phenomenon has not yet been sufficiently investigated to afford a satisfactory explanation.

Non-crystalline substances such as glass, sealing wax and various other waxes and wax mixtures, and most colloidal substances do not exhibit a sharp melting point but under the application of heat first soften very gradually and at a considerably higher temperature melt sufficiently to flow. This phenomenon of melting through a long range of temperature may be due to the amorphous nature of the substance or to the fact that it consists of a very large number of components of many different melting points.

The fats and oils of natural origin, that is, the animal and vegetable fats and oils, consist of mixtures of glycerides and, generally speaking, of a considerable number of such components. These components are crystalline and when separated in the pure state have definite melting points, although some exhibit the phenomenon of double melting point. For the most part the naturally occurring glycerides are mixed glycerides. In the natural fats and oils there are present also certain higher alcohols of which cholesterol is characteristic of the animal fats and oils and phytosterol of many of the vegetable fats and oils. In addition to the crystalline glycerides and the higher alcohols present in neutral fats, there are in fats of lower grade, fatty acids, which are crystalline, and also various non-crystalline impurities of an unsaponifiable nature, and the presence of these impurities tends to lower the melting point. They also tend to induce undercooling when the liquid fat or oil is being chilled for purposes of solidification or in determination of titer.

The presence of water, especially when this is thoroughly mixed or emulsified with a fat or oil, also influences the melting point to a marked extent, causing the mixture to melt through a longer range of temperatures than would be the case if the water were absent. This is particularly true of emulsified fats and oils, such as butter and oleomargarine, both of which contain, besides water, the solids naturally present in milk or cream and including casein, milk sugar, and salts. The melting point method recommended by the Committee is not applicable to such emulsions or other watery mixtures and the Committee has found it impossible to devise an accurate method for making softening-point or melting-point determinations on products of this nature. Not only the amount of water present but also the fineness of its particles, that is, its state of subdivision and distribution, in a fat or oil influences the softening point or melting point and causes it to vary widely in different samples.

As a consequence of the foregoing facts, natural fats and oils do not exhibit a definite melting point, composed as they are of mixtures of various crystalline glycerides, higher alcohols, fatty acids, and non-crystalline substances. Therefore, the term melting point when applied to them requires further definition. Various methods have been devised to determine the so-called melting point of fats and oils. Most of these methods, how-

ever, determine, not the melting point, but the softening point or the flow point of the fat and the great difficulty has been in the past to devise a method which would determine even this point with reasonable accuracy and so that results could be easily duplicated. It has been the aim of the Committee to devise a simple method for the determination of the melting point of fats and oils, but it should be understood that the term melting point in the scientific sense is not applicable to natural fats and oils.

BICHROMATE SOLUTION

The Committee calls attention to the fact that occasionally potassium bichromate is found containing sodium bichromate, although this is of rare occurrence. If the operator suspects that he is dealing with an impure potassium bichromate, the purity can be ascertained by titration against re-sublimed iodine. However, this is unnecessary in the great majority of cases.

GLACIAL ACETIC ACID

The glacial acetic acid used for preparation of the Wijs solution should be of 99.5 per cent strength or higher and should have a freezing point of 14.7 to 15° C. (m. p. 16.7°). In case of glacial acetic acids of somewhat lower strength, the Committee recommends freezing and centrifuging or draining as a means of purification.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

The 11th Annual Meeting of the American Institute of Chemical Engineers will be held in Chicago, Ill., January 15 to 18, 1919 headquarters at the Congress Hotel. The preliminary program follows:

WEDNESDAY, JANUARY 15

- 9 : 30 A.M.—Registration.
Address of Welcome.
Business Session, including canvass of ballot for officers.
- 10 : 30 A.M.—Address of President Thompson, "Our Chemical Industries Made Permanent."
- 11 : 00 A.M.—Symposium on Maintenance and Preservation of Our Chemical Industries:
Dr. Grinnell Jones, of the United States Tariff Commission.
Dr. Louis Matos, of the National Aniline and Chemical Company.
Dr. L. C. Jones, of the Semet Solvay Co.
Mr. Wm. H. Rollin, of the Rollin Chemical Company, "Future of the Barium Industry."
- 2 : 00 P.M.—Dr. A. A. L. Veillon, of the Monsanto Chemical Works.
Dr. Edw. Gudeman, "Reconstruction Aspects of Some Chemical Industries in the United States."
General Discussion by representatives of other chemical industries.

- 8 : 00 P.M.—Reading of Papers:
Dr. F. W. Frerichs, "Reinforced Concrete Tanks for Storing Ammonia Liquors."
Dr. David Wesson, "Some Wild Engineering I Have Known."

9 : 00 P.M.—Smoker.

THURSDAY, JANUARY 16

- 9 : 00 A.M.—All day excursion to the Argo Plant of the Corn Products Refining Company.
8 : 00 P.M.—Joint Meeting with the Chicago Section of the American Chemical Society.

FRIDAY, JANUARY 17

- 9 : 30 A.M.—Business Session.
10 : 30 A.M.—Reading of Papers.
1 : 30 P.M.—Excursion to the plant of the Lindsay Light Company and the Underwriters' Laboratories.
7 : 00 P.M.—Subscription Dinner.

SATURDAY, JANUARY 18

Choice of two excursions:

- (1) Standard Oil Company Plant at Whiting, Ind.
- (2) Plant of the Newport Hydrocarbon Company near Milwaukee, Wis.

THE JOHN SCOTT LEGACY MEDAL AND PREMIUM

The City of Philadelphia, acting on the recommendation of The Franklin Institute, recently awarded the John Scott Legacy Medal and Premium to Ernest J. Sweetland, of Upper Montclair, N. J., for the Sweetland Filter Press.

This invention is to provide a self-dumping filter press, which will reduce to a minimum the labor involved in discharging the solid residue left in the press after filtration and, also, the labor of cleaning the press by hand.

THE PERKIN MEDAL AWARD

The Perkin Medal for 1918 has been awarded to Dr. F. G. Cottrell for brilliant and useful research and development work in bringing about the practical and successful commercial operation of his method for smoke, fume, and dust abatement.

The Medal will be presented at a meeting of the New York Section of the Society of Chemical Industry to be held in Rumford Hall, Chemists' Club, New York City, on January 17, 1919.

THE NICHOLS MEDAL

On account of the large number of research men who have been engaged during the year past on war problems to which publicity could not be given, the Nichols Medal Committee has decided to make no award of the Medal this year.

NOTES AND CORRESPONDENCE

DON'TS

FOR WOULD-BE WRITERS OF SCIENTIFIC ARTICLES FOR THE PUBLIC PRESS

As an aid to the development of popular presentation of matters chemical by the members of the AMERICAN CHEMICAL SOCIETY, Dr. Edwin E. Slosson, a member of the Publicity Committee of the Society, has upon request prepared the following suggestions. Dr. Slosson's successful experience in this art amply qualifies him as a sound guide.—[EDITOR.]

Don't overestimate the reader's knowledge and don't underestimate the reader's intelligence. He may not know as much as you about this particular thing—let's hope not, but otherwise he may be as bright as you are—let's hope so.

Don't try to tell all you know in 500 words. Leave some over for another time. The clean-plate rule does not apply here.

Don't think that because a thing is old to you it is known to the public. Many of your readers are living in the nineteenth century; some of them are in the eighteenth.

Don't imagine that the readers of a popular periodical are, like pupils in a class, obliged to pretend to pay attention to you no

matter how dull you may be. "First catch your reader" is the rule of successful writing.

Don't leave out the human interest. Your reader is a human being even if you are merely a scientist.

Don't forget that your reader is interrupting you every ten lines to ask, "Why?" "What for?" "Well, what of it?," and if you don't answer his tacit questions he will soon stop reading.

Don't think that you can make your topic more attractive by tricking it out with fairy lore or baby talk or irrelevant jokes or extravagant language. Bring out its real and intrinsic interest as forcibly as you can. Set off as much red fire as you like but be sure it lights up the object instead of drawing the attention away from it.

Don't say, "This discovery is interesting" unless you can prove that it is. And if you can prove it, you don't have to say it.

Don't suppose that you must give bibliographical references to all the literature of the subject, but don't fail to give a clue by which the interested reader can get on its trail.

Don't fail to put your best foot forward. Otherwise you won't have a chance to use the other foot. Note the construction of the news story in any first-class paper. It is built up on the same logical system as the symphony or opera. The opening paragraph gives in succinct fashion the main point of interest, the gist of the story, just as the first movement or overture of a musical composition expresses the main theme or *motif*.

Don't expect the editor to explain why he rejects your manuscript. He is probably right in his verdict, but if you make him give a reason for it he will have to invent one and it would probably be wrong.

Don't say you can't find anything to write about. This number of the *Journal of Industrial and Engineering Chemistry*—and every other—contains at least \$15 worth of good popular science stuff. Chesterton says: "There are no uninteresting subjects, there are only uninterested people."

Don't regurgitate undigested morsels. It is a disgusting habit.

Don't refer to notes or books while writing. Read up on the subject as thoroughly as you can, and take as many notes as you need. Then put away all your notes and books out of reach and next day, or at least an hour later, lay a clean sheet of paper on a clean desk and write out what you know about it in your own way. Afterwards, preferably next day, read over your manuscript critically, verify your facts, correct your data, revise your English, and add any essential points you may have forgotten. But don't expect the reader to be interested in what is so uninteresting to you that you cannot keep it in mind a single hour.

Don't define a hard word by a harder one. Vladivostok is a hard word, but when the war correspondent arrives at Vladivostok he says so and goes right on inland without stopping to explain that "this is a city south of Khabarovks and east of Tsitsikhar." So you, if you want to say "calorie" say it but don't make it worse by "explaining" it as "the quantity of heat necessary to effect a rise of temperature of one degree centigrade of a cube of water, each dimension of which is one tenth part of the length of a bar of platinum and iridium alloy lying in the observatory of St. Cloud if it has not been smashed up by a shell from the Big Bertha." If you think you must define the calorie say casually that 100 calories of energy can be derived from four lumps of sugar (Hoover size) or from a one inch cube of butter, or explain that a man needs to expend a hundred calories an hour all day to keep his body running and 160 calories if he is working hard.

Don't think you must leave out all technical terms. Use them, whenever necessary, without apology and, if possible, without formal definition. People are not so easily scared by strange words as you may think. They rather like 'em. Kipling is read with delight by old and young, yet his prose and verse are crammed with technical terms. Having exhausted the military, nautical, and mechanical vocabularies he invented a new and unknown nomenclature for his story "With the Night Mail." In his "Just-So" stories for the kiddies he sticks in long names like plums in a pudding. A Kipling dictionary has been published but even the editors could not run down all the peculiar words Kipling has picked up. But the ordinary reader does not need the dictionary. He gets the meaning from the run of the story, for the story is so written that he will get the meaning. Observe that the war correspondent writes without hesitation:

At zero hour the barrage was raised and the poilu and the doughboy sprang over the top, sticking their bayonets into the boche.

And the man in the street reads it without batting an eye although the sentence contains half a dozen words not to be found in his vocabulary four years ago, or in the dictionary yet. But if this sentence was being written by one of our conscientious scientists he would word it in this fashion:

At zero hour—to use the military term for the time set for the beginning of an offensive—the barrage—that is to say the line on which the artillery fire is directed—was raised and the poilu—this is a French slang term for soldier meaning "hairy" and corresponding to our "roughneck"—and the doughboy—this is an American slang term for infantryman derived either from the round buttons worn in the civil war, or the dome huts inhabited in the Mexican war or the pipeclayed belts of the Revolutionary war—sprang over the top—that is to say surmounted the parapet of the entrenchments—sticking their bayonets—a weapon invented at Bayonne, France, in 1650—into the boche—a contemptuous term referring to the Germans, probably an abbreviation of *caboché* or blockhead originally applied to Alsatians.

EDWIN E. SLOSSON¹

CHEMICAL NOMENCLATURE

The resolution² passed by the Division of Organic Chemistry at the Cleveland meeting of the AMERICAN CHEMICAL SOCIETY, in which the use is encouraged of "the pure English terms 'benzene,' 'toluene,' and 'xylene,' including all of their derivatives, in place of the hybrid forms 'benzol,' 'toluol,' 'xylool,' etc.," suggests a few remarks. The recommendation is worthy to be heeded by all English-speaking people, as it appeals to me, not so much because the discredited forms are used by the Germans, although an appearance of aping the German is of course distasteful to us all, but because the forms favored are good English chemical nomenclature. As is well known, in careful usage the endings in the names of chemical compounds often have special meanings. They designate classes of compounds. The "-ol" ending in organic nomenclature, *e. g.*, is reserved for hydroxyl derivatives of hydrocarbons (alcohols) and the "-ene" ending is used for certain classes of hydrocarbons. The unsuitability of the name "benzol" for C_6H_6 is obvious. Although "benzene" is a good English word, as shown by usage, and by its conformity to approved nomenclature rules, it is interesting to note that it, as well as "benzol," was first suggested as the name for C_6H_6 by a German. "Benzol" is Liebig's name; Hofmann suggested "benzene."

Both in Great Britain, where, by the way, efforts have also been made to discourage the use of "benzol" in favor of "benzene," and in the United States the use of "benzol" has been more common among industrial men. The fact is significant that these men are more frequently speaking not of the pure compound C_6H_6 but of the commercial mixture of hydrocarbons of the benzene series obtained in the refinement of coal tar. There is some question as to whether or not it is suitable to give this mixture, which may contain less than 50 per cent of C_6H_6 , the same name as given to the pure compound; some favor the use of "benzene" for the compound and "benzol" for the commercial mixture. (The "-ol" ending rule only applies to definite compounds.) In the office of *Chemical Abstracts* we recognize that there are arguments for such a differentiation and for a while tried to apply the two names accordingly, but we have finally decided in favor of the use of "benzene" in both cases, with such modifications as crude, 90 per cent, 50 per cent, etc., in suitable cases. This has seemed better particularly in view of the fact that the rather common use of both names for the pure compound would lead to confusion.

There are other chemical words and names more or less commonly used incorrectly in the United States. Many of the incorrect names are corruptions due to German influence, often bad translations; this makes them seem particularly undesirable now, but there are other better reasons for avoiding them. Good nomenclature is important for its own sake. A correct name of a compound frequently serves to tell the nature of the compound and often its structure also. Correct usage avoids confusion and aids in indexing. In scientific matters it is important to be exact in words and phrases used just as it is im-

¹ Literary Editor of *The Independent* and associate in the School of Journalism, Columbia University.

² THIS JOURNAL, 10 (1918), 944.

portant to be exact with figures. Our experience in editing *Chemical Abstracts* proves this assertion over and over again. Good English in chemical literature, particularly in naming compounds, needs cultivation.

The Organic Division chose a good time to start a movement for better nomenclature and it seems to me that while correcting ourselves in regard to the benzene hydrocarbons we would do well to give thought to other needed reforms. It seems as though such a statement should be accompanied by some specific recommendations. I am not an authority, but possibly the accumulated experience from the constant effort which has been made in the office of *Chemical Abstracts* to keep the abstract journal an example of good nomenclature justifies the statement of a few preferences. The subject has been carefully studied, particularly by those who preceded the present editor and later in connection with the Decennial Subject Index,¹ and the advice of those who seemed best able to help has often been sought. I believe that there will be no disagreement concerning the preferences stated below although frequent divergence from them is observable. They are abridged from "Directions for Assistant Editors and Abstractors of *Chemical Abstracts*." The nomenclature rules in these directions have come to be known, it seems, as representing the forms approved by the AMERICAN CHEMICAL SOCIETY. Requests for information as to the forms so approved are not infrequent. To make our list of nomenclature rules, perhaps after modification, more authoritative, or to formulate a new one and to settle points of disagreement (a number of other preferences could be stated but the chances of disagreement would be greater with reference to them), it would seem to me that a revival of the Society's dismissed Committee on Inorganic Nomenclature and its Committee on Organic Nomenclature would be opportune. Such a suggestion will be made.

In naming a compound so as to indicate that oxygen is replaced by sulfur the prefix *thio* and not *sulfo* should be used (*sulfo* denotes the group SO_3H); thus HCNS , thiocyanic acid; H_3AsS_4 , thioarsenic acid; $\text{Na}_2\text{S}_2\text{O}_3$, sodium *thio*sulfate; $\text{CS}(\text{NH}_2)_2$, *thio*urea. Note particularly that *thiocyanate* is preferable to *sulfocyanide* for salts of HCNS .

The word *hydrate* should not be used for a compound with OH ; it is reserved for compounds with H_2O . Thus, chlorine *hydrate*, $\text{Cl}_2 \cdot 10\text{H}_2\text{O}$; barium *hydroxide*, $\text{Ba}(\text{OH})_2$.

Salts of chloroplatinic acid are *chloroplatinates* (not *platinichlorides*). Similarly salts of chlorauric acid are to be called *chloraurates*.

Hydroxyl derivatives of hydrocarbons are to be given names ending in *-ol*, as *resorcinol*, *pinaol* (not *pinacone*), *mannitol* (not *mannite*). There may be objection to the form *glycerol* rather than *glycerin* because the latter is so well established.

German names ending in *-it* should be translated *-ite* rather than *-it*; as *permutite*. If it seems desirable to retain the original form of a trade name it should be placed in quotations, as "*permutit*." Alcohols such as $\text{C}_6\text{H}_8(\text{OH})_6$ (German *Dulcitol* = *dulcitol*) are exceptions.

The German ending "*-carbonsäure*" should never be translated "*-carbonic acid*."

It is desirable that in the case of organic compounds the connective *o* be used invariably in such names of substituent radicals as *amino-*, *bromo-*, *chloro-*, *cyano-*, and *iodo-*; thus *bromobenzene*, *chloroacetic*, *nitroaniline*. This conforms to the demands of euphony and also makes for uniformity in indexing. The use of this connective makes for better English; its omission is German-like. There are a few apparent exceptions to this rule as *cyanamide*, *chloraurate*.

The names of the groups NH_2 , NHR , NR_2 , NH , or NR should end in *-ido* only when they are substituents in an acid group, otherwise in *-ino*; thus $\text{MeC}(\text{NH})\text{OEt}$, ethyl *imido*acetate; $\text{NH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$, β -*amino*propionic acid (not *amidopropionic acid*); $\text{NHPhCH}_2\text{CH}_2\text{CO}_2\text{H}$, β -*anilino*propionic acid; $\text{CH}_3\text{C}(\text{NH})\text{CO}_2\text{H}$, α -*imino*propionic acid.

Hydroxy-, not *oxy-*, should be used in designating the hydroxyl group; as *hydroxyacetic acid*, $\text{CH}_2(\text{OH})\text{CO}_2\text{H}$, not *oxyacetic acid*. *Keto-* is to be preferred to *oxy-* to designate the group -CO- . This is a case in which it is particularly bad to follow German practice.

The term *ether* should never be used for compounds which are properly called esters.

Salts of organic bases with hydrochloric acid should be called *hydrochlorides* (not *hydrochlorates* nor *chlorhydrates*). Similarly *hydrobromide* and *hydriodide* (not *hydroiodide*) are preferable.

Sucrose is preferable to *saccharose* or *cane sugar*.

A rather common practice among American chemists and one which does not seem good is the use of the word *body* when *chemical compound* or *chemical substance* is meant. It is desirable to distinguish between a physical body and a chemical substance or compound. The fact that the Germans rather frequently use "*Körper*" for "chemical compound" has probably influenced this not incorrect but undesirable use of "*body*" in English.

OHIO STATE UNIVERSITY
COLUMBUS, OHIO

E. J. CRANE

AN INTERNATIONAL SUGAR SCALE

Editor of the Journal of Industrial and Engineering Chemistry:

As one whose regular work calls for frequent use of the polariscope, I wish to express my approval of the proposition made by C. A. Browne in your issue of November 1, that this is an opportune time to adopt an international sugar scale and that the Sidersky and Pellet scale based on a normal weight of 20 g. instead of the French and German scales now in use. The arguments advanced in favor of the proposed scale are convincingly stated and certainly no more favorable time can arrive than the present critical time for the proposed change.

I would suggest that no time be lost in bringing the matter to the attention of polariscopists in Great Britain, France, and Italy.

Would it not be an advantage to have every polariscope equipped with both the angular scale and the sugar scale, with the outer edge of the vernier reading on one scale and the inner edge fitted to read fractional parts on the other? The expense would not be serious.

Now that many polariscopists are using as a standard light filter a bichromate of potash filter in which the thickness in centimeters multiplied by the percentage of crystals = 9, we have a standard of approximately monochromatic light which is more conveniently reproduced than the sodium flame, now that electric lights are in use everywhere. It should not be difficult to secure standard glass plates whose absorption as filters would equal in every respect that of the bichromate filter.

With the new scale, the standard light filter, and the standard quartz control plate adopted universally, international polariscopy would seem to have been placed on a very desirable footing.

REGINA, CANADA
November 15, 1918

W. W. ANDREWS

THE 1918 DIRECTORY—AMERICAN CHEMICAL SOCIETY

The 1918 Directory of the AMERICAN CHEMICAL SOCIETY is now available for members. It contains 422 pages as compared with the 1916 Directory's 289 pages, and it exceeds by approximately 4,000 the number of members listed in the 1916 issue. The Directors have voted that it may be obtained by members from the Secretary on payment of \$1.00 to cover partial cost of printing and upon their written statement that it is desired for their personal use only and will not be loaned or disposed of to any firm with which they may or may not be connected or to any individual to be used for advertising purposes.

WASHINGTON, D. C.
December 10, 1918

CHARLES L. PARSONS

RAMSAY MEMORIAL FUND

Over \$3,000 has been contributed to the Ramsay Memorial Fund in the United States up to date. The committee will be glad to receive further American subscriptions. Checks should be made payable and sent to the Ramsay Memorial Fund Committee, W. J. Matheson, Treasurer, 21 Burling Slip, New York City.

¹ See Patterson and Curran, *J. Am. Chem. Soc.*, **39** (1917) 1623-38.

WASHINGTON LETTER

By PAUL WOON, Union Trust Building, Washington, D. C.

With practically all government restraint removed, officials here are very generally of the opinion that the chemical industries are adjusting themselves to a peace-time basis with unexpected facility. Little difficulty is being experienced in placing with private concerns the chemists who have been engaged in war work. In fact, practically all employers are taking on more chemists than they employed in normal times. Dr. Charles L. Parsons, the secretary of the AMERICAN CHEMICAL SOCIETY, who is in very close touch with the situation, despite some early misgivings, now feels assured that all chemists engaged in war work will be absorbed by the industry.

The Government is rapidly concluding its war-time arrangements for chemical supplies. This is particularly true of those entering into gas warfare. The situation, speaking generally, is made much easier of solution by the fact that most chemical supplies were being used nearly as rapidly as produced. For this reason, stocks are not great. Such surpluses as exist will be disposed of, it has been announced officially, in such manner as to produce the least possible effect on the market.

Producers of manganese, pyrites, chrome, and tungsten have been in Washington the past month seeking what they term a square deal from the Government. Consumers and importers of these commodities also have been consulted. Government officials are very generally of the opinion that some relief should be extended to producers who took unusual risks to mine materials needed in the war. They are faced, however, by the most intricate problem in determining a safe and equitable manner for granting the relief. The Secretary of the Interior has refused positively to use any of the appropriation carried by the War Minerals Act. His position is that the Act was intended to aid the Government in securing these mineral supplies for war purposes. With the change in conditions, Secretary Lane will use none of the money, despite the fact that the bill technically places it within his power, to attempt to straighten out the manganese-pyrites-chrome situation. He will take this action, he states, if instructed to do so by the President or if Congress can indicate in some way that it would approve of such a course. There is little hope, however, that any relief to the producers of war minerals will come without new legislation.

Chemical manufacturers, who are carrying large stocks of war minerals, are not disposed to take up any additional supplies. This they indicated at conferences with officials. Along with the steel manufacturers, they declined to become parties to several plans which included the absorption of a considerable portion of the over-production.

While there is no denying that the Government has incurred a certain amount of moral obligation in the stimulation of the production of the war minerals, it also is a fact that some responsibility rests on the producers and the consumers. Take chrome, for instance. When the War Industries Board called the producers and consumers into conference, the consumers stoutly maintained that their requirements would be 160,000 tons. The producers, when asked as to their maximum amount of additional production, placed it at 10,000 tons. Instead of using 160,000 tons, the consumers took only 97,000 tons. On the other hand, the producers more than doubled their estimate and produced 25,000 tons in excess of the normal chromite production.

The situation is rapidly coming to a head. The next few weeks will determine, in all probability, just what may be expected. The problem is greatly complicated by the fact that it ramifies into practically every industry.

Important developments in the sulfur situation are expected in the near future. A situation which has been restrained by the desire of the Union Sulfur Co. not to interfere with the sulfur production during the war, is expected to come to a focus quickly. The Union Sulfur Co. contends that the essential features of the Frasch patents date from 1905. The original Frasch patents, however, were granted in 1901. Acting on the assumption that the essential features of the Frasch process date from 1901, and consequently have expired, competitors of the Union Sulfur Co. are utilizing certain features of the Frasch process. The claim of the Union Sulfur Co. has been upheld in the District Court in Delaware. Thus encouraged and with the crisis

passed in the sulfur situation, active proceedings by the Union Sulfur Co. are expected. Not only is the Freeport Sulfur Co. affected, but the Gulf Sulfur Co. also will be involved. The Gulf Sulfur Co. is expected to begin producing sulfur in January from what is regarded as the most promising sulfur deposit which has been discovered in the United States. The deposit is situated at Matagorda, Texas. It was not the intention of the owners to open the property at this time but largely at the insistence of the Government, a plant of great capacity has been installed. This step was taken to insure sulfur supplies, had the war continued. With the turn that world affairs have taken, it now probably will be necessary for the owners to operate the property so as to be reimbursed for their expenditures.

The sulfur producers are coming in for warm praise for the effective manner in which they contributed to the war program. The Union Sulfur Co., it is understood, was able to triple normal output.

In his report to Congress, the Commissioner of Internal Revenue has the following to say in regard to synthetic glycerin:

The facilities of the Bureau for chemical experimentation were utilized in part during three months of the year on the undertaking, which proved successful, of developing a new process for the production of glycerin. The ordinary method of recovering from fats this essential constituent of explosives might conceivably fail to produce an adequate supply for military requirements. In the enemy countries this situation occurred, but was overcome by employing a synthetic process developed by the German chemists. To insure the military program of this Government and of its associates in the war against the contingency of such a shortage of fats, it was deemed advisable to discover a method of securing glycerin from an alternative source.

The Bureau's chemists succeeded, after three months, in developing a practicable process for recovering from the fermentation of sugar any quantity of glycerin which might be required. By a large-scale experiment, later conducted in an industrial plant, it was established that the process not only provided a practicable means of manufacturing glycerin in a military emergency, but also was capable of profitable commercial exploitation. The process was secured to the United States through letters patent and made available for use by the associated governments. Interested manufacturers in this country were given detailed descriptions enabling them to install plants and proceed at once with the manufacture of synthetic glycerin.

The Secretary of War in his annual report to Congress enumerates a number of very interesting facts with regard to the Chemical Warfare Service. In part, he says:

The surprise use of gas by the Germans in 1915 forced upon the allied armies a new form of warfare. The chemical work thus necessitated in the United States Army was at first undertaken by a number of governmental agencies. At the very outset of our participation in the war Dr. Van H. Manning offered the services and facilities of the Bureau of Mines to the War Department for research work in problems of gas warfare. The Bureau was particularly fitted to perform this highly important pioneer work because of its exhaustive studies of poisonous gases and protection by means of masks made in connection with mining problems. Similar work was soon started at the American University laboratories. The development and production of gas masks and other articles of defense were shortly undertaken by the Medical Department. The production of toxic gases, containers, and the mechanical apparatus necessary for their active employment was made the task of the Ordnance Department. The Corps of Engineers sent the first men into service as gas and flame troops.

The first consolidation of these separate operations was made for our forces in France early in September 1917, when the Gas Service of the American Expeditionary Force was established. The uniting of the various agencies in the United States came about by executive order June 28, 1918, with the creation of the Chemical Warfare Service under Maj. William L. Sibert. In addition to the development, production, and testing of articles of gas offense and defense, the Chemical Warfare Service is in charge of the training of gas officers, the training of all troops in gas defense, and the organization of gas troops. On November 1, 1918, the personnel of this service included 1,654 commissioned officers and 18,027 enlisted men.

Gas is employed in offensive operations in various ways. Attacks are made by the concentration of artillery fire in which gas-filled shell and mortar bombs are used. Effective attacks are also made with the so-called Livens projectors. A thousand or more of these long, narrow tubes containing gas-filled drums are placed underground in groups of about 25, from 50 to 100 yards apart, and are set off instantaneously by means of electrical connection. Grenades filled with gas and smoke preparations

are used by the infantry in trench fighting. The production of these projectiles and mortars and the various types of containers is under the jurisdiction of the Ordnance Department. The production of toxic gases and the filling of all containers is the work of the Chemical Warfare Service. Gases are produced at Edgewood Arsenal, Edgewood, Md., and at a number of auxiliary plants which have been erected since the war. The progress made in gas production has been so satisfactory that it has been possible not only to fill all shell and containers available and to ship quantities of gas to our forces overseas, but also to make large sales to the Allies. At the signing of the armistice we were equipped to produce gases at a more rapid rate than France, England, or Germany.

Through the coöperation of the various governmental agencies an American type of mask has been developed which affords twenty times the protection of the German mask. Not a case is on record of an American soldier who has fallen victim of a gas attack when protected by the American mouthpiece type of mask. Recently production has commenced on the American Tissot mask, an adaptation of the French type, which, while equally effective, affords the wearer greater comfort than in the case of the mouthpiece mask by enabling him to breathe both through the nose and the mouth.

Production of gas masks started in July 1917. To November 9, 1918, the total production of all types was over 5 $\frac{1}{4}$ million, of which over 4 $\frac{1}{2}$ million were suitable for overseas use and nearly 4 million had been shipped to the American Expeditionary Force. In October 1918, 925,000 were completed and inspected. It was expected that a maximum monthly production of 1,200,000 masks would be attained beginning in December.

The greater part of this production has been at the government gas defense plant at Long Island City, N. Y. The average daily production there in October was approximately 24,260.

The serious shortage of carbon for gas-mask canisters in the summer of 1918, due to the scarcity of coconut shells, was relieved in a large measure by the coöperation of the American Red Cross in the vigorous campaign throughout the country for the saving of fruit pits and nut shells.

When it is considered that the Chemical Warfare Service, as such, has been in existence for less than five months, its achievements may be truly considered remarkable.

One of the heritages which came to the Bureau of Mines from the War Industries Board was the difficult problem of "emancipating the American farmer from the grip of Germany's monopoly on potash." At first the Bureau of Mines entertained the hope that money carried by the War Minerals Act could be used in an effort to build up a domestic potash industry, which in a few years would be able to hold its own against the German product. Later it was decided that no War Minerals money should be used for that purpose. Any special activity to stimulate potash production probably will have to wait until after the signing of the peace treaty, as it is understood that the German potash deposits must be looked to for a portion of the indemnity. In turning potash matters over to the Bureau of Mines, the War Industries Board made the following statement with regard to potash:

Before the signing of the armistice, the War Industries Board had already attacked the problem. Chairman Baruch himself had appeared before the congressional committee in behalf of an amendment to the revenue bill which would give encouragement to private industries which would undertake the risk of establishing potash production in this country. The Chemicals Division, on the other hand, in coöperation with other departments of the Government, had turned its attention to the specific task of extracting potash from waste products. A committee of experts, representing the steel and iron industry of the country and certain scientific departments of the Government, was in process of formation, under the auspices of the Chemicals Division, at the time hostilities ceased. Its purpose was to determine as quickly as possible the feasibility, from a commercial standpoint, of extracting potash from the fumes of blast furnaces.

Prior to the outbreak of the war, Germany, by reason of her monopoly of the potash supply, had gradually extended her arm around the food crops of the world. It was to Germany that the farmers of this and other countries had to look for the principal ingredient of their fertilizers. Nowhere else were to be found the vast potash deposits which insured to the German potash exporters a natural supply sufficient to meet the demands of the world for several thousands of years to come.

When the outbreak of the European war suddenly cut off this supply the situation of the American farmer was for a time desperate. Under the stimulus of necessity, efforts were launched by private industries to meet the situation, and in consequence there has been a considerable development in the amount of potash produced in this country. By no means, however, has this development approached the requirements of the country. Before the war the American imports of pure potash from Germany for the year ending July 1914 amounted approximately to 250,000 tons. Last year there were produced in the United States 32,000 tons, and this year it is estimated that the output will amount to about 60,000 tons.

The War Industries Board undertook to approach the problem in a larger way, and it is now proposed by arrangement between the Chemicals

Division and the Department of the Interior that the program be carried forward by the latter department.

The suggestion of extracting potash from blast furnace fumes is based on the fact that potash in varying quantities is found not only in the iron ores, but in the coke and lime used in reducing the ores. In Alabama the ores are particularly rich in potash. At present this potash is allowed to escape during the processes in the blast furnaces. Divided into microscopic particles of dust it is volatilized and carried off with the waste fumes.

Several methods of saving this potash have been suggested by scientists. Of these the most feasible appears to be the electric precipitation process devised by Dr. Fred D. Cottrell, of the Bureau of Mines. This involves cooling the gases as they emerge from the blast furnaces and passing them through a series of sheet steel tubes, eight to twelve inches in diameter. Through the center of these tubes is run a wire, or chain, carrying a high voltage charge of static electricity. This electric charge tends to electrify the fine particles of potash dust, causing them to consolidate, or "colonize," and drop down the sides of the tubes. A fair-sized installation for this process requires as many as 400 of these tubes through which to pass the gases. It is this process which the Bethlehem Steel Company has experimented with on a small scale.

Another method tried out involves the spraying of the gas fumes with water and passing them through moist bags, which retain the potash. This method has been tried out in extracting potash from the fumes given off in the manufacture of cement. Its first practical application took place when a cement plant located near Redlands, California, undertook, in response to neighborhood protests, to cut down the volume of fumes emitted from its chimneys. Other cement plants have tried it out, and in the East the Security Cement and Lime Company at Hagerstown, Md., has been foremost in the recovery of potash from cement dust. Cement mixture contains potash in proportions varying from 1 per cent to 1 $\frac{1}{4}$ per cent. When calcining cement clinkers the addition of salt to the coal that is burned in the kiln renders the potash soluble in water.

At a conference of experts recently held in the office of C. H. MacDowell, director of the Chemicals Division of the War Industries Board, the opinion prevailed that it would be entirely feasible to commercially develop a method of extracting the potash from blast furnace fumes, particularly in regions where the blast furnaces are located near ores in which potash occurs in quantities sufficient to insure substantial recoveries. The problem presents many technical difficulties since care must be taken in developing a by-product process not to interfere with the primary output.

The potash deposits in Germany resulted from the crystallization of sea water. In all of the 202 mines in that country, the potash is found in water-soluble form and for certain purposes can be used just as it comes from the mines without further refining. At Searles Lake, California, potash in this water-soluble form has been found in small quantities, and two factories have been established there to extract it. In Nebraska it has been possible to recover potash in fair quantities from certain alkali lakes located in that state. In Utah, Mr. MacDowell himself established a plant at which pure potash is recovered from alunite.

Elsewhere experiments have been made in recovering potash from certain by-products, such as beet-root molasses and wool scourings. Other sources of supply being studied are the potash shales of Alabama and Georgia, the greensands of New Jersey, and the leucite deposits of Wyoming. There is, in fact, a considerable development now under way in the production of potash from leucite; and production likewise has been undertaken in Utah from certain brines contained in salt deposits west of Salt Lake City.

Unquestionably it is going to cost much more to produce potash in Germany and Alsace. War taxes, high food costs, and other fundamentals will bring this about so that it will be a long time before European potash is brought to this country at the low cost prevailing before 1914.

The Secretary of Agriculture, in his report to Congress, tells of the purchase and distribution of nitrate of soda as follows:

The Food Control Act, which authorized the President to procure and sell nitrate of soda to farmers at cost for the purpose of increasing production, appropriated \$10,000,000 for that purpose. By direction of the President, the War Industries Board made arrangements for the purchase of the nitrate, and the Secretary of Agriculture for its sale and distribution. The Bureau of Markets was designated as the agency to handle the work for the Department.

Contracts were made for the purchase of about 120,000 short tons of nitrate, and arrangements were effected through the Shipping Board to secure tonnage for transporting it from Chile. A selling price of \$75.50 on board cars at port of arrival was announced in January 1918, and farmers were given an opportunity to make applications through the county agents and committees of local business men appointed for the purpose. Applications for amounts totaling more than 120,000 tons were received from 75,000 farmers, who asked for lots ranging from one-tenth of a ton to more than 100 tons. On account of the lack of available shipping it was possible to bring in, up to June 30, 1918, only about 75,000 tons, practically all of which actually was sent to farmers by that date.

Some of the nitrate was shipped direct to farmers, but the greater part was consigned to county distributors in the counties requiring large quantities. These distributors were appointed when it became evident

early in the year that, on account of the lack of vessels, sufficient nitrate would not arrive in time to make complete delivery during the period of greatest need. Through them it was possible to make quick and equitable distribution and to save farmers the interest on deposits required for payments, since shipments for the county were made to the distributors on sight draft with bill of lading attached and distribution was made by them to the farmers. On June 30, there remained in Chile between 39,000 and 40,000 short tons of nitrate for which the Department had been unable to secure transportation to this country from the Shipping Board.

The Federal Trade Commission has ordered The Consolidated Oil Company, of Cleveland, Ohio, and two of its officers, Nathan Weisenberg and Aaron Bernstein, the Eastland Linseed

Company, of Cleveland, Ohio, and David Bernstein to cease and desist from unfair methods of competition, admitted by them.

Among the prohibited practices was the using of stationery and letterheads bearing pictures of extensive manufacturing plants which do not in fact exist; adulteration of linseed and other oils with low-grade mineral oils and acids; and publication of representations that the Ohio Food and Drug Commission had made a ruling requiring that all linseed oils, spirits of turpentine, and the like, not used as food, must be labelled "adulterated."

The Commission's orders were issued on agreement with the concerns which waived right to introduce testimony in support of their practices.

PERSONAL NOTES

Dr. Harry Percival Corliss, until recently an Industrial Fellow in the Mellon Institute of Industrial Research, University of Pittsburgh, died at Ray, Arizona, on November 16, 1918, of pneumonia following influenza.

Dr. Corliss was born at Thornton, N. H., October 21, 1886. He attended Brewster Academy at Wolfeboro, N. H., and graduated in 1910 from New Hampshire State College with the degree of Bachelor of Science in Chemical Engineering. He then continued the study of chemistry at the University of Toronto, specializing in physical and organic chemistry. In July 1912 he accepted a position as Industrial Fellow at the Mellon Institute and in 1913 received the degree of Doctor of Philosophy from the University of Pittsburgh. Dr. Corliss' work at the Mellon Institute extended over a period of five years, during most of which time he was engaged in physical, chemical, and metallurgical research.

This research resulted in the development of several important improvements upon the flotation process for the recovery of metals. Perhaps his greatest contribution to this industry was the discovery of alpha-naphthylamine as a flotation agent. It is too early as yet to estimate the full value of this discovery, but the excellent practical results already following its use warrant the belief that the work of Dr. Corliss will eventually be recognized as being of first importance in this field.

In July 1917 he accepted a position as chemical and metallurgical engineer with the Metals Recovery Company in order to initiate the large scale application of his discoveries in the flotation mills of the southwest. In this work he was uniformly successful and was rapidly making for himself an enviable reputation as a metallurgical engineer when death called him.

From his boyhood up, Dr. Corliss' associates have recognized in him the qualities of marked intellectual brilliancy and very real moral worth. All through his student days the highest scholastic honors came to him without conscious effort on his part, because he loved the study of chemistry in all its branches. He brought the same qualities of mind and spirit to his research work at the Mellon Institute and to its extension in the wider fields of industrial application.

His many friends will feel that by his death the world was deprived of a life which held unusual possibilities for useful work and high accomplishment.

Mr. R. S. Buhrman, formerly chief chemist for the Haynes Stellite Company of Kokomo, Ind., died of influenza, November 1, 1918.

Dr. Frank O. Amon, who was connected with the Mellon Institute at Pittsburgh, as Research Fellow, for some months in 1917, and who enlisted in the U. S. Gas Defense work in 1917, died of pneumonia, at Souilly, France, on October 12, 1918. Dr. Amon was a graduate of Allegheny College at Meadville, Pa., and later took his doctorate at New York University. He was a young man of much ability and promise.

Major William A. Hamor, Chemical Warfare Service, who returned from France on November 17, 1918, after ten months' service in the American Expeditionary Forces, has resumed his work at the Mellon Institute of Industrial Research as Assistant Director. Major Hamor served as Assistant Chief of the Technical Division, C. W. S., A. E. F., until the conclusion of hostilities.

Mr. D. R. Pinnock, formerly chief chemist and works manager for the Nucofa Butter Co., is now chief castor bean inspector in the Bureau of Aircraft Production. He is engaged in working out the details of a new method of milling castor beans for the production of castor oil for airplane lubrication which bids fair to result in a saving of more than a million dollars on the 1919 crop.

Mr. Stephen G. Simpson, formerly chemist for the Great Northern Paper Co., Millinocket, Me., was called for military service and then granted an indefinite furlough in order to act as instructor in chemistry in the S. A. T. C. at the Massachusetts Institute of Technology.

J. Brevet, a lieutenant in the Holland army reserves, employed by the Portland Gas and Coke Company at its plant at Portland, Oregon, has been placed in charge of the Y. M. C. A. class in chemistry. For two years he was control chemist for the Royal Dutch Oil Co., of Java.

Mr. Delbert Brown has been granted an indefinite furlough in order to take charge of the chemistry department at Olivet College, Olivet, Mich.

Mr. John Gaub, in charge of the laboratories at the Filtration Plant, Washington, D. C., has resigned to become Health Officer and Examiner of Foods for the town of Montclair, N. J.

Mr. Theodore E. Kendrick, research chemist with the Electrometallurgical Co., after his entrance into the army in August, was sent to the Franklin Union U. S. Army Training Detachment, Boston, Mass., to learn the trade of sheet metal worker. Upon application of his former employer he was granted an indefinite furlough and returned to his former concern, where he is doing work on the preparation of a military explosive.

Mr. W. W. Hodge has resigned his position as instructor in chemistry at the University of North Dakota in order to accept a position as assistant professor of organic chemistry in the Oregon Agricultural College.

Mr. Archibald F. Borbeck has been commissioned Second Lieutenant in the Chemical Warfare Service and has been detailed for work in France.

Mr. A. J. Phillips, formerly chief chemist for the Western Alkali Refining Co., is now research chemist with the Aetna Explosives Co., Emporium, Pa.

Mr. C. F. Landsheft has been transferred from the Olean, N. Y., Tannery of the Cattaraugus Tanning Company to the J. H. Ladew Company Tannery, Newark, N. J., to become assistant to the general superintendent of the two concerns.

Mr. R. T. Will, president of the Will Corporation, who discontinued his business because of the war, was commissioned Captain in the Chemical Warfare Service and has been stationed at the Long Island laboratory of the Gas Defense Division.

Mr. R. P. Tucker, formerly chief chemist of the Leigh Hunt Engineering Co., is now with the Armour Fertilizer Company.

Mr. Leon S. Ward, formerly instructor in chemistry in the Greeley High School, Greeley, Col., is now employed as chemist by the Hercules Powder Company at the U. S. Explosives Plant "C," Nitro, W. Va.

Mr. Montgomery R. Trimmer, formerly manager of the Chemical Department of the S. S. White Dental Manufacturing Co., Prince Bay, N. Y., is now supervisor of manufacture with the du Pont Engineering Co., Jacksonville, Tenn.

Captain J. L. Brown has been transferred from the E. I. du Pont de Nemours & Company Barksdale plant, located near Washburn, Wis., where he was Acting Quartermaster and Inspector of Ordnance for the U. S. Ordnance Dept., to the Toronto District Ordnance Office, to take charge of the inspection and manufacture of all powder and high explosives in Canada for the U. S. Ordnance Department.

Mr. W. O. Gordon, formerly with the U. S. Bureau of Chemistry, and recently with the Industrial Appliance Co., Chicago, has accepted a position as chief chemist with Mead Johnson and Co., Evansville, Ind., who are manufacturers of dextro-maltose and other malt products.

Dr. R. W. Hess, formerly chemist in the dyestuff department at the Chicago plant of the Sherwin-Williams Co., has recently accepted a position as senior research chemist with the National Aniline and Chemical Co., Buffalo, N. Y.

Mr. Sidney Davis has been commissioned Captain in the Chemical Warfare Service and is stationed in Washington representing the Development Division which has its headquarters in Cleveland.

Dr. Arthur R. Hitch, formerly chief chemist of the Storage Battery Factory of the National Carbon Co., Inc., Cleveland, Ohio, is now chief chemist of the Ashland Iron and Mining Co., Ashland, Ky.

Miss V. L. Gibbons, Ph.D., formerly research chemist for the National Carbon Co., Inc., has accepted a similar position with the National Aniline and Chemical Co., Buffalo, N. Y.

Mr. J. M. Janitchek, formerly chief chemist of the Tallassee Power Company, Badin, N. C.—a subsidiary of the Aluminum Company of America—is now connected with the Aluminum Company of America Research and Laboratory Department, New Kensington, Pa.

Captain J. Herbert Hunter has recently been promoted to the rank of Major and now has charge of high explosives and research work in the Ordnance Department.

Mr. Rudolph Gahl, formerly metallurgist of the Inspiration Consolidated Copper Co., has recently taken up general practice as a consulting metallurgist.

The chemistry department of the University of Nebraska announces the following additions to its teaching staff: Mr. T. J. Thompson, of Kansas Wesleyan University, as instructor in organic chemistry; Dr. Horace G. Deming, of the University of Illinois, as professor of chemistry in charge of general and physical chemistry; Mr. B. Clifford Hendricks, of Peru, Neb., State Normal School, as assistant professor of chemistry.

Mr. K. R. Morgan has recently accepted the position of chief chemist and assistant superintendent at the Reserve factory of the Leon Godchaux Co., Reserve, La.

Mr. R. D. Kehoe, formerly of the Machinery Utilities Co., Inc., has announced the formation of the Technical Products Co., Inc., with offices in New York, Chicago, and St. Louis. The new company is organized for the purpose of purchasing idle equipment and placing this in essential industries.

Mr. Charles W. Mudge, for many years chemist in the N. Y. State Department of Agriculture, now called the Department of Farms and Markets, Albany, N. Y., has accepted a position as chemist with the Standard Oil Company, N. J., and is located at their new chemical research laboratory at Bayway, N. J.

Mr. Sarangadhār Das has resigned his position as chief chemist for the Maui Agricultural Company in order to complete some special work at the University of California.

Mr. Theodore W. Fowle has been released from his work as inspector of smokeless powder for the Ordnance Department at the Howard plant of the Aetna Explosives Co., in order to take up work with the General Chemical Company on the manufacture and testing of catalyst for direct ammonia synthesis at Laurel Hill, L. I.

Mr. F. R. McLean, formerly chief chemist for the Brooklyn Rapid Transit Co., is now chief chemist for the Lehigh Navigation Electric Co., Allentown, Pa.

The School of Chemistry of the University of Pittsburgh announces the following additions to its staff: Dr. Alexander Lowy, assistant professor of organic chemistry; Mr. Leon E. Jenks, assistant professor of analytical chemistry; Mr. Blaine B. Westcott, instructor in inorganic chemistry.

Mr. Morgan F. Rogers, formerly chemical engineer with the Independent Lamp and Wire Co., Wechawken, N. J., is now an engineer of tests with the Ordnance Department and is located at the plant of the Gorham Manufacturing Co., Providence, R. I.

Dr. D. J. Brown, formerly assistant professor of chemistry at the Agricultural and Mechanical College of Texas, has for the past year been at the University of Texas during the absence of Dr. J. R. Bailey.

Mr. Clarence Huckle, formerly chemist for the Douglas Packing Co., Rochester, N. Y., is now at the Jackson laboratory of E. I. du Pont de Nemours & Co., Wilmington, Del.

Dr. Harrison E. Patten, of the Bureau of Chemistry, Department of Agriculture, has been commissioned Captain in the Quartermaster's Corps.

Mr. George A. Rankin, of the American University Experiment Station, has been commissioned Captain in the Chemical Warfare Service.

Mr. G. L. McDonough, formerly connected with the Scientific Materials Co., Pittsburgh, has accepted a position as chemist with the American Alloy and Chemical Co., Los Angeles, Cal.

Mr. B. E. Broadwell, formerly connected with the Aluminum Company of America, Niagara Falls, N. Y., has been engaged as general superintendent of the new factory being erected by the Republic Carbon Company.

Mr. Henry P. Walters, Syracuse, N. Y., in charge of the picric acid department of the Split Rock plant of the Semet-Solvay Co., will be placed in charge of the new plant now being constructed at Grand Rapids, Mich., to be operated for the Government for the production of picric acid.

Mr. Louis S. Potsdamer, for the past five years chemist in the employ of Toch Bros., is now a Sergeant in the Gas Defense Service, U. S. A., located at the Philadelphia Control Laboratory, Philadelphia, Pa.

Mr. H. G. Osborn has given up his position as chief chemist of the City of East Chicago, and is now with Morris and Co.; U. S. Yards, Chicago.

Dr. Oscar Harder has resigned his position in the research department of N. K. Fairbanks Co., Chicago, Ill., to accept a fellowship at the Mellon Institute of Industrial Research, Pittsburgh, Pa.

Lafayette College, Easton, Pa., announces the following appointments to instructorships in the chemistry department: Mr. Landon A. Sarver, a private in the Chemical Warfare Service and formerly instructor in chemistry at Johns Hopkins University, and Mr. Walter G. Kleinspehn, a graduate of Lafayette in the class of 1918.

Dr. H. H. Hodgson has been appointed head of the department of coal-tar color chemistry at the Huddersfield Technical College. He has for nearly three years been chief chemist to one of the largest firms of chemical manufacturers in England, and was previously head of the chemical department at the Northern Polytechnic Institute in London.

Mr. D. Forest Hungerford, professor of chemistry at the University of Arkansas, has accepted a position with the United States Department of Agriculture, with headquarters at Athens, Ga.

Mr. David E. Wait, formerly connected with the Tindell, Morris Co., Eddystone, Pa., as assistant to the metallographist, having charge of the metallographic and chemical laboratory, has, since February 1918, been attached to the Worcester District Physical Laboratory of the American Steel and Wire Company as a metallographist.

Mr. Thomas E. Keitt, formerly of Clemson College, Clemson, S. C., has been appointed chemist at the Georgia Experiment Station, Experiment, Ga.

Wm. M. Barr, consulting chemist of the Union Pacific System, now has charge of all water supply problems on the Union Pacific Railroad, the Oregon Short Line Railroad, the Oregon-Washington Railroad & Navigation Lines, the Los Angeles & Salt Lake Railroad, and the St. Joseph & Grand Island Railroad.

Lieut. Alvin R. Lamb, Sanitary Corps, Division of Food and Nutrition, formerly of the chemistry section, Iowa Agricultural Experiment Station, is now stationed at Ft. Oglethorpe, Georgia.

Dr. A. Richard Bliss, Jr., professor of pharmacology in the School of Medicine of Emory University, Atlanta, was one of those recommended by the Rockefeller Institute of Medical Research for commission in the corps of chemists organized by that institution at the request of the War Department to take charge of the work in clinical chemistry in the cantonment hospitals here and abroad, and received an appointment as a Lieutenant in the medical department early in September.

Mr. E. Wertheim, recently in the Graduate Department, University of Chicago, is now assistant professor of chemistry in the University of Kansas.

Mr. Edward G. Pugh, formerly of the research laboratory of the Pennsylvania Salt Manufacturing Co., in Philadelphia, has been transferred to their plant at Wyandotte, Mich., to take charge of the erection of a zirconia plant there.

Mr. Harry Fawley is now in charge of research work at the Wyandotte, Mich., plant of the Pennsylvania Salt Manufacturing Company, having been transferred from their research laboratory at Philadelphia.

Mr. James Chester Ashby, formerly instructor in chemistry at Lehigh University, South Bethlehem, Pa., is now working in the research laboratory at the Buffalo Works of the National Aniline and Chemical Co., Buffalo, N. Y.

Mr. J. Miller has returned to his former position with the Western Canada Flour Mills Co., Winnipeg, Man., his position with the Department of Inspection, Imperial Ministry of Munitions at Moncton, N. B., having been only of a temporary nature during the munitions rush.

Mr. F. L. Woods, formerly assistant superintendent at the Bradley Fertilizer Works of the American Agricultural Chemical Company at North Weymouth, Mass., has just been appointed superintendent of the Tygert-Allen Works of the same company at Philadelphia, Pa.

Mr. William A. Kirk, formerly chemist at the Los Angeles Laundry Company, is now chemist at the Wyoming Sugar Co., Worland, Wyoming.

Mr. Charles L. Bliss has recently taken a position as chemist in the State Board of Health of Michigan and is located in Lansing.

Mr. Horace A. Shonle, now in the Chemical Warfare Service, on furlough from the Bureau of Chemistry for the period of the war, has been transferred to the laboratory section of the Sanitary Corps, stationed at Rockefeller Institute, New York City.

Mr. J. J. Brennan has been assigned to duty in the office of Col. Marston T. Bogert, Chief, Relation Sections, Chemical Warfare Service, U. S. A., Washington, D. C.

Mr. Andrew M. Fairlie, consulting chemical engineer, has opened an office for general consulting practice at 1204 Third National Bank Building, Atlanta, Ga.

Professor Hilton Ira Jones has just been elected head of the department of chemistry at the Oklahoma Agricultural and Mechanical College to succeed Dr. L. Chas. Raiford who becomes associate professor in organic chemistry in the University of Iowa. Dr. Jones was formerly head of the department of chemistry at Dakota Wesleyan University, Mitchell, South Dakota.

Mr. Arthur H. Johnson, formerly at Carney's Point, N. J., as civilian inspector for the Ordnance Dept., U. S. A., is now in the Chemical Warfare Service and stationed at Cleveland, Ohio.

Mr. Lester Yoder, formerly with the chemical section of the Agricultural Experiment Station of Iowa State College, is now at the U. S. Technological School, Carney's Point, N. J.

Dr. S. B. Kuzirian, assistant chemist for the chemical section of the Agricultural Experiment Station, and Prof. J. S. Coye, chief of the chemical section of the Engineering Experiment Station of Iowa State College, have entered the employ of the General Chemical Company, and will be located at their Laurel Hill Works, New York.

Priv. Ralph E. Brewer, Chemical Warfare Service, has been furloughed back to Iowa State College where he will again teach chemistry.

Professor B. B. Freud, of Armour Institute, B. S., University of Chicago, 1904, and candidate for the degree of Ph.D., has been appointed Captain in the Chemical Warfare Service and is now in France.

Miss E. T. Foster, formerly with Roben and Haas, is now with the Dearborn Chemical Company.

Mr. Joseph C. Winslow, formerly in the research division of the insulation department of the Westinghouse Electric & Manufacturing Co., has accepted a position as chemist with the Redmanol Chemical Products Company.

Mr. R. J. Carr, president of the Dearborn Chemical Company, is a Major on the general staff at Washington, D. C.

Mr. C. A. Tibbals, Jr., of Armour Institute, has a Captain's commission and is in charge of the research laboratory at the Picatinny Arsenal.

Mr. Arden R. Johnson has been appointed instructor at Northwestern University, Evanston, Ill.

Mr. E. F. Heizer, formerly with the Dearborn Chemical Company, is now in the Ensign School at the Municipal Pier, Chicago, Ill.

Mr. Wm. M. Corse, formerly general manager of the Titanium Bronze Co., Niagara Falls, N. Y., has accepted a position as manufacturing engineer with the Ohio Brass Co., Mansfield, Ohio.

Mr. C. L. Brickman, formerly chief chemist for the Rex-Hide Rubber Mfg. Co., East Brady, Pa., has assumed the position of chief chemist with the Dreadnaught Tire and Rubber Co., Baltimore, Md.

Mr. Wilbur F. Brown, formerly Chief Chemist of the Ball Brothers Glass Co., at Muncie, Ind., is now in the research division of the Chemical Warfare Service and is devoting his attention to the problems connected with the manufacture of optical glass.

INDUSTRIAL NOTES

The Air Reduction Co., N. Y., has bought a site at Richmond, Va., for the establishment of a plant to make oxygen, nitrogen, and acetylene gas. It is probable that other gases and also storage batteries will be made.

The Northern Alkali and Chemical Co., Huntington, W. Va., recently incorporated with a capital of \$60,000, has perfected its organization, and is planning to commence the production of caustic potash at an early date.

One of the many Canadian industries directly promoted by the war is the manufacture of chemicals. The demand has been enormously increased and prices obtained have been for the most part unprecedented. It is believed that through the war the industry has been so firmly established that it will be in a favorable position to meet competition after the war.

E. M. De Souza and Co., of Rangoon, India, have decided to commence the manufacture of chemicals on a large scale. They have engaged the services of Dr. H. K. Len and four other qualified chemists. The new venture will be known as the Rangoon Pharmaceutical and Chemical Works.

Experiments in Norway with a view to extracting salt from ocean water by means of electricity have been successful, and two salt factories will be started for this purpose under the name of De Norske Saltverker.

The *Frankfurter Zeitung* recently announced that M. France, head of the Biological Institute of Munich, had discovered a new source of fat from plants growing in waste lands. This oil called "edaphon" has been found by test to be equal to coconut oil.

The Reduction and Concentration Corporation of Birmingham, manufacturers of fertilizers, has been incorporated under the laws of New Jersey with a capital of \$200,000.

The detonator-assembling building of the du Pont Cap Works, at Pompton Lakes, N. J., was destroyed by explosions and fire on December 5, 1918.

At a meeting of the directors of the Pennsylvania Salt Manufacturing Company held at Philadelphia, General R. Dale Benson retired from the board. R. G. Wood, president of the Allan Wood Iron and Steel Co., was elected his successor.

The Machinery and Metal Sales Company is erecting a factory in Brazil for the manufacture of caustic soda and other chemicals. The total capital involved is reported to be \$500,000, and the estimated daily production 15 tons of caustic soda, 15 tons of chloride of lime, 600 kilos of muriatic acid, and 600 kilos of potassium chlorate.

According to a recent report issued by the Treasury Department, chemists in the Internal Revenue Bureau have developed a synthetic process for the making of glycerin by the fermentation of sugar. The process was tried out at a chemical plant in Aurora, Ill., and found commercially profitable.

"There are at present only two mills in operation in this country for the manufacture of potato flour," Major S. C. Prescott, chief of the Dehydration Division, Bureau of Chemistry, Dept. of Agriculture, stated in a recent address, "but others will be in operation in a few weeks in Minnesota, Maine, Nebraska, and South Carolina. I expect to see potato flour mills spring up in every potato-growing district. The potato crop is approximately 360,000,000 bushels yearly."

The War Trade Board has revoked the restriction on the importation of tanning materials and extracts, and applications will be considered for licenses to import these products, except quebracho wood, in an amount not to exceed 12,000 tons per month.

An Associated Press despatch from Rhenish Prussia states that the German potash production in November was 70 per cent below normal.

Exports of coconut oil from the Philippine Islands during the first eight months of 1918 were valued at \$16,180,371, against \$7,036,710 in the same time last year.

LIST OF APPLICATIONS MADE TO THE FEDERAL TRADE COMMISSION FOR LICENSES UNDER ENEMY-CONTROLLED PATENTS PURSUANT TO THE "TRADING WITH THE ENEMY ACT"

| YEAR | PAT. NO. | PATENTEE | ASSIGNEE | PATENT | APPLICANT |
|------|--------------------------------|--|--|--|---|
| 1909 | 943,600 | Wilhelm Jahns, Offenbach-on-the-Main, Germany | | Centrifugal regulators | Massey Machine Company, Watertown, N. Y. |
| 1917 | 1,214,941 | Frank Fairchild Morris, Pittsburgh, and Frederick Melchior Luchs, Wilkensburg, Pa. | Firm of Drägerwerk, Heiner. and Bernh. Dräger, Lübeck, Germany | Resuscitating device | The Draeger Oxygen Apparatus Company, Wilkensburg, Pa. |
| 1905 | 807,666 | Johann Heinrich Dräger, Lübeck, Germany | | Apparatus for respiring within spaces full of smoke or noxious gases | The Draeger Oxygen Apparatus Company, Wilkensburg, Pa. |
| 1911 | 1,005,816 | Alexander Bernhard Dräger, Lübeck, Germany | Firma of Drägerwerk, Heiner. and Bernh. Dräger, Lübeck, Germany | Portable breathing apparatus | The Draeger Oxygen Apparatus Company, Wilkensburg, Pa. |
| 1912 | 1,033,681 | Alexander Bernhard Dräger, Lübeck, Germany | Firm of Drägerwerk, Heiner. and Bernh. Dräger, Lübeck, Germany | Universal coupling | The Draeger Oxygen Apparatus Company, Wilkensburg, Pa. |
| 1914 | 1,085,674 | Alexander Bernhard Dräger, Lübeck, Germany | Drägerwerk, Heiner. & Bernh. Dräger, Lübeck, Germany | Battery for absorbing carbonic acid such as used in breathing apparatus | The Draeger Oxygen Apparatus Company, Wilkensburg, Pa. |
| 1913 | 1,049,346 | Johann Heinrich Dräger, Lübeck, Germany | Firm of Drägerwerk, Heiner. & Bernh. Dräger, Lübeck, Germany | Artificial breathing apparatus | The Draeger Oxygen Apparatus Company, Wilkensburg, Pa. |
| 1912 | 1,044,031 | Johann Heinrich Dräger, Lübeck, Germany | | Method of causing artificial respiration | The Draeger Oxygen Apparatus Company, Wilkensburg, Pa. |
| 1915 | 1,136,517 | Johann Heinrich Dräger, Lübeck, Germany | Firm of Drägerwerk, Heiner. & Bernh. Dräger, Lübeck, Germany | Artificial breathing apparatus | The Draeger Oxygen Apparatus Company, Wilkensburg, Pa. |
| 1913 | Trade-mark No. 94,620 | Drägerwerk, Heiner. & Bernh. Dräger, Lübeck, Germany | | Pulmotor for mechanical respiratory apparatus and devices for administering oxygen | The Draeger Oxygen Apparatus Company, Wilkensburg, Pa. |
| 1903 | 741,029 | Richard Gley and Otto Siebert, Berlin, Germany | Actien-Gesellschaft für Anilin Fabrikation, Berlin, Germany | Red azo lake (dyes) | The Ault & Wiborg Company, Cincinnati, Ohio |
| 1905 | 782,739 | Emil Fischer, Berlin, Germany | E. Merck, a co-partnership, Darmstadt, Germany | C-C-Dialkylbarbituric acid and processes of making same | Rector Chemical Company, 2 Rector Street, New York, N. Y. |
| 1913 | 1,075,171 | Albrecht Thiele and Georg Wichmann, Berlin, Germany | Chemische Fabrik auf Actien (vorm. E. Schering), Berlin, Germany | Process for the manufacture of 2-phenylquinolin-4-carboxylic acid | Sunbeam Chemical Company, Chicago, Ill. |
| 1911 | Trade-mark Atophan, No. 84,596 | Chemische Fabrik auf Actien (vorm. E. Schering), Berlin, Germany | | Remedies for treatment of gout and rheumatism | Sunbeam Chemical Company, Chicago, Ill. |

Ambrine Laboratories of Manhattan, drugs, medicines, etc., has been incorporated under the laws of New York with a capital of \$250,000 by H. O. Berg, H. V. Dunham, and G. W. Jackson, 347 Madison Ave., New York City.

The Fatty-Acid Reduction Company of Syracuse has been incorporated under the laws of New York State with a capital of \$200,000.

According to a special cable to the *New York Times* from Paris, dated December 3, 1918, the Compagnie Nationale des Matières Colorantes et des Produits Chimiques has been incorporated, with a capital of 40,000,000 f. for the manufacture of all kinds of chemicals. It already has a factory capable of producing 2000 tons of indigo annually. This corporation is allied with the Société des Produits Chimiques et Colorantes, which has a capital of 31,000,000 f. and was formed in 1918 for the manufacture of intermediary dye products.

According to the annual report of the Secretary of the Treasury approximately 52,487,117 proof gallons of alcohol were specially denatured during the last fiscal year in this country for the production of explosives and other military purposes. Distilled spirits from materials other than fruit amounted to 173,476,473.7 gallons. This was a decrease of 104,357,892.9 gallons compared with a year ago, a falling off of 37.56 per cent during the year ending June 30, 1918.

The Department of Commerce has received notice of the formation of the British Metals Corporation, capitalized at the English equivalent of \$24,330,000, to promote and develop empire trade in all the non-ferrous metals, especially copper, lead, zinc, and tin. "The corporation," according to Commercial Attaché Philip B. Kennedy, "will provide machinery for carrying on a form of control over the metal industry. Prior to the war the German metal combine was represented in Great Britain by Henry Merton and Company. This firm has been refused a license under the Non-ferrous Metals Act and, it is understood, will go into liquidation. All German control of the metal industry in the British Empire has been destroyed."

A new industry, developed by the war, is the exploitation of the cohune nut, a tropical product, similar in shape and properties to a dwarf coconut. The kernel contains approximately 70 per cent of vegetable fat, which has become of great importance in the manufacture of fine soaps and nut butters. During the war the shells have been used as the source of a superior grade of carbon for gas masks, and it has been discovered that they may be used for the production of producer gas of excellent quality, or as fuel for steam production.

The Industrial Accident Commission of California has recently issued a pamphlet entitled *How to Store and Use Explosives*, compiled by J. J. Rosewell, construction engineer, Department of Safety. The pamphlet sets forth the Federal and State requirements regarding the storage and use of explosives, and contains chapters on the sale of fuse and blasting materials.

The Texas Gulf Sulfur Co., Austin, Texas, has increased its capital stock from \$75,000 to \$3,000,000, and is preparing to develop a large underground sulfur deposit near Matagorda, Texas.

A number of Danish soap factories have combined in a company called Dansk Sæbeindustri, with a capital of \$335,000, with the head office in Copenhagen.

The War Trade Board of the United States, Russian Bureau, Inc., has been incorporated under the auspices of the War Trade Board, at the direction of the President. Its capitalization is \$5,000,000, and the company will engage in exporting needful commodities to Russia and bringing back Russian and Siberian raw materials, including platinum and raw materials necessary for the chemical industries.

Dr. Van H. Manning, director of the Bureau of Mines, has been instructed by Secretary Lane, of the Interior Department, to whom the task of stimulating domestic production of potash has been entrusted by a Presidential order dated November 11, 1918, to make a survey of the domestic resources specified in the Minerals Bill recently passed by Congress.

Reports recently received by the U. S. Geological Survey show that domestic mines now supply nearly one-third of the high-grade manganese ore needed in this country, whereas in 1917 the domestic mines supplied only one-sixth of the amount needed.

The Canadian Industrial Alcohol Co., Ltd., has been incorporated at Montreal, Canada, with a capital of \$5,000,000.

A large phosphate washing, drying, and grinding plant is being built near the Century mines, Maury County, Tennessee, by the J. Ogden Armour Fertilizer Company of Chicago.

Mesothorium has been developed by the Bureau of Mines as a substitute for radium used in the manufacture of luminous paints.

According to recent advices, pyrites mines have been opened in Cuba by prominent American sulfuric acid interests, with the expectation that the material will replace former importations from Spain.

According to a recent tabulation by the Pulp and Paper Division of the War Industries Board the annual production of paper and paper products in the United States in 821 pulp and paper mills amounts to about 5,658,000 tons. Of this amount, the production of strictly chemical products amounted to 1,287,000 tons.

The Price Fixing Committee of the War Industries Board has authorized the announcement that the maximum prices on sulfuric and nitric acids were discontinued on December 30, 1918. The Committee expressed its appreciation of the hearty cooperation received from the industry.

Secretary Baker told the Congressional Appropriations Committee on December 6, 1918, that the operation of the Muscle Shoals nitrate plants will probably be continued, and that the Neville Island plant, under construction in the Ohio River, will be used for the making of powder and guns.

The H. W. Johns-Manville Co., of New York, manufacturers of magnesia products and asbestos, are planning the erection of a \$3,000,000 plant at Waukegan, Ill.

A new refractory and abrasive material, called corindite, has been patented in France. The material is a vesicular mass containing many small crystals of alumina obtained when bauxite is melted by mixing it with anthracite and blowing air through the mixture.

According to the *Weekly Bulletin* of the Canadian Department of Trade and Commerce, a company in Milan, Italy, has been formed for the manufacture of white lithopone. The product has previously been obtained from Germany, but Italy possesses the necessary raw materials, and a promising start has already been made in the factory at Brescia.

A solder in which cadmium has been substituted for tin is being developed by the U. S. Bureau of Standards. Laboratory tests indicate that a material composed of 80 per cent lead, 10 per cent tin, and 10 per cent cadmium will prove practical.

The entire capital stock of the Bayer Company, Inc., was sold at public auction on December 12, 1918, by Alien Property Custodian, A. Mitchell Palmer, to the Sterling Products Company, of Wheeling, W. Va. The price paid was \$5,310,000. On December 15, H. F. Behrens, president of the Sterling Products Company, gave out the statement that the chemical end of the business of the Bayer Chemical Company had been sold by his company to the Grasselli Chemical Company, of Cleveland, for \$2,500,000.

The scarcity of potassium cyanide has brought about the use of a so-called cyanide mixture composed of sodium cyanide and potassium chloride, which when dissolved forms potassium cyanide and sodium chloride. An equivalent of 98 per cent potassium cyanide can be obtained, and this reagent is found to answer the same purpose as the true potassium salt.

The American Potash and Nitrate Corporation has been formed under the laws of Delaware with a capitalization of \$500,000. The incorporators are Robert Hobart, C. Fash, James F. Starek, and Elisha W. Kelly, of New York.

Manufacturers of cement, road oils, and other road-building materials have been advised by the Bureau of Foreign and Domestic Commerce that there is a promising field for their product in the Far East. China is especially strong in the purpose to build up a system of good roads for the development of natural resources.

The Air Reduction Company, of New York City, is erecting an \$80,000 chemical plant in Jersey City, N. J.

The Marden, Orth and Hastings Corporation has moved into its new quarters at 136 Liberty St. The following allied companies have their offices at the same address: Calco Chemical Co., United Oil and Chemical Co., Buttercup Oil and Tar Corporation, Edible Oil Co., Inc., Ruhm Phosphate Mining Co., and M. O. H. of the West Indies.

The Rector Chemical Company has opened a new factory in Brooklyn, N. Y., where it will manufacture pharmaceutical preparations.

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. Commerce 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 Commerce Reports mailed daily is \$2.50 per year, payable in advance, to the Superintendent of Documents.

CONGRESSIONAL COMMITTEES

Minerals and Mineral Lands. The following five reports of congressional committee activities relate to various phases of this subject.

(1) Report of hearings on H. R. 11259, which provides for encouragement in the production, conservation, and control of distribution of ores, metals, and minerals which have formerly been largely imported, or of which there is or may be inadequate supply for war purposes. 672 pp.

(2) Report to accompany H. R. 11259, made as Senate Report 558; submitted to the Senate on September 5 by Mr. Henderson. 4 pp.

(3) Conference report on H. R. 11259; submitted as Senate Document 281 on September 26. 5 pp.

(4) Conference report to the House of Representatives on H. R. 11259; submitted as House Report 803 on September 23. 7 pp.

(5) Report to accompany Senate Joint Resolution 156, which suspends requirements of annual assessment work on mining claims during the continuation of the war; submitted in House Report 766, September 2. 1 p.

TARIFF COMMISSION

Census of Dyes and Coal-Tar Chemicals, 1917. Tariff Information Series 6. 73 pp.

Glass Industry. Tariff Information Series 5. 147 pp. This is a report on the influence of the war upon the glass industry, including a discussion of new branches of industry, changes in manufacture and trade due to war conditions, holding of export and domestic trade after the war, a discussion of glass trade conditions in European countries, including testimony of leading American glass manufacturers.

NATIONAL MUSEUM

Power, Its Significance and Needs. C. G. GILBERT AND J. E. POGUE. Bulletin 102, Part V. 53 pp. Paper, 10 cents. This is the fifth portion of a report on the mineral industries of the United States.

Petroleum: A Resource Interpretation. C. G. GILBERT AND J. E. POGUE. Bulletin 102, Part VI. 76 pp. "This paper makes an economic study of the resource and the industry engaged in its development, and traces the causes of waste to certain maladjustments in the economic situation, pointing out how these may be remedied by a constructive economic policy applied to the matter. The desirability of developing shale oil to replace petroleum as it becomes incapable of meeting the demand is gone into and the advisability of using benzol and alcohol as substitutes for gasoline is considered. The natural gas industry is also treated."

GEOLOGICAL SURVEY

Gypsum in 1917. R. W. STONE. Being a Separate from Mineral Resources of the United States, 1917, Part II, pp. 85-95. Published July 11, 1918.

The quantity of crude gypsum mined in the United States

in 1917 was slightly less than that mined in 1916, owing largely to a reduction in building operations in the last quarter of the year. The output nevertheless exceeded that of any year previous to 1916.

On the other hand, the total value of the crude and calcined gypsum produced in the United States in 1917 far surpassed that of any other year. In 1916, for the first time, the total value of gypsum products of the United States in a single year exceeded \$7,000,000, but in 1917 they exceeded \$10,000,000. The increase in 1917 was \$2,536,311, or 32 per cent over the total value in 1916, as compared with an increase of \$3,000,000 in the ten years from 1907 to 1916.

Mineral Resources of Alaska. Report on Progress of Investigations in 1916. A. H. BROOKS AND OTHERS. Bulletin 662. 469 pp.

Asphalt Deposits and Oil Conditions in Southwestern Arkansas. H. D. MISER AND A. H. PURDUE. Bulletin 691-J. Contributions to Economic Geology, 1918, Part II, pp. 271-292. Published August 16, 1918. "Seven asphalt deposits, three of which are in Pike County and four in Sevier County, in southwestern Arkansas, were examined by the writers during the progress of the field work for the DeQueen-Caddo Gap folio, which is now in preparation. These deposits are all found at or near the same horizon in the Trinity formation. Only one has so far been developed into a mine from which asphalt has been shipped in commercial quantity. This deposit, which has been described by Hayes, is about 2½ miles south-south-east of Pike, in Pike County. Of the other six deposits only three have been prospected.

"There is no possibility that either oil in commercial quantities or gas in large pools will be found in the Ouachita Mountain region of west-central Arkansas or in most of this region in Oklahoma. The carboniferous and older rocks have been so highly tilted and so much fractured and metamorphosed that if oil or gas were ever present in them the gas and much of the oil would have made their escape to the surface and the remainder of the oil would have been distilled to asphalt."

Coal in 1916. C. E. LESHNER. Mineral Resources of the United States, 1916, Part II, pp. 901-991. Published August 17, 1918.

Tin in 1917. A. KNOPF. Mineral Resources of the United States, 1917, Part I, pp. 63-72. Published September 16, 1918.

The metallic tin estimated as recoverable from ore of domestic origin mined in 1917 was 90 short tons, a decrease of 50 short tons from the output of 1916. As in recent years, the bulk of the tin-bearing concentrate was obtained by dredges in Alaska, whose working season is limited by climatic conditions to less than 100 days a year. Part of the concentrate was shipped from Seattle to Singapore to be smelted and part was sent to the smelter at Perth Amboy, N. J.

The tin imported in 1917 as metal and metal in concentrate reached the record quantity of 77,866 short tons, or 57 per cent of the world's output for the year. The metal imported and entered for consumption was 72,166 short tons, and the domestic smelter output was 6,000 tons. The total supply of new tin available for consumption was, therefore, 78,000 tons. It is estimated that an additional 17,500 tons of tin became available by recovery from drosses and waste metals.

The unprecedentedly high prices of tin that prevailed during the latter part of 1917 and that still prevail have stimulated interest in the deposits of tin ore in the United States. References to the most recent published information on these deposits are given on pages 71-72. The known deposits are unfortunately small in number, and but few of these are commercially promising. Governmental stimulation, therefore, is not likely to add significantly to the domestic supply of tin. It is not probable that the country will achieve in 1918 an output much

in excess of 200 tons of metallic tin from ores of domestic origin. The largest amount heretofore produced in any one year was 140 tons, or 0.2 per cent of the imports for that year.

Silver, Copper, Lead, and Zinc in the Central States in 1917. J. P. DUNLOP AND B. S. BUTLER. Mines Report. Mineral Resources of the United States, 1917, Part I, pp. 73-130. Published October 24, 1918.

Fuller's Earth in 1917. J. MIDDLETON. Mineral Resources of the United States, 1917, Part II, pp. 253-255. Published September 18, 1918.

The quantity, value, and average price per ton of fuller's earth sold in 1917 were the largest ever recorded by the United States Geological Survey, the increase in quantity being 5,048 short tons, or 7 per cent, and in value \$69,681, or nearly 10 per cent, over 1916, the previous leading year. Almost from the beginning of the industry in this country the quantity and value and the average price per ton of the domestic product have exceeded those of the imports. The quantity and the value of the earth produced in the United States in 1917 were more than four times as great as those of the earth imported, and the average price per ton of the domestic earth was 28 cents more than that of the imported earth. The apparent consumption—production plus imports—increased from 84,623 short tons in 1916 to 89,864 tons in 1917, and the domestic fuller's earth formed 81 per cent of the consumption in 1917, against 80 per cent in 1916.

The imports of fuller's earth for consumption in 1917 showed a small increase in quantity—193 tons—and a considerable increase in value—\$36,753, or 26 per cent, compared with 1916. The increase in quantity was entirely in the unwrought or unmanufactured earth, the wrought or manufactured earth showing a decrease. Both varieties showed large increase in value. The average price per ton for all imported earth increased \$2.07, for unwrought earth \$1.29, for wrought earth \$2.16.

Asbestos in 1917. J. S. DILLER. Mineral Resources of the United States, 1917, Part II, pp. 197-204. Published September 18, 1918.

The total quantity of domestic asbestos reported to the Geological Survey as sold in 1917 was 1,683 short tons, valued at \$506,056, an increase in quantity of 204 short tons and in value of \$57,842, representing about 13 per cent in both quantity and value of the product marketed in 1916.

The average price for the whole country of all grades of asbestos, both crude and mill fiber, was \$301 a short ton, practically the same as the average price for 1916. This average price is in strong contrast to the corresponding price of Canadian fiber, which in 1916 was \$38.97, and in 1917 was \$50.04 a short ton. This marked difference in the average price in the two countries is due to the larger proportion of crude fiber shipped without milling in the United States. In the United States nearly half of the total output is crude fiber, but in Canada less than a twentieth part is crude fiber.

The chief source of supplies for the large manufacturers of asbestos in the United States is in imports mostly from Canada. The total imports of unmanufactured asbestos in 1917 were 134,108 short tons, an increase of 15 per cent over the imports of 1916 and nearly eighty times the production of the United States in 1917.

On account of the increased demand for asbestos, prices have continued to advance, especially for the Canadian fiber, the prices for which in New York are given below.

RANGE OF NEW YORK PRICES PER TON FOR CANADIAN CHRYSOTILE FIBER
IN 1917

| | 1917 | |
|---------------------|--------|---------|
| No. 1 crude..... | \$700- | \$1,500 |
| No. 2 crude..... | 500- | 900 |
| No. 1 fiber..... | 150- | 450 |
| No. 2 fiber..... | 75- | 150 |
| Shorter fibers..... | 18- | 75 |

Silica in 1917. F. J. KATZ. Mineral Resources of the United States, 1917, Part II, pp. 207-211. Published September 13, 1918.

The reports to the United States Geological Survey on the production in 1917 of silica for various uses considered in this chapter are summarized in the following table. The combined output of these materials increased 187 per cent in quantity and 68 per cent in value in 1917, as compared with 1916.

SILICA SOLD FOR POTTERY, PAINTS, FILLERS, POLISHERS, ABRASIVES, AND OTHER USES IN 1917

| MATERIAL | 1917 | |
|--|------------------------|------------------|
| | Quantity Short Tons | Value Dollars |
| Quartz (vein quartz, pegmatite, and quartzite).... | 142,673 | 318,069 |
| Sand and sandstone(1)..... | 532,454 | 1,195,142 |
| Tripoli..... | 26,069 | 92,416 |
| Diatomaceous earth(2)..... | 3,033 | 31,368 |
| | 704,229 | 1,636,995 |

(1) Includes only finely ground material. Figures probably incomplete.

(2) Excludes California product used for filters and as insulating and fireproofing material.

So far as can be learned no true flint or chert has been produced for consumption as crushed or ground silica in grinding mills in the United States. The manufacture of flint, chert, and quartzite blocks for tube-mill lining is reported in the chapter on abrasive materials.

Quartz from quartz veins, pegmatite, and quartzite, amounting to 142,673 short tons, valued at \$318,069, was sold in 1917. This was an increase of 61 per cent in quantity and 31 per cent in value as compared with 1916. The increase in quantity was entirely in the quantity sold crude or merely crushed and graded.

The prices of crude quartz in 1917 ranged from \$2 to \$5.10 a long ton and (exclusive of large quantities used in copper smelting and foundry work, valued at between 45 and 85 cents a ton) averaged \$3.25, as compared with \$2.37 in 1916 and \$3.30 in 1915. Prices for ground quartz ranged from \$6 to \$14 a short ton and averaged \$12.25, as compared with \$9.09 in 1916 and \$10.56 in 1915.

Abrasive Materials in 1917. F. J. KATZ. Mineral Resources of the United States, 1917, Part II. 20 pp. Published September 24, 1918.

The total value of the abrasive materials which are considered in this report and which entered into trade in 1917 was \$11,085,147. This was an increase of \$5,929,049, or 115 per cent as compared with 1916. There was an increase in the value of domestic production of natural and artificial abrasives amounting to nearly 30 and to more than 177 per cent, respectively, and imports increased about 46 per cent in value.

Among the natural abrasives a large gain was shown in production of grindstones and pulpstones, and there were gains also in production of oilstones, scythestones, emery, pumice, pebbles for grinding, and tube-mill lining ("flint liners"). The reported output of diatomaceous earth and tripoli and of garnet and millstones was less than in 1916. The total estimated value of different abrasive materials imported into the United States for consumption in the last four years is given in the following table:

| | |
|---|----------|
| Millstones and burrstones..... | \$18,227 |
| Grindstones and pulpstones..... | 57,950 |
| Hones, oilstones, and whetstones..... | 10,636 |
| Emery and corundum..... | 210,602 |
| Diatomaceous earth, tripoli, and rottenstone..... | 17,864 |
| Pumice..... | 147,278 |
| Diamond dust and bort..... | 349,746 |
| | 812,303 |

The artificial abrasives considered are of three kinds: (a) Metallic abrasives, manufactured by the Pittsburgh Crushed Steel Co., Pittsburgh, Pa., and including "diamond crushed steel" (crushed crucible steel), "angular grit" (crushed chilled iron), and "crushed cast iron;" (b) Silicon carbides—carborundum, manufactured by the Carborundum Co., at Niagara Falls, N. Y.; crystolon, manufactured by the Norton Co., at

Chippewa, Ontario; and carbolon, manufactured by the Exolon Co., at Thorold, Ontario, and Blasdel, N. Y.; (c) Aluminum oxides—alundum, manufactured by the Norton Co., at Niagara Falls, N. Y., and Chippewa, Ontario; aloxite, manufactured by the Carborundum Co., at Niagara Falls, N. Y., Niagara Falls, Ontario, and Shawinigan, Quebec; exolon, manufactured by the Exolon Co., at Blasdel, N. Y., and Thorold, Ontario; lionite, manufactured by the General Abrasives Co., Inc., at Niagara Falls, N. Y.

Besides the firms just mentioned which manufactured abrasives in 1917, the D. A. Brebner Co., Ltd., and the National Abrasive Company have plants at Hamilton, Ontario, for the manufacture of aluminum oxide abrasives. The product of the Brebner Company is named coralox.

So far as known to the Geological Survey these are the only artificial abrasives manufactured in North America. Artificial abrasives sold under other names are merely the above-named products marketed under special trade names or are imported products.

ARTIFICIAL ABRASIVES PRODUCED IN THE UNITED STATES AND CANADA IN 1917

| ARTIFICIAL ABRASIVES | Quantity Short Tons | Value |
|---------------------------|---------------------------|-------------|
| Silicon carbide(a)..... | 8,323 | \$1,074,152 |
| Aluminum oxide(b)..... | 48,463 | 6,969,387 |
| Metallic abrasive(c)..... | 1,125 | 93,703 |
| | 57,911 | 8,137,242 |

(a) "Carborundum," "crystolon," "carbolon."

(b) "Alundum," "aloxite," "exolon," "lionite."

(c) "Diamond crushed steel," "angular grit," "crushed cast iron."

Bibliography of North American Geology for 1917. J. M. NICKLES. Bulletin 684. 154 pp.

Structure and Oil and Gas Resources of the Osage Reservation, Oklahoma. W. B. EMERY. Bulletin 686-B. 9 pp.

Geology and Oil and Gas Prospects of the Lake Basin Field, Montana. E. T. HANCOCK. Bulletin 691-D. Contributions to Economic Geology, 1918, Part II. 47 pp. Published July 17, 1918.

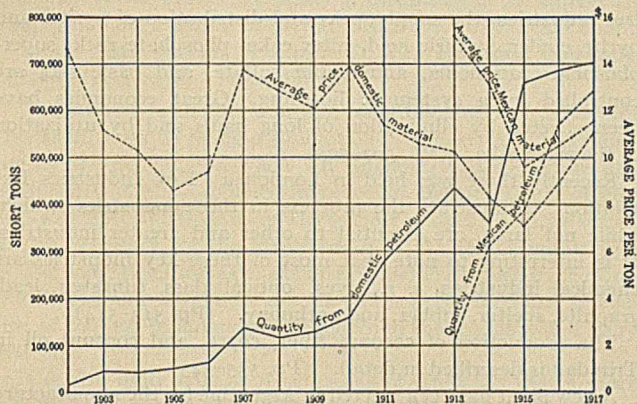
Asphalt, Related Bitumens, and Bituminous Rock in 1917. J. D. NORTHROP. Mineral Resources of the United States, 1917, Part II. 20 pp. Published October 22, 1918.

The quantity of native bitumens, pyrobitumens, ozokerite, and bituminous rock produced and sold at mines and quarries in the United States in 1917 was 80,904 short tons. This quantity was less by 17,573 tons, or 18 per cent, than the output of corresponding materials in 1916.

The average price received for this material at the sources of production was \$9.10 a ton and the market value of the entire production was \$735,924, a loss of 27 cents a ton in average unit price and of \$187,357, or 20 per cent, in gross market value, compared with 1916. At the mines, gilsonite sold in 1917 for an average of \$14.43 a ton, elaterite for \$88.68 a ton, grahamite for \$8 a ton, bituminous sandstone for \$3.31 a ton, and bituminous limestone for \$2 a ton. An analysis of the statistics of production in 1916 and 1917 shows gain in 1917 of 32 per cent in the output of gilsonite and of 350 per cent in the output of ozokerite, but loss of 51 per cent in the combined output of maltha, elaterite, and grahamite and of 34 per cent in the output of bituminous sandstone and bituminous limestone.

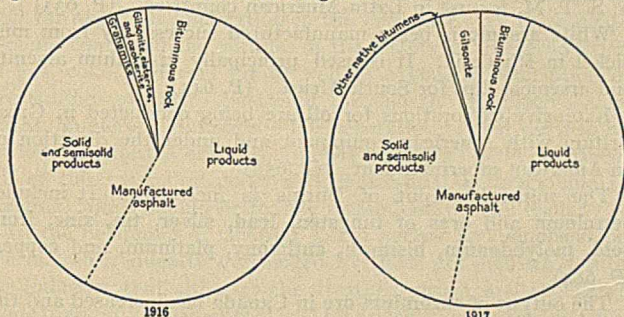
The gain in the output of gilsonite is ascribed to several factors, including the increased demand for marine paints and protective coatings for steel work, of which that mineral forms the base, the increasing demand for automobile tires and other rubber products, in which gilsonite is used as a filler, and presumably to a slight extent to increased utilization of gilsonite fluxed with petroleum in the manufacture of paving cements. The decreased output of elaterite and grahamite was undoubtedly due to the cost of mining and marketing these materials and to the strength of the market competition with certain grades of oil asphalt.

The gross sales of manufactured asphalt derived from Mexican petroleum included 338,485 tons of solid and semi-solid products, valued at \$4,657,152, an average of \$13.76 a ton, and 307,128 tons of liquid products, valued at \$2,784,661, an average of \$9.07 a ton.



ASPHALT FROM DOMESTIC AND FROM MEXICAN PETROLEUM MARKETED IN THE UNITED STATES, 1902-1917

Compared with the prices received in 1916 for corresponding products those received in 1917 for the solid and semisolid varieties averaged \$1 a ton higher, and those received for the liquid varieties 66 cents a ton higher.



PROPORTION OF EACH PRINCIPAL VARIETY OF DOMESTIC ASPHALTIC MATERIAL, INCLUDING MATERIAL MANUFACTURED FROM CRUDE PETROLEUM OF DOMESTIC ORIGIN, MARKETED IN THE UNITED STATES IN 1916 AND 1917

The accompanying figures show graphically the trend of the market for manufactured asphalt in the United States since 1902.

Structure and Oil and Gas Resources of the Osage Reservation, Oklahoma. K. C. HEALD. Bulletin 686-E. 17 pp.

Barytes and Barium Products in 1917. J. M. HILL. Mineral Resources of the United States, 1917, Part II. 7 pp. Published October 14, 1918.

During 1917 the domestic crude barytes marketed amounted to 206,888 short tons, valued at \$1,171,184. As will be seen from the table below, this was a decrease in quantity of 15,064 tons, or about 7 per cent, from the very large production of barytes in 1916, but an increase in value of \$159,952, or nearly 16 per cent. The average price of \$5.66 a short ton in 1917 exceeded by \$1.10 the price in 1916 and by a still larger amount the price in any preceding year. With the exception of South Carolina, all producing states showed a marked increase in price. In Missouri the average price was approximately \$6.60 a ton, but in the other states the averages ranged from \$4.50 to \$5.80 a ton. The smallest advance was 12 cents a ton, in Virginia; the greatest was \$1.58 a ton, in Georgia.

As will be seen from the following table, the sales of barium chemicals and lithopone were larger in 1917 than in 1916, the expansion of the barium chemical industry being particularly marked. The sales of ground barytes, however, declined considerably.

BARIUM PRODUCTS OF DOMESTIC MANUFACTURE SOLD, 1915-1917

| PRODUCT | 1915 | 1916 | 1917 |
|---------------------|---------------------|---------------------|---------------------|
| | Quantity Short Tons | Quantity Short Tons | Quantity Short Tons |
| Barium chemicals(a) | 8,823 | 16,792 | 22,503 |
| Ground barytes | 51,557 | 65,440 | 52,694 |
| Lithopone | 46,494 | 51,291 | 63,713 |
| | 106,874 | 133,523 | 138,910 |

(a) In order to avoid duplication of figures, barium chemicals manufactured from secondary products bought in open market are not included in table.

According to statistics collected by the Bureau of Foreign and Domestic Commerce, Department of Commerce, and compiled by J. A. Dorsey, of the United States Geological Survey, the imports of barium products in 1917 were valued at only \$53,150, a decrease of more than \$400,000, or 88 per cent, from the imports in 1916. As is shown in the following table, the larger part of the imports consisted of lithopone and natural barium carbonate, though some ground barytes, precipitated barium carbonate, and blanc fixe were imported. It is believed that imports of barium products can be further restricted if necessary to release more shipping.

VALUE OF BARIUM PRODUCTS ENTERED FOR CONSUMPTION IN THE UNITED STATES, 1917

| | |
|---|---------|
| Manufactured barytes(a) | \$1,743 |
| Lithopone | 29,199 |
| Barium carbonate: | |
| Natural | 17,321 |
| Manufactured | 1,554 |
| Barium binocide | .. |
| Barium chloride | .. |
| Blanc fixe or artificial barium sulfate | 3,333 |
| | 53,150 |

(a) "Manufactured barytes," as given by the Bureau of Foreign and Domestic Commerce, is believed to be the equivalent of ground and floated barytes as used by the Geological Survey.

BARIUM CHEMICALS OF DOMESTIC MANUFACTURE SOLD, 1915-1917

| CHEMICAL | 1915 | 1916 | 1917 |
|-----------------------------|---------------------|---------------------|---------------------|
| | Quantity Short Tons | Quantity Short Tons | Quantity Short Tons |
| Barium binocide | (a) | 1,980 | (a) |
| Barium carbonate | 2,746 | 6,844 | 8,238 |
| Barium chloride | 2,106 | 3,643 | 4,870 |
| Barium nitrate | 971 | 446 | 165 |
| Barium sulfate (blanc fixe) | (a) | 3,337 | 6,314 |
| Other barium chemicals(b) | 3,000 | 542 | 2,916 |
| | 8,823 | 16,792 | 22,503 |

(a) Included under "other barium chemicals."

(b) Includes, 1915: Binocide, hydroxide, sulfate, sulfide, and other barium chemicals not specified; 1916: Hydroxide and sulfide; 1917: Binocide, hydroxide, and sulfide.

Gold, Silver, Copper, and Lead in Alaska in 1917. G. C. MARTIN. Mineral Resources of the United States, 1917, Part I. 15 pp. Published November 21, 1918.

Structure and Oil and Gas Resources of the Osage Reservation, Oklahoma. D. E. WINCHESTER. Bulletin 686-C. 5 pp.

Relations of Late Paleozoic and Early Mesozoic Formations of Southwestern Montana and Adjacent Parts of Wyoming. D. D. CONDIT. Professional Paper 120-F. Shorter contributions to General Geology, 1918. 11 pp. Published October 21, 1918.

A Description of the Quantitative Classification of Igneous Rocks with Tables for the Calculation of the Norm. H. S. WASHINGTON. Extract from Professional Paper 99. Appendices 1-5. 35 pp.

BUREAU OF MINES

Efficiency in the Use of Oil Fuel. J. M. WADSWORTH. 86 pp. Paper, 15 cents. Published August 1918. A handbook for boiler-plant and locomotive engineers.

How to Improve the Hot-Air Furnace. C. W. BAKER. Technical Paper 208. 20 pp. Paper, 5 cents. Published October 1918.

Economic Operation of Steam Turbo-Electric Stations. C. T. HIRSHFELD AND C. L. KARR. Technical Paper 204. 29 pp. Paper, 5 cents. Published June 1918.

Saving Coal in Boiler Plants. H. KREISINGER. Technical Paper 205. 24 pp. Paper, 5 cents. Published July 1918.

Gold Dredging in the United States. C. JANIN. Bulletin 127. 226 pp. Paper, 50 cents. Published May 1918.

Use of the Hydrogen-Volatile Matter Ratio in Obtaining the Net Heating Value of American Coals. A. C. FIELDNER AND W. A. SELVIG. Technical Paper 197. 13 pp. Paper, 5 cents. Issued September 1918.

Production of Explosives in the United States during the Calendar Year 1917. A. H. FAY. Technical Paper 192. 21 pp. Paper, 5 cents. Issued July 1918. Contains notes on coal-mine accidents due to explosives and list of permissible explosives tested prior to April 30, 1918.

Low-Rate Combustion in Fuel Beds of Hand-Fired Furnaces. H. KREISINGER, C. E. AUGUSTINE AND S. H. KATZ. Technical Paper 139. 54 pp. Paper, 10 cents. Issued June 1918.

The Tars Distilled from Bituminous Coal in Hand-Fired Furnaces. S. H. KATZ. Technical Paper 195. 20 pp. Paper, 5 cents. Issued March 1918.

Methods for Routine Work in the Explosives Physical Laboratory of the Bureau of Mines. S. P. HOWELL AND J. E. TIFFANY. Technical Paper 186. 63 pp. Paper, 10 cents. Issued May 1918.

DEPARTMENT OF AGRICULTURE

Neufchatel and Cream Cheese: Farm Manufacture and Use. K. J. MATHESON AND F. R. CAMMACK. Farmers' Bulletin 960. 35 pp. Contribution from the Bureau of Animal Industry.

Typical Specifications for Bituminous Road Materials. P. HUBBARD AND C. S. REEVE. Department Bulletin 691. 60 pp. Paper, 10 cents. Issued July 10, 1918. Contribution from the Office of Public Roads and Rural Engineering.

Articles from the Journal of Agricultural Research

Influence of Humidity upon the Strength and the Elasticity of Wool Fiber. J. I. HARDY. 14, 285-296 (August 19).

Availability of Potash in Some Common Soil-Forming Minerals and Effect of Lime upon Potash Absorption by Different Crops. J. K. PLUMMER. 14, 297-316 (August 19).

Influence of Reaction on Nitrogen-Assimilating Bacteria. E. B. FRED AND A. DAVENPORT. 14, 317-334 (August 19).

Acidity of Silage Made from Forage Crops. R. E. NEIDIG. 14, 395-410 (September 2).

Comparative Toxicity of Cottonseed Products. W. A. WITHERS AND F. E. CARRUTH. 14, 425-451 (September 2).

Variations in the Moisture Content of the Surface Foot of a Loess Soil as Related to the Hygroscopic Coefficient. F. J. ALWAY AND G. R. MCDOLE. 14, 453-480 (September 9).

BUREAU OF FOREIGN AND DOMESTIC COMMERCE

Standard Specifications for Structural Steel for Buildings. Industrial Standards Series. 21 pp. Paper, 5 cents.

COMMERCE REPORTS—NOVEMBER 1918

A summary is given of measures taken in Great Britain to develop the manufacture of optical glass and chemical glassware. Strict government control was exercised, both over raw materials, glass pots, and finished products. During the first quarter of 1918 the output of optical glass in England was 90 times that in the same period in 1913 and 10 times the total consumption for the 1913 period. Seventy-five kinds of optical glass are being made in England. (Pp. 441-443)

Exports of Chinese wood oil from China to the United States are again increasing. Through the Browne heat test, adulteration of the oil has been almost eliminated. The oil is shipped in kerosene cans, as loss arose from shipping in casks. (P. 476)

The first shipment of hematite from British Columbia to the United States has just been made to the smelter at Irondale, Wash. (P. 484)

In order to furnish oils for edible and industrial uses, and cattle food as well, efforts have been directed in Denmark to the cultivation and pressing of mustard, sunflower, flax, and poppy seed, and beech nuts. (P. 486)

In connection with the British control of the acid and fertilizer industries, the supply, price and distribution of pyrites and pyrite cinder, sulfuric acid, niter cake, phosphate rock, superphosphate, ammonia, ammonium sulfate, and basic slag are controlled by a system of licensing. Great economies have been effected by elimination of long hauls and by utilization of the niter cake. (Pp. 502-505)

Recently there was held in London a "Key Industries Exhibition" to illustrate the progress in those industries which, while not large, are essential to other and greater industries. It is interesting to note that most of these key industries are chemical industries, *e. g.*, dyes, optical glass, tungsten, lead, graphite, spelter, rubber, and antimony. (Pp. 513-514)

The production of coconut fiber, copra, and coconut oil in Trinidad is described in detail. (Pp. 535-543)

A new plant has been erected in Argentina for the manufacture of argols and grape-seed oil. (P. 546)

The United States High Commission has recommended the adoption of the metric system to improve commercial relations with other American republics. (P. 628)

The Bureau of Foreign and Domestic Commerce has published in Spanish and English standard steel specifications of the A. S. T. M. for use in Latin-American countries. (P. 633)

White arsenic is being manufactured successfully from mispickel in Rhodesia. It is used principally in sodium arsenite and arsenical dips for South Africa. (P. 643)

Extensive explorations for oil are being conducted in Great Britain with American equipment and under the direction of an American superintendent. (P. 658)

The mineral output of Burma is increasing. It includes petroleum and ores of tungsten, lead, silver, tin, zinc, iron, gold, molybdenum, bismuth, antimony, platinum, and copper. (P. 684)

The output of chromium ore in Canada has increased and the production of ferrochrome has been started. (P. 769)

A detailed report is given on numerous Chinese mineral products, including alum, antimony, arsenic, asbestos, borax, copper, gold, iron ore, jade, lead potash, mercury, arsenic, salt, silver, soapstone, tin, tungsten ore, and zinc. (Pp. 785-792)

Switzerland's dependence on Germany for iron and steel arises from the lack of coal and iron deposits. Only one small blast furnace and a few small steel works are operated in Switzerland. (P. 810)

SPECIAL SUPPLEMENTS

| | |
|-----------------|-------------------------|
| GREECE—7b | PANAMA—35a |
| SPAIN—15c | COLOMBIA—42a |
| SWITZERLAND—17b | AUSTRALIA—60b |
| ENGLAND—19i | BRITISH EAST AFRICA—65b |
| MEXICO—32c | |

STATISTICS OF EXPORTS TO THE UNITED STATES

| | | |
|---------------------|--------------------|-------------------|
| ENGLAND—Sup. 19i | SWITZERLAND—Sup. | MEXICO—Sup. 32c |
| Fuller's earth | 17b | Chicle |
| Hides | Chemicals | Copra |
| Iron ore | Aniline dyes | Hides |
| Sal ammoniac | Artificial indigo | Logwood |
| Oxalic acid | Artificial silk | Rubber |
| Alum | Glycerin | Gold |
| Barium carbonate | Saccharine | Silver |
| Carbolic acid | Synthetic perfumes | Copper |
| Creosote | | Lead |
| Naphthalene | | Sugar |
| Glue | | Wax |
| Gum copal | | Mercury |
| Castor oil | AUSTRALIA—Sup. 60b | Antimony |
| Palm kernel oil | Chrome ore | Cottonseed oil |
| Reefe seed oil | Copra | |
| Bluing | Hides | |
| Iron oxide | Nickel matte | GREECE—Sup. 7b |
| Paris white | Cocunut oil | Opium |
| Driers | Eucalyptus oil | Magnesite |
| Ultramarine | Osmiridium | Saffron |
| Rubber | Tin | Tanning materials |
| Antimony | | |
| Barium peroxide | | |
| Strontium carbonate | | |
| Fluorspar | | |

BOOK REVIEWS

The Treasures of Coal Tar. By ALEXANDER FINDLAY, M.A., Ph.D., D.Sc., F. I. C., Professor of Chemistry in the University of Wales and Director of the Edward Davies Chemical Laboratories, Aberystwyth. 138 pp. D. Van Nostrand Company, New York, 1918. Price, \$2.00.

The author, in the preface, sets forth his object of publishing this small book as being a promotion of the better understanding by the people as a whole (in England) of the nature and complexity of the problems involved in the utilization of coal tar, with special emphasis on the subject of dyes which, he states, are so necessary for the maintenance of the textile industry.

The same situation as exists in England exists also in the United States, and the call for a book on the production and utilization of coal tar in language intelligible to the layman is a very real one.

It is also quite true of America, as of England, that a more general appreciation of the ultimate results of work in pure research should be fostered, and the author brings out this point in relation to England most clearly in his preface. It was, therefore, with a great deal of anticipation that the book was received.

Chapters 1, 2, and 3 deal, respectively, with the production of coal tar, the distillation of coal tar, and the constituents of coal tar and their application in the raw state. In these chapters are contained the outlines of the history of the production of gas, coke, and coal tar as well as a general description of present-day practice. Scattered through the descriptive matter are numerous statistics. The separation of coal tar into its various fractions is outlined, and the fractions briefly described. All of this matter is given with substantial accuracy and in language which should be readily understood by any reader.

In the beginning of Chapter 3, the author lays emphasis on the fact so frequently overlooked by those not connected with the industry, that although the dyestuffs, drugs, and explosives made from the constituents of coal tar appeal more to the imagination of the layman, yet "there are other industries dependent on the distillation products of coal tar * * * * which * * * * together make up a large part of the wealth derived from coal tar. Indeed, it is probably to these industries which depend on the use of coal-tar products in the raw state that the tar distiller mainly looks for the maintenance of his profits."

Chapter 3, therefore, deals with the uses of the benzols and naphthas as solvents, phenol and cresol as disinfectants, creosote oil as a wood preservative, and refined tars and pitch for road work, saturating felt, etc.

So far, the intention of dealing with the subject without the use of technical terms has been carried out, but in Chapter 4 the author endeavors to lead the reader into making a mental effort to grasp the distinction between atom and molecule, the meaning of valency, the difference between saturated and unsaturated hydrocarbons, the chemist's means of depicting substances by their formulas, and the theory of molecular structure, with several other explanations, such, for instance, as isomerism.

While there is no denying that the subjects covered are well treated and condensed, yet the impression conveyed when coming on this chapter is that the author after further consideration decided it was easier to educate the reader in the rudiments of chemistry than to explain the relation of dyestuffs to coal-tar products without the aid of formulas and symbols. In fact, the author devotes the last two pages of the chapter to the justification of urging the layman to endeavor to understand formulas. However, it can hardly be denied that the character of the book changes from this point on, and it becomes rather

an elementary description of the coal-tar dyes, drugs, and explosives for those who have specialized in other lines of chemistry, and can refresh the studies they made of the aromatic compounds in younger days, or for those who, in their training, received a little instruction in chemistry and are anxious to increase their elementary knowledge. It is impossible to conceive that more than one in ten of the average readers who might very well be seekers after some deeper information on this topic would come through the chapters on dyes with other than a confusion of ideas.

It is, therefore, necessary to view the balance of the book from a slightly different angle.

There are four chapters on the subject of dyes. The first is a general chapter containing some interesting historical notes and relating more particularly to the so-called aniline dyes. The second chapter is devoted to azo dyes; the third to anthracin and vat dyes; and the fourth to indigo and its derivatives.

The chapter on "The Production of Dyes from Coal Tar," the first of the four, is quite elementary, and gives a good view of the simpler dyes, and is especially full of historical data. It also explains the relation of chromophores to the dyes.

The chapter on azo dyes is fairly elementary, but each chapter becomes less so, until the chapter on indigo appears not unlike the usual technical description.

The chapter on "Drugs, Perfumes, and Photographic Developers" is a particularly interestingly condensed history of these products of coal tar.

The last chapter, that on "Explosives," is of particular attraction in these war times, and could be read with interest and profit by any chemist who has not specialized in explosives, as well as laymen. There is more familiarity among the people at large with the explosives, such as picric acid and TNT, than with the chemical names of dyes and their intermediates, and no doubt this chapter could be absorbed to better advantage than the previous ones.

Let us hope, however, that familiarity with chemical names and processes will become more and more universal, and we believe that many more can appreciate this book now than could a few years back. If the majority of readers, however, in England, can absorb the facts presented in this book to-day, then they have advanced farther than we have in the United States, and we hope the time will come with us when such a book will be generally understood.

D. H. JAYNE

Metallurgical Calculations. By JOSEPH W. RICHARDS, A.C., Ph.D., Professor of Metallurgy in Lehigh University. xxiii + 675 pp. McGraw-Hill Book Company, Inc., New York, 1918. Price, \$5.00 net.

This volume is the collection, re-arrangement, and enlargement of a series of papers first printed serially, subsequently issued in three separate parts, and now published in a single volume. The book as a whole may be considered a study of energy changes, thermo and electric, as applied to metallurgical operations. In Part I the author discusses Chemical and Thermal Principles, Problems in Combustion, and Radiation and Conduction of Heat; in Part II, Application to the Metallurgy of Iron and Steel; in Part III, Applications to Other Metals (non-ferrous). Under each part is a series of chapters in each of which is discussed a great variety of metallurgical reactions bearing upon some phase of the subject, and under each chapter a series of problems. As an example of the variety of subjects covered, the titles under Part III are here quoted: Balance Sheet of the Blast Furnace, Calculation of Furnace Charge, Utilization of Fuel in the Blast Furnace, Heat Balance Sheet of the Blast Furnace, Rational of Hot Blast and Dry Blast, The

Bessemer Process, Thermo-Chemistry of Bessemer Process, Temperature Increment in the Bessemer Converter, Open-Hearth Furnace, Thermal Efficiency of Open-Hearth Furnace, Electrometallurgy of Iron and Steel, Problems for Practice.

It will be seen that the book is made up of a multiplicity of detail, of an infinite mass of data, collected and arranged in logical order.

Each subject is studied thoroughly and the book should lead to a more intelligent understanding of quantitative metallurgy.

HENRY FAY

The Metallurgists' and Chemists' Handbook. By DONALD M. LIDDELL. Second Edition. McGraw-Hill Book Company, Inc., New York, 1918. Price, \$4.00 net.

The additions made in this second edition of Liddell's Handbook have been, as stated in the author's preface, "largely those bearing on war activities such as additional information on alloys and toxic gases." The arrangement is practically the same as in the first edition, a short chapter having been added "to serve as a reminder of simplest formulas and properties of the more common organic compounds."

The sections are as follows:

- Section I—Mathematics
- Section II—Price and Production Statistics
- Section III—Physical Constants
- Section IV—Chemical Data
- Section V—Sampling, Assaying and Analysis
- Section VI—Ore Dressing
- Section VII—Cyanidation
- Section VIII—Fuels and Refractories
- Section IX—Mechanical Engineering and Construction
- Section X—General Metallurgy
- Section XI—Organic Chemistry
- Section XII—First Aid

The main criticism that may be made of the book is the inadequate treatment of some divisions. The author forestalls criticism in this respect in his preface to the first edition thus: "This book is a * * * * collection of tables, those which my own experience * * * * have led me to believe were most necessary to the chemist and metallurgist * * * *. Certain sections will probably be criticised for their brevity, but these treat of those processes where there are no tables of constants, and the matter must either be descriptive or else non-existent." Certain sections which are now somewhat disappointing, notably that on copper leaching, will doubtless be amplified in later editions.

The Handbook is well worth buying, and is especially valuable in that it contains, in addition to the usual tables and data, a mass of tabulated data of value to the student and professional man, and not collected or easily accessible elsewhere.

The author, nevertheless, displays some unnecessary pessimism regarding the fruits of his labors, in stating in his preface: "He (Mr. Barbour) is doubtless the only man beside the author who will ever read the entire book." Also it is evident in the chapter on First Aid that Mr. Liddell accepts no responsibility as to the efficacy of the antidotes for poisons, since he gives as the last step in the treatment of cyanide poisoning: "Then call the undertaker."

G. D. VAN ARSDALE

Colour and Its Relation to Chemical Constitution. By E. R. WATSON. 197 pp. Longmans, Green & Company, New York and London, 1918. Price, \$4.00.

This book is one of a series of Monographs on Industrial Chemistry, which is being edited by Sir Edward Thorpe, C.B., LL.D., F.R.S., Emeritus Professor of General Chemistry in the Imperial College of Science and Technology, South Kensington, England. It fortunately appears at a time when it is very

essential that the more important theoretical speculations bearing on the subject of color chemistry should be presented for the guidance of our future investigators in this rich field of work. We have no good summary of this subject in our language and this work of Watson's not only opens up a new subject to us and meets a long-felt want, but also should serve as a guide and stimulus for young researchers to interest themselves in a field which offers great possibilities. The time is now ripe for new developments in this field in this country.

The work is based on a course of lectures delivered at the University of Leeds in 1917, which have been expanded into a readable book giving a connected and simple account of the most important lines of color research and the fundamental theories which have hitherto been proposed to explain the cause and nature of color. A most valuable feature of the book is an excellent and very complete bibliography of works of reference which has been incorporated. The book should be in every chemical library and especially on the bookshelf of our graduate schools for the reading of advanced students who are working for advanced degrees in chemistry.

TREAT B. JOHNSON

Nomon: Sugar Technologists' Edition. An adaptation of the Nomon designed by Horace G. Deming. By A. F. BLAKE, Chief Chemist, Atlantic Sugar Refineries, Limited, St. John, N. B. In 6 sections. For reading purity exponents from Brix and polarization. The Nomon Sales Agency, Urbana, Ill. Price, \$1.50.

Mr. A. F. Blake, chief chemist of the Atlantic Sugar Refineries Limited of St. John, N. B., Canada, has arranged a special form of nomon, *i. e.*, nomographic reckoner, for calculating the purities of sugar solutions from the observed density in degrees Brix and the polarization.

This tabular arrangement is a modification of the original general tables invented by Dr. Horace G. Deming of the University of Illinois and described in the *Journal of the American Chemical Society*, 39 (1917), 2137.

Ordinarily the exponent of purity is calculated by the Casamajor method employing the formula, $\text{Exp.} = \text{Pol.} \times \frac{26}{\text{Sp. Gr.} \times \text{Brix}}$, and while this formula is ordinarily simplified

by use of a table of factors covering the values of $\frac{26}{\text{Sp. Gr.} \times \text{Brix}}$ for every degree Brix, it still is cumbersome, requiring reference to the table of factors and a multiplication for each test, or else the calculation and printing of extremely extended tables to cover the possible range of degrees Brix and all the polarizations.

The sugar nomon as published consists of a few heavy sheets of cardboard, $9\frac{1}{2} \times 12$ in., on each of which is printed a set of eleven accurately subdivided scales all arranged vertically except the one at the extreme right, which inclines outward toward the top, at an angle of about 30 degrees. The others are placed at very precisely varying distances from each other. Their graduations are so arranged that if a straight edge is laid upon the figure representing the degrees Brix in the left-hand column and is swung around until it also crosses the right-hand column at the figure representing the second and third numbers in the polarization, the purity of the solution may be read immediately at the point of intersection with that vertical column whose position in the series corresponds with the first digit in the polarization.

The design is so clever and its operation so simple it must commend itself to all who see it and it will prove a very acceptable help in all sugar laboratories.

As any ordinary calculation may be made on the nomon that can be made on the slide rule and with greater ease and accuracy, it will be found very serviceable by chemists generally.

W. D. HORNE

NEW PUBLICATIONS

- Alternating Current Electrical Engineering. PHILIP KEMP. 8vo. 505 pp. Price, 17s. The Macmillan Co., London.
- Asphalts and Allied Substances; Their Occurrence, Modes of Production, Uses in the Arts and Methods of Testing. HERB. ABRAHAM. 8vo. 606 pp. Price, \$5.00. D. Van Nostrand Co., New York.
- Chemical Analysis: Qualitative Chemical Analysis; A Laboratory Guide. W. W. SCOTT. 3rd Ed. Revised and enlarged. 12mo. 350 pp. Price, \$3.00. D. Van Nostrand Co., New York.
- Chemistry: Industrial and Manufacturing Chemistry. I. Organic. GEOFFREY MARTIN 4th Ed. Revised and enlarged. 764 pp. Price, 36s. Crosby Lockwood & Son, London.
- Chemistry: Industrial and Manufacturing Chemistry. II. Inorganic. Vol. I. GEOFFREY MARTIN. 2nd Ed. 516 pp. Price, 28s. Crosby Lockwood & Son, London.
- Chemistry: Introduction to Organic Chemistry. J. T. STODDARD. 2nd Ed. Revised. 12mo. 423 pp. Price, \$1.50. P. Blakiston's Son & Co., Philadelphia.
- Chemistry: Laboratory Exercises in General Chemistry. W. M. BLANCHARD. 2nd Ed. 12mo. 156 pp. Price, \$1.00. D. Van Nostrand Co., New York.
- Chemistry: Organic Chemistry for Advanced Students. Vol. 1, Reactions; Vol. 2, Structure; Vol. 3, Synthesis. J. B. COHEN. 2nd Ed. Price, 18s. each. E. Arnold, London.
- Chemistry of Synthetic Drugs. PERCY MAY. 2nd Ed. Revised and enlarged. 8vo. 256 pp. Price, 10s. 6d. Longmans, Green & Co., London.
- Dyes: Application of the Coal-Tar Dyestuffs. The Principles Involved and the Methods Employed. C. M. WHITTAKER. 8vo. 225 pp. Price, 7s. 6d. Baillière, Tindall & Cox, London.
- Ether: l'Ether, Moteur Unique des Forces Materielles. J. LE HARBONNIER. 6f. Plon-Nourit & Co., Paris.
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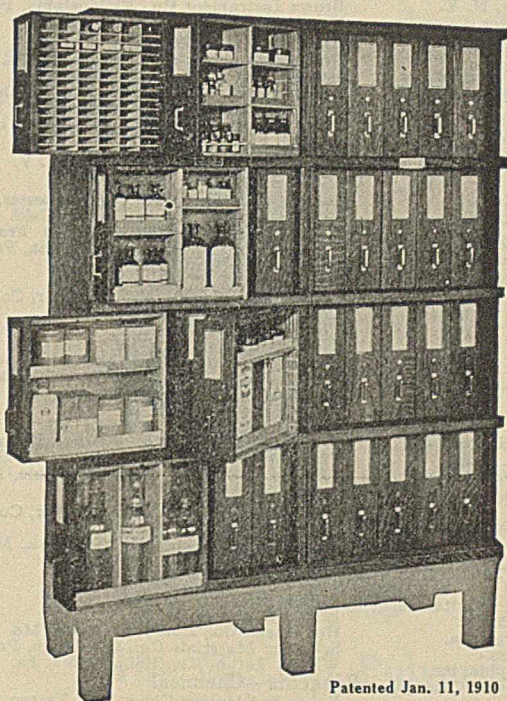
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Sperry & Co., D. R., Batavia, Ill.
Stevens Brothers, N. Y. C.
Werner & Pfeiderer Co., Saginaw, Mich.
- Kettles (Stoneware)**
 General Ceramics Co., N. Y. C.
 Knight, M. A., East Akron, O.
 U. S. Stoneware Co., The, Akron, O.
- Kilns (Bone Black)**
 Colwell, Lewis, Chicago, Ill.
- Laboratory Apparatus—Designing & Manufacturing**
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Engelhard, Charles, N. Y. C.
 Fletcher Works, Philadelphia, Pa.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Standard Scientific Co., N. Y. C.
- Laboratory Burners**
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Detroit Heating & Lighting Co., Detroit, Mich.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Mine and Smelter Supply Co., The, N. Y. C.
 Scientific Materials Co., Pittsburgh, Pa.
- Laboratory Chemicals**
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Dow Chemical Co., The, Midland, Mich.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Merck & Co., N. Y. C.
 Powers-Weightman-Rosengarten Co., Phila., Pa.
 Scientific Materials Co., Pittsburgh, Pa.
- Laboratory Gas Machine**
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Detroit Heating & Lighting Co., Detroit, Mich.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Scientific Materials Co., Pittsburgh, Pa.
- Laboratory Glassware**
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Macbeth-Evans Glass Co., Pittsburgh, Pa.
 Scientific Materials Co., Pittsburgh, Pa.
- Laboratory Supplies**
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Detroit Heating & Lighting Co., Detroit, Mich.
 Duriron Castings Co., N. Y. C.
 Eimer & Amend, N. Y. C.
 Engelhard, Charles, N. Y. C.
 Greiner Co., Emil, N. Y. C.
 Griebel Instrument Co., Carbondale, Pa.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Mine and Smelter Supply Co., The, N. Y. C.
 Palo Company, N. Y. C.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Standard Scientific Co., N. Y. C.
 Thomas Co., Arthur H., Philadelphia, Pa.
 Whitall Tatum Co., Philadelphia, Pa.
- Laboratory Supplies, Platinum**
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Baker & Co., Inc., Newark, N. J.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Scientific Materials Co., Pittsburgh, Pa.
- Lacquer**
 General Bakelite Co., N. Y. C.
- Lactic Acid**
 Hell Chem. Co., Henry, St. Louis, Mo.
 Powers-Weightman-Rosengarten Co., Phila., Pa.
- Lamps—Arc and Incandescent**
 General Electric Co., Schenectady, N. Y.
- Leaching Cells**
 Swenson Evaporator Co., Chicago, Ill.
 Zarembo Co., Buffalo, N. Y.
- Lead Burning**
 McNamara, M., Everett, Mass.
- Lead Lined Pipe and Accessories**
 Badger & Sons Co., E. B., Boston, Mass.
 United Lined Tube & Valve Co., Boston, Mass.
- Lightning Arresters**
 General Electric Co., Schenectady, N. Y.
- Linings, Cupola**
 Herold China & Pottery Co., Golden, Col.
- Lithopone**
 New Jersey Zinc Co., The, N. Y. C.
- Lubricants**
 Dearborn Chemical Co., Chicago, Ill.
- Machinery—Chemical**
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Devine Co., J. P., Buffalo, N. Y.
 Werner & Pfeiderer Co., Inc., Saginaw, Mich.
- Machinery—Electrical**
 General Electric Co., Schenectady, N. Y.
- Machinery—Mining and Metallurgical**
 Abbé Engineering Co., N. Y. C.
 Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco.
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 General Filtration Co., Inc., Rochester, N. Y.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Scientific Materials Co., Pittsburgh, Pa.
 Stokes Machine Co., F. J., Philadelphia, Pa.
- Machinery—Mixing and Kneading**
 Abbé Engineering Co., N. Y. C.
 Elyria Enameled Products Co., Elyria, O.
 Jacoby, Henry B., N. Y. C.
 Pfaunder Co., Rochester, N. Y.
 Sowers Mfg. Co., Buffalo, N. Y.
 Werner & Pfeiderer Co., Saginaw, Mich.
- Machinery—Pulverizing**
 Abbé Engineering Co., N. Y. C.
 Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco.
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Raymond Bros. Impact Pulv. Co., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
- Machinery (Special)**
 Badger & Sons Co., E. B., Boston, Mass.
 Birmingham Mch. & Fdy. Co., Birmingham, Ala.
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Cleveland Brass Mfg. Co., The, Cleveland, O.
 Devine Co., J. P., Buffalo, N. Y.
 Duriron Castings Co., N. Y. C.
 Jacoby, Henry B., N. Y. C.
 Sowers Mfg. Co., Buffalo, N. Y.
 Stevens Brothers, N. Y. C.
 Werner & Pfeiderer Co., Saginaw, Mich.
- Magnesium—Metal and Salts**
 Dow Chemical Co., The, Midland, Mich.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Merck & Co., N. Y. C.
 Powers-Weightman-Rosengarten Co., Phila., Pa.
- Mercury—Salts of**
 Hell Chem. Co., Henry, St. Louis, Mo.
 Merck & Co., N. Y. C.
 Powers-Weightman-Rosengarten Co., Phila., Pa.
- Metallographic Apparatus**
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Central Scientific Co., Chicago, Ill.
 Eimer & Amend, N. Y. C.
 Hell Chemical Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.
 Scientific Materials Co., Pittsburgh, Pa.
- Metallurgical Laboratory Equipment**
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco, Cal.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Engelhard, Charles, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Hoskins Mfg. Co., Detroit, Mich.
 Palo Company, N. Y. C.
 Scientific Materials Co., Pittsburgh, Pa.
 Thomas Co., Arthur H., Philadelphia, Pa.
- Meters—Flow Air, Gas, Water**
 General Electric Co., Schenectady, N. Y.
- Microscopes**
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Thomas Co., Arthur H., Philadelphia, Pa.
- Microtomes**
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Hell Chemical Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Thomas Co., Arthur H., Philadelphia, Pa.
- Micro Photo. Apparatus Mfrs.**
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Scientific Materials Co., Pittsburgh, Pa.
- Mills—Ball, Pebble and Tube**
 Abbé Engineering Co., N. Y. C.
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Mine and Smelter Supply Co., The, N. Y. C.
 Palo Company, N. Y. C.
- Mixers**
 Elyria Enameled Products Co., Elyria, O.
 Pfaunder Co., Rochester, N. Y.
 Pratt Engineering & Machine Co., Atlanta, Ga.
 Sowers Mfg. Co., Buffalo, N. Y.
 Werner & Pfeiderer Co., Saginaw, Mich.
- Mixing Tanks**
 Badger & Sons Co., E. B., Boston, Mass.
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Detroit Heating & Lighting Co., Detroit, Mich.
 Devine Co., J. P., Buffalo, N. Y.
 Duriron Castings Co., N. Y. C.
 Elyria Enameled Prod. Co., Elyria, O.
 Lumsum Co., The, Walter E., Boston, Mass.
 Pfaunder Co., Rochester, N. Y.
 Sowers Mfg. Co., Buffalo, N. Y.
 Stevens Brothers, N. Y. C.
 Werner & Pfeiderer Co., Saginaw, Mich.
- Molybdates**
 Central Scientific Co., Chicago, Ill.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Merck & Co., N. Y. C.
 Powers-Weightman-Rosengarten Co., Phila., Pa.
- Molybdc Acid**
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Mine and Smelter Supply Co., The, N. Y. C.
 Scientific Materials Co., Pittsburgh, Pa.
- Montejus—Automatic**
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Devine Co., J. P., Buffalo, N. Y.
 General Ceramics Co., N. Y. C.
 Knight, Maurice A., East Akron, O.
- Mortars & Pestles**
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Scientific Materials Co., Pittsburgh, Pa.
 Whitall Tatum Co., Philadelphia, Pa.
- Muffles**
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Engelhard, Charles, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Mine and Smelter Supply Co., The, N. Y. C.
 Norton Co., Worcester, Mass.
 Scientific Materials Co., Pittsburgh, Pa.
- Nickel—Salts of**
 Hell Chem. Co., Henry, St. Louis, Mo.
 Merck & Co., N. Y. C.
 Powers-Weightman-Rosengarten Co., Phila., Pa.
- Nitrating Apparatus**
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Devine Co., J. P., Buffalo, N. Y.
 Fletcher Works, Philadelphia, Pa.
- Nitrating Pots**
 Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Devine Co., J. P., Buffalo, N. Y.
 Duriron Castings Co., N. Y. C.
 Elyria Enameled Products Co., Elyria, O.
 General Ceramics Co., N. Y. C.
 Knight, Maurice A., East Akron, O.
 Pfaunder Co., Rochester, N. Y.
 Sowers Mfg. Co., Buffalo, N. Y.
 Stevens Bros., N. Y. C.
 U. S. Stoneware Co., The, Akron, O.
 Werner & Pfeiderer Co., Saginaw, Mich.
- Nitrators—Sulphonators, Etc.**
 Bethlehem Fdy. & Mch. Co., South Bethlehem, Pa.
 Stevens Bros., N. Y. C.
- Nitre Pot Acid Pipes**
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Cleveland Brass Mfg. Co., The, Cleveland, O.
 Duriron Castings Co., N. Y. C. (Special Alloy)
 Elyria Enameled Prod. Co., Elyria, O.
 General Ceramics Co., N. Y. C.
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- Nitric Acid Apparatus**
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Duriron Castings Co., N. Y. C.
- Nitric Acid Plants—Chemical Stoneware**
 Knight, Maurice A., East Akron, O.
- Nitric Acid Retorts**
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
- Nozzles (Acid Proof)**
 Duriron Castings Co., N. Y. C.
- Oil Products**
 National Oil Products Co., Harrison, N. J.
- Oil Testing Instruments**
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Griebel Instrument Co., Carbondale, Pa.
 Hell Chemical Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Taylor Instrument Cos., Rochester, N. Y.
 Thomas Co., Arthur H., Philadelphia, Pa.
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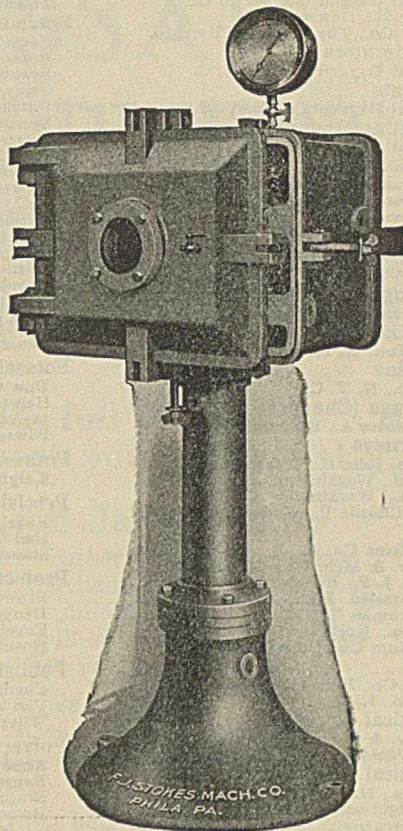
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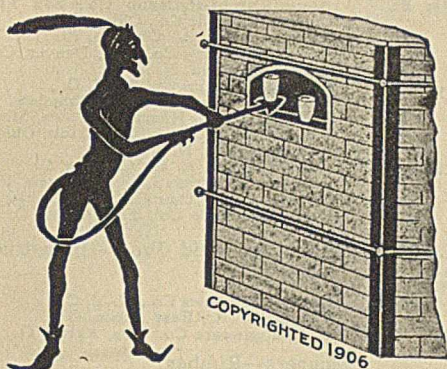
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 Palo Company, N. Y. C.
 Thwing Instrument Co., Philadelphia, Pa.
- Optical Pyrometer**
 Denver Fire Clay Co., The, Denver, Colo.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.
 Scientific Materials Co., Pittsburgh, Pa.
- Oxygen (Pure)**
 International Oxygen Co., N. Y. C.
 Levin, Isaac H., Newark, N. J.
 Oxygen Gas Co., The, Kansas City, Mo.
- Oxygen Generators**
 International Oxygen Co., N. Y. C.
- Oxygen Plants**
 International Oxygen Co., N. Y. C.
- Oxygen Testing Apparatus**
 International Oxygen Co., N. Y. C.
- Packings (Condensing Tower)**
 General Ceramics Co., N. Y. C.
 Knight, Maurice A., East Akron, O.
 U. S. Stoneware Co., The, Akron, O.
- Paints**
 Toch Brothers, N. Y. C.
- Panels, Rheostats, Motor Generator Sets and Tungal Rectifiers**
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- Paper, All Kinds**
 Angel Co., Inc., H. Reeve, N. Y. C.
- Paranitraniline**
 Merck & Co., N. Y. C.
- Partition Rings (Chemical Acid Proof)**
 Knight, Maurice A., East Akron, O.
- Patent Attorneys**
 Brickenstein, John H., Washington, D. C.
 Foster, A. B., Washington, D. C.
 Parker, C. L., Washington, D. C.
 Townsend, Clinton P., Washington, D. C.
- Percolators**
 Badger & Sons Co., E. B., Boston, Mass.
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Devine Co., J. P., Buffalo, N. Y.
 Elyria Enamelled Prod. Co., Elyria, O.
 General Ceramics Co., N. Y. C.
 Pfaudler Co., Rochester, N. Y.
 Whitall Tatum Co., Philadelphia, Pa.
- Perhydrol**
 Hell Chem. Co., Henry, St. Louis, Mo.
 Merck & Co., N. Y. C.
- Pharmaceutical Dryers**
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Werner & Pfeleiderer Co., Inc., Saginaw, Mich.
- Pharmaceutical Preparations**
 Merck & Co., N. Y. C.
 Powers-Weightman-Rosengarten Co., Phila., Pa.
- Phenol Apparatus**
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
- Photomicrography**
 Gravelle, Phillip O., S. Orange, N. J.
- Photo-Micrographic Apparatus**
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Central Scientific Co., Chicago, Ill.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.
 Scientific Materials Co., Pittsburgh, Pa.
 Thomas Co., Arthur H., Philadelphia, Pa.
- Physical Apparatus**
 Standard Scientific Co., N. Y. C.
- Picric Acid Apparatus**
 Knight, Maurice A., East Akron, O.
- Pipe and Accessories (Acid Proof)**
 Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
 Cleveland Brass Mfg. Co., The, Cleveland, O.
 Duriron Castings Co., N. Y. C.
 Elyria Enamelled Prod. Co., Elyria, O.
 General Ceramics Co., N. Y. C.
 Herold China & Pottery Co., Golden, Col.
 Knight, Maurice A., East Akron, O.
 Thermal Syndicate, Ltd., N. Y. C. (Fused Silica.)
 United Lined Tube & Valve Co., Boston, Mass.
 U. S. Stoneware Co., The, Akron, O.
- Pipe and Fittings—Lead or Tin Lined**
 United Lined Tube & Valve Co., Boston, Mass.
- Pipe Coverings**
 The Magnesia Association of America, N. Y. C.
- Pipes—Steam Jacketed**
 Devine Co., J. P., Buffalo, N. Y.
- Pitch for Protective Coatings**
 The Barrett Co., N. Y. C.
- Platinum (Sheet, Wire and Foil)**
 American Platinum Works, Newark, N. J.
 Baker & Co., Inc., Newark, N. J.
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Bishop & Co., J., Platinum Works, Malvern, Pa.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.
 Sargent & Co., E. H., Chicago, Ill.
- Platinum Ware (Laboratory)**
 American Platinum Works, Newark, N. J.
 Baker & Co., Inc., Newark, N. J.
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Bishop & Co., J., Platinum Works, Malvern, Pa.
- Braun Corporation, Los Angeles, Cal.
 Braun-Knecht-Heimann Co., San Francisco.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Engelhard, Chas., N. Y. C.
 Griebel Instrument Co., Carbondale, Pa.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Thomas Co., Arthur H., Philadelphia, Pa.
- Porcelain Ware—Laboratory**
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Engelhard, Charles, N. Y. C. ("Impervite")
 Griebel Instrument Co., Carbondale, Pa.
 Guernsey Earthenware Co., The, Cambridge, O.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Herold China & Pottery Co., Golden, Col.
 Palo Company, N. Y. C.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Standard Scientific Co., N. Y. C.
 Thomas Co., Arthur H., Philadelphia, Pa.
- Portable Ozonators**
 General Electric Co., Schenectady, N. Y.
- Potassium—Salts of**
 Dow Chemical Co., The, Midland, Mich.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Merck & Co., N. Y. C.
 Powers-Weightman-Rosengarten Co., Phila., Pa.
- Pots—Acid Proof Stoneware**
 Knight, Maurice A., East Akron, O.
- Precision Instrument Makers**
 Engelhard, Charles, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Scientific Materials Co., Pittsburgh, Pa.
- Protecting Tubes, Thermocouples**
 Brown Instrument Co., The, Phila., Pa.
 Denver Fire Clay Co., The, Denver, Colo.
 Engelhard, Charles, N. Y. C.
 Hoskins Mfg. Co., Detroit, Mich.
- Publishers**
 Chemical Publishing Co., Easton, Pa.
 Van Nostrand Co., D., N. Y. C.
 Wiley & Sons, Inc., John, N. Y. C.
- Pulverizers—Laboratory**
 Abbé Engineering Co., N. Y. C.
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Hell Chemical Co., Henry, St. Louis, Mo.
 Mine and Smelter Supply Co., The, N. Y. C.
 Palo Company, N. Y. C.
 Pratt, Engineering & Machine Co., Atlanta, Ga.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Sturtevant Mill Co., Boston, Mass.
 Thomas Co., Arthur H., Philadelphia, Pa.
 Williams Patent Crusher & Pulv. Co., Chicago.
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 Bausch & Lomb Optical Co., Rochester, N. Y.
 Central Scientific Co., Chicago, Ill.
 Cleveland Brass Mfg. Co., The, Cleveland, O.
 Devine Co., J. P., Buffalo, N. Y.
 Duriron Castings Co., N. Y. C.
 Eimer & Amend, N. Y. C.
 General Ceramics Co., N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Mine and Smelter Supply Co., The, N. Y. C.
 Palo Company, N. Y. C.
 Schutte & Koerting Co., Philadelphia, Pa.
 United Lined Tube & Valve Co., Boston, Mass.
 U. S. Stoneware Co., The, Akron, O.
- Pumps (Chemical)**
 American Well Works, The, Aurora, Ill.
- Pumps (Laboratory Vacuum)**
 Abbé Engineering Co., N. Y. C.
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Central Scientific Co., Chicago, Ill.
 Crowell Mfg. Co., Brooklyn, N. Y.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Devine Co., J. P., Buffalo, N. Y.
 Eimer & Amend, N. Y. C.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Hubbard's Sons, Norman, Brooklyn, N. Y.
 Palo Company, N. Y. C.
 Sargent & Co., E. H., Chicago, Ill.
 Thomas Co., Arthur H., Philadelphia, Pa.
- Pumps (Vacuum)**
 Abbé Engineering Co., N. Y. C.
 Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
 Crowell Mfg. Co., Brooklyn, N. Y.
 Devine Co., J. P., Buffalo, N. Y.
 Jacoby, Henry E., N. Y. C.
- Pump Parts Metal (Acid Proof)**
 Duriron Castings Co., N. Y. C.
- Pyrometer Tubes**
 Brown Instrument Co., The, Phila., Pa.
 Denver Fire Clay Co., The, Denver, Colo.
 Engelhard, Charles, N. Y. C.
 Norton Co., Worcester, Mass.
- Pyrometers**
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco.
 Brown Instrument Co., Philadelphia, Pa.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Engelhard, Chas., N. Y. C.
 Greiner Co., Emil, N. Y. C.
 Griebel Instrument Co., Carbondale, Pa.
 Hanovia Chemical & Mfg. Co., Newark, N. J.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Hoskins Mfg. Co., Detroit, Mich.
 Leeds & Northrup Co., The, Philadelphia, Pa.
 Palo Company, N. Y. C.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Taylor Instrument Cos., Rochester, N. Y.
 Thomas Co., Arthur H., Philadelphia, Pa.
 Thwing Instrument Co., Philadelphia, Pa.
- Pyrometers—Electrical**
 Brown Instrument Co., Philadelphia, Pa.
 Engelhard, Charles, N. Y. C.
- Pyrometers (Optical)**
 Braun-Knecht-Heimann Co., San Francisco.
 Brown Instrument Co., Philadelphia, Pa.
 Hell Chem. Co., Henry, St. Louis, Mo.
- Pyrometers (Radiation)**
 Brown Instrument Co., The, Phila., Pa.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Leeds & Northrup Co., The, Philadelphia, Pa.
 Taylor Instrument Cos., Rochester, N. Y.
 Thwing Instrument Co., Philadelphia, Pa.
- Quartz**
 Booth Apparatus Co., Syracuse, N. Y.
- Quartz Glass**
 Bausch & Lomb Optical Co., Rochester, N. Y.
 Braun Corporation, Los Angeles, Calif.
 Braun-Knecht-Heimann Co., San Francisco.
 Brown Instrument Co., Philadelphia, Pa.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Engelhard, Chas., N. Y. C.
 Greiner Co., Emil, N. Y. C.
 Griebel Instrument Co., Carbondale, Pa.
 Hanovia Chemical & Mfg. Co., Newark, N. J.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Thermal Syndicate, Ltd., The, N. Y. C.
 Thomas Co., Arthur H., Philadelphia, Pa.
- Radium**
 Denver Fire Clay Co., The, Denver, Colo.
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 Hell Chemical Co., Henry, St. Louis, Mo.
 Palo Company, N. Y. C.
- Reagent Bottles**
 Central Scientific Co., Chicago, Ill.
 Eimer & Amend, N. Y. C.
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 Scientific Materials Co., Pittsburgh, Pa.
 Whitall Tatum Co., Philadelphia, Pa.
- Reagents—Chemical**
 Baker & Adamson Chem. Co., Easton, Pa.
 Baker Chem. Co., J. T., Phillipsburg, N. J.
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 Braun-Knecht-Heimann Co., San Francisco.
 Central Scientific Co., Chicago, Ill.
 Daigger & Co., A., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 Griebel Instrument Co., Carbondale, Pa.
 Hell Chemical Co., Henry, St. Louis, Mo.
 Merck & Co., N. Y. C.
 Palo Company, N. Y. C.
 Powers-Weightman-Rosengarten Co., Phila., Pa.
 Sargent & Co., E. H., Chicago, Ill.
 Scientific Materials Co., Pittsburgh, Pa.
 Thomas Co., Arthur H., Philadelphia, Pa.
- Recording Instruments**
 Braun-Knecht-Heimann Co., San Francisco.
 Brown Instrument Co., Philadelphia, Pa.
 Central Scientific Co., Chicago, Ill.
 Denver Fire Clay Co., The, Denver, Colo.
 Eimer & Amend, N. Y. C.
 General Electric Co., Schenectady, N. Y.
 Hell Chem. Co., Henry, St. Louis, Mo.
 Hoskins Mfg. Co., Detroit, Mich.
 Palo Company, N. Y. C.
 Scientific Materials Co., Pittsburgh, Pa.
 Taylor Instrument Cos., Rochester, N. Y.
 Thwing Instrument Co., Philadelphia, Pa.
- Recording Instruments (For Pressure, Temperature, Etc.)**
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 Denver Fire Clay Co., The, Denver, Colo.
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 Hell Chem. Co., Henry, St. Louis, Mo.
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- Reduction Kettles**
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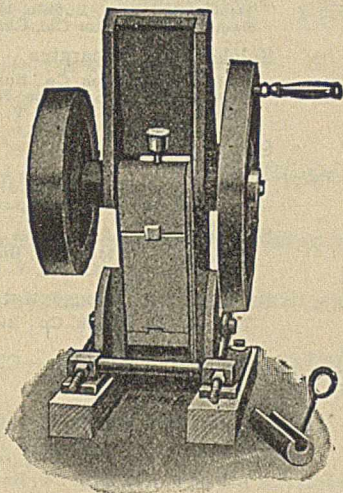
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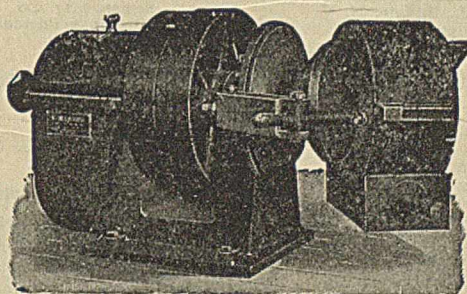
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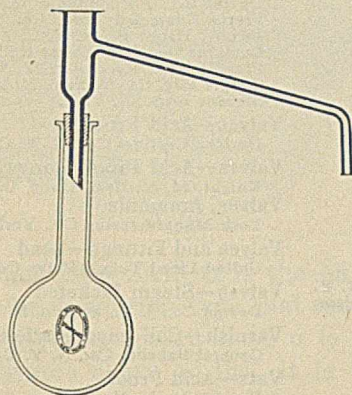
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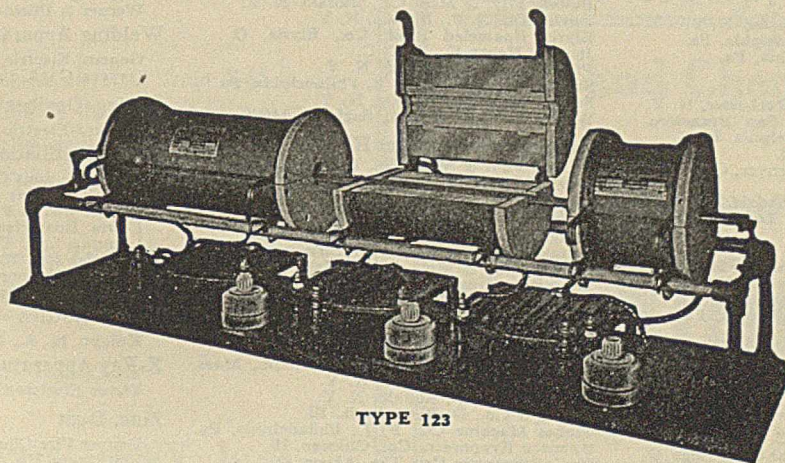
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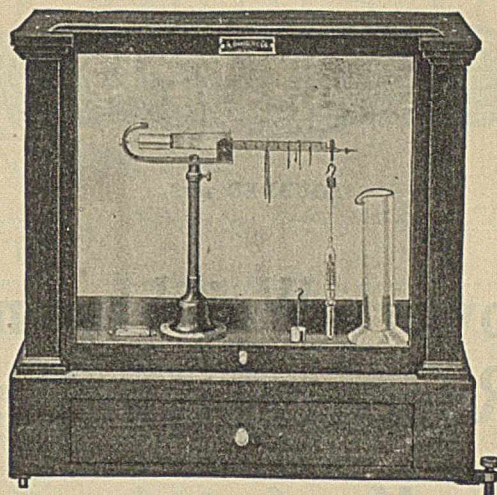
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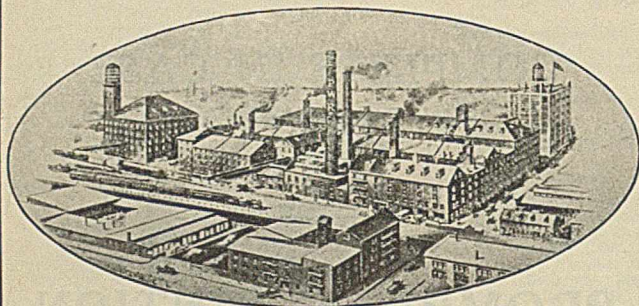
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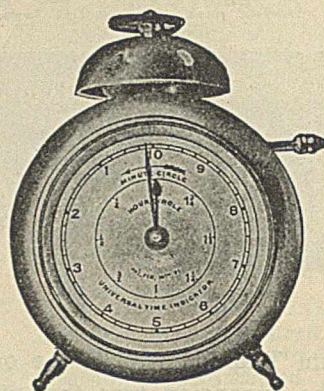


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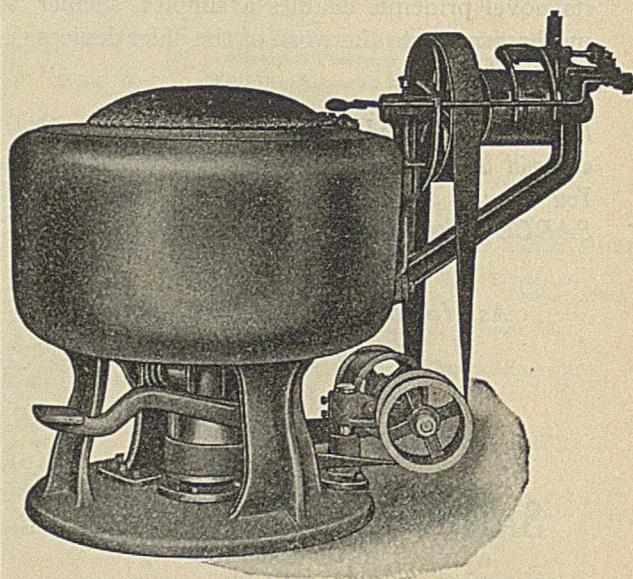
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